Disclaimer

This summary contains information in a very condensed form. Its purpose is by no means to replace official airplane manuals or approved training or operational documentation. It is solely a private compilation of information and hints earned in different training, refresher and instruction situations and flight duties. Please note that no distinction is made here between information that is mandatory and therefore shall be adhered to; and other information which is of a more facultative nature and thus by no means compulsory. Originally written to cover the EMB-145LR, it has been augmented with the EMB-135BJ Legacy variants and different operating procedures, and finally completed to cover all ERJ 145 family members, be it the EMB-135/140/145(XR) and the EMB-135BJ Legacies 600/650. However, it can neither be guaranteed that all differences have been taken care of nor that the text is up to date. Note that the Embraer Legacies 450/500 (EMB-545/550) are not covered as they do not belong to the ERJ 145 family.

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1. TECHNICAL

2-00 LIMITATIONS

Operation		Area of operation		60°S .. 80°N	
		Extended overwater ops		**120**min	

Masses	[kg, NM]	135LR	140LR	145LR	145XR	600	650
	MTOM	20'000	21'100	22'000	24'100	22'500	24'300
	MLM	18'500	18'700	19'300	20'000	18'500	20'000
	MZFM	16'000	17'100	17'900	18'500	16'000	16'400
	Pax	37	44	48-50	48-50	13-16	13-16
	Range	1'750	1'650	1'550	2'000	3'400	3'900
	Cargo capacity			1'200kg		454kg	
				≤400kg per section		≤390kg/m²	
						tighten if ≥125kg/m²	

Speeds	Min SPD OEI **incl. icing**	v_2	(T/O safety SPD)
	Final T/O segment, clean	v_{FS}	(SE best ROC)
	Final APP, LDG config	v_{APP}	
	Min SPD 50ft over threshold	v_{REF}	= **1.3v_{S0}** = **v_{APPCLB}**
	OEI G/A, F9, gear up	**v_{APPCLB}**	= v_{REF}
	Gear retraction	v_{LOR}	200KIAS
	Gear extension	v_{LOE}	250KIAS = v_{LE}
			max 3000ft in icing conditions
	Flaps extension	$v_{FE\ \mathbf{9/18/22/45}}$	**250/200**/200/**145**KIAS
		$v_{FE\ \mathbf{45}}$	**160**KIAS (650)
		ALT_{FE}	max **20'000ft**
	Manoeuvring speed	v_A	**200**KIAS
	(full aileron and rudder deflection protected)		
	Best angle of climb	**v_X**	≈ **v_{FS}**
	Best rate of climb	v_Y	**210**KIAS / AOM
	Clean speed	v_{Pclean}	**180 / 200** (ice) KIAS
	(30° bank protected;	v_{P9}	**160**KIAS
	flap manoeuvring speeds)	v_{P22}, v_{P45}	**140**KIAS
			(150 w/F22 after ice)
	Turbulent air speed	v_{RA}	**200**KIAS ≤ 10'000ft
			250KIAS > 10'000ft,
			then M **0.63** if lower
	Max operating speed	v_{MO}	**250**KIAS < 8'000ft
			300KIAS (650)
			320KIAS > 10'000ft
		M_{MO}	0.78 (145)
			0.80 (135BJ)
	A/S after T/O / during		
	climb without **retrimming**	max	**160**KIAS
	Direct vision window remove	max	**140**KIAS
	Hydroplaning speed	T/O	113kts
	(typical)	LDG	97kts
	Taxi speed	recomm.	30kts dry straight
			10kts dry turns
			10kts wet/cont strght
			5kts wet/cont turns
	Min control speed	$v_{MCA/L/G}$	112 / 105 / 101KIAS

ALT	Max ALT	FL**370** (145), FL**410** (135BJ)
	YD disengaged	FL350 (> M 0.70)
	Max airport ALT	**8'500**ft

Temperature		Temp **above FL250** is limited to **-45°C TAT**
		FL410: Min **-65°C SAT**
		Qualified maintenance inspection after **LDG below -40°C**
		No temp limitation for anti-icing system automatic operation

WND	**XWND**	**30**kts	**dry / wet RWY** recommended
		25kts	**compacted snow** or for **CAT II**
		20kts	**standing water / slush**
		15/11kts	CAT III (AEO/OEI)
		10kts	**ice (not melting)**
		"Critical engine": On luv side (for XWND LDG)	
	TWND	**10**kts	
		5kts	for steep APP (max. **5.5°**)
	HWND	**60**kts	
		23kts	CAT II
		25kts	CAT III
	Parking	If WND ≥ 65kts	Shelter in hangar

RWY		Paved; Slope	**-2% .. +2%**

Airframe contamination		T/O: No frozen contamination on wing upper surface; underwing max 3mm frost layer

Structural	Pitch limitation	max ANU	**20°** up to 3000ft/MAA
	Load factor	Flaps 0	-1.0 .. +2.51g
		Any flaps	0.0 .. +2.0g

2-01 AIRPLANE DESCRIPTION

Dimensions		135	140	145	145XR	135BJ
	Wingspan	20.04m	20.04 m	20.04m	21.00m	21.17m
	Length	26.33 m	28.45m	29.87m	29.87m	26.33m
	Height	6.76m	6.76m	6.76m	6.76m	6.76m
	Turning radius	14.94m (nose covers wing tips)				

Probes		Pitot/static **3**: For **ISIS** and **cabin** pressurization CPAM
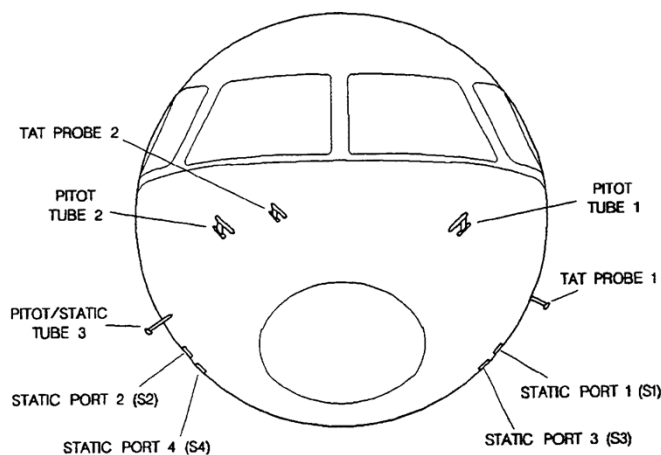
Antennas		ELT: RH ceiling panel of lavatory. Antenna: On top of fuselage
		TCAS: Directional antenna on top, omnidirectional at bottom
Cockpit		Circuit breaker panel, overhead panel, glareshield panel,
		main instrument panel, consoles, control pedestal
		2 cockpit windows, can be opened from inside and outside
Doors		2 overwing exits, can be opened from inside and outside (MC)
		Baggage door cannot be opened from inside
		135BJ: No service door
Hatches	Fwd	Cockpit underfloor access hatch door
	LH	**Battery** compartment
	RH	**Hydraulic** compartment
	Aft LH	Rear electronic compartment door (rudder servo, cables)

2-02 EQUIPMENT AND FURNISHINGS

Operator specific. - Toilet on 135BJ: 6l "blue water"

2-03 EMERGENCY EQUIPMENT

Operator specific.

2-04 CREW AWARENESS

EICAS		**DAU**s provide each 2 channels; select channel B via DAU button on
		reversionary panel on center pedestal
		DAU deliver messages to IC-1 and IC-2 and to the RMU
	DAU-1	Front part of A/C systems, ENG 1
	DAU-2	Rear part of A/C systems, ENG 2
	PFD "CAS MSG"	#messages disagree between IC-1/2
	Inhibition logic	T/O When crossing v_1-15kts until RA>400ft or CAS<60kts or after 1min
		LDG 200ft RA until on GND for ≥3sec or after 1min
	Backup display	on RMU if SG fail. Selections on the RMU can be done as before, but 20sec
		after last selection backup EICAS is displayed again
		TEST button on display controller with WOW and A/S<50kts:
		EICAS invalid display
Stall protection	Components	SPC, AOA sensor, stick shacker, stick pusher
	Inputs	2 channels, from IRS, ADC, flaps, spoilers, LDG gear, ice detection,
		W/S detection, RA
	SPS	Light is on after power-up, remains on after unsuccessful test
	Stick shaker	May be activated at 1.0 .. 1.13 v_S
	Stick pusher	Is activated at or below 1.0 v_S
		Inhibited if: Quick **disconnect switch** pushed or cutout switch
		pushed, below 200ft RA, RA failure, until 10sec after T/O,
		below 0.5g, above 200KIAS, SPS advanced
		Activation needs agreement of both stall protection computers
	SPS advanced	AOA disagree, flaps/spoilers disagree, SPC/ADC/IRS fail

EGPWS		Includes windshear detection and escape guidance function	
	Updrafts	**MC**, yellow WINDSHEAR on PFD, 1x "Caution windshear"	
	Downdrafts	**MW**, red WINDSHEAR on PFD, 3x "Windshear"	
		Escape guidance mode by pressing **G/A buttons** (<1500ft)	
		Windshear mode does not stop at ASEL ALT	
	Inputs	IRS, ADC, SPS, RA1	
	Outputs	Both IC600 (2 PFD, EICAS for WINDSHEAR INOP), AWU	
		'E': Terrain DB. Red: 30sec. Yellow: 60sec.	

	Mode I	Excessive descent rate	"sink rate", "pull up"
	Mode II	Excessive terrain closure	"terrain", "pull up"
		IIa Flaps not in LDG configuration	
		IIb Flaps in LDG configuration	
	Mode III	Baro ALT loss after T/O	"don't sink"
	Mode IV	Min terrain clearance	"too low"
		IVa/b/c	"terrain", "gear", "flap"
	Mode V	Excessive G/S deviation (1.3 dots)	"glideslope"
	Mode VI	VIa 10°/30ft .. 55°/≥2450ft	"Bank angle"
		VIb DH	"minimum"
		VIc APP	"500", "200", "100"

	Enhanced	Based on a terrain database
		No warnings when landing 2NM short of the RWY
		Inhibit terrain awareness alerting and display (TERRAIN SYS OVRD) within **15NM** of T/O, APP or LDG when
		- no instrument APP procedure,
		- longest RWY < 1067m / 3500ft, or
		- A/P not in data base

Terrain awareness:

Solid yellow	60sec to impact
Solid red	30sec to impact
Red dots	2000ft above A/C
Yellow dots	1000..2000ft above A/C
Medium yellow dots	500ft below to 1000ft above A/C
Medium green dots	500..1000ft below A/C
Light green dots	1000..2000ft below A/C
Black	>2000ft below A/C

TCAS II		Has priority over instructions from ATC
		Normal range -27..+27, above/below: ±70
		Climb: Above; Cruise: Normal; Descent: Below
	Inner ring	2NM, removed if range above 20NM
	TA	**Inform ATC**, do NOT perform an escape manoeuvre
	RA	**Preventive** ("Monitor V/S") / **corrective** ("Climb, climb now")
		ATC: "**TCAS RA**"
	RA inh	Descent 400ft/AGL, climb 600ft/AGL
	RA DESC inh	Descent 1000ft/AGL, climb 1200ft/AGL
	TA auto	TCAS automatically pops up in case of TA/RA
	TA only	During abnormal situations (**OEI**, ...)
	Test	RMU: Cursor into ATC/TCAS, TST for 7sec

	◊	Other traffic			
	♦	Proximate traffic (within **6.5NM**, **1200ft**)			
	●	**TA**	**35..45**sec	amber	"Traffic"
	■	**RA**	**20..30**sec	red	"Monitor" (preventive)
					"..." (corrective)

Rate of intruder is only indicated if >500FPM

|		
Weather radar		**12"** flat type antenna, tiltable **±15°**
		Avoid storm cells by 5..10NM (recommended: 25NM), divert to luv side
		Adjust tilt regularly (no GND echoes)
	Limitations	300ft from refueling operations
		15ft from personnel or flammables
	Tilt	T/O **8°**, manual tilt selection
		5000ft 5°, for each additional 5000ft subtract 1°
	Operation	Do not switch on if large metallic objects within scan sector,
		(re)fueling within 100ft or GND personal too close to 270° sector
	Colors	Magenta - red - yellow - green - white (turbulence)
	RCT	Rain Echo Attenuation Compensation
		Cyan where further compensation is not possible
	STB	Exit **forced STBY mode** by pressing **4x STB** in 3sec
	TGT	Display a 'T' (on PFD/MFD) if a red level is within ±7.5°
	SECT	Select between ±120° and ±60°

2-05 ELECTRICAL

Batteries		2 NiCad 24VDC **44**Ah. Min **23.5V**. Disconnect if <-10°C
		MW if temp above **70°C** (2 temp sensors, only one used for indication, but both for the MW)
		BATT **charging**: **1 GEN** required
		BATT are not charged with GPU online (even not by APU)
		BATT can only be **loaded if ≥19V** (if below: **exchange**)
		Hot bus 1 powers backup buses
		1 lead-acid 24VDC **5**Ah (**backup battery** for **GCUs**, charged if BACKUP button is in)
	Durations	Power supply in case of elec EMG **40**min (**ESS PWR**)
		Flashlights 45min
		ELT **48**h (121.5/243/406MHz)
		(right ceiling panel of lavatory, antenna on top of A/C. :00..:05 for testing)
		ULB 30 days (37.5kHz)
		EMG cabin lights 15min
		(4 dedicated batteries, recharged by essential bus, 6 static INV converting 6VDC → 130VAC, 450Hz. Come on when ESS DC power is lost. F/A may switch them on regardless of cockpit switch)
		CVR memory 2h
		(**power cut at 5g**. Erasable on GND only with parking brake on)
		FDR memory (solid state) 25h
		(on if red beacon on or A/C airborne)
Generators		Primary elec source inflight. 4 ENG GEN, 1 APU Starter/GEN
		Max load **400A**, except APU GEN above 30'000ft: **300**A
		28VDC. All brushless, except APU GEN
		GEN **1**, **3**: **LH** ENG; GEN **2**, **4**: **RH** ENG
		Online when **N2** reaches **56.4**%
		APU GEN normally supplying DC BUS 2 via central DC bus, but may replace a DC BUS 1 GEN as well
		Online **7**sec after **95**% RPM
		GND: Air cooled. Inflight: Via naca air inlet.
	GCU	GEN control, system protection, BIT
		Voltage regulation, line contactor control, parallel operation, current limiting (400A)
		To reset GCU: Cycle GEN button

(subject to variant-specific changes)

GEN 1 / GEN 3 / APU GEN / GPU / GEN 2 / GEN 4

CENTRAL DC BUS

SHED DC BUS 1
- COCKPIT RECIRCUL
- GALLEY OVEN POWER
- NOSE LANDING LIGHTS
- MUSIC
- PRE RECORDED ANNOUNCEMENTS
- READING LIGHTS/ATTENDANT CALL1
- SELCAL SYSTEM

(SBC 1)

DC BUS 1
- AILERON CONTROL SYSTEM 1
- AIR/GROUND POSITION A
- AOA 1 SENSOR HEATING
- BRAKE T° INDIC OUTBD
- CABIN LIGHTING 1
- CMC
- COCKPIT READING LIGHT
- COURTESY/STAIR LIGHTS 2
- CREW PEDAL ADJUSTMENT
- CREW SEAT ADJUSTMENT 1
- EICAS POWER (DAU 1B)
- ELECTRIC FLIGHT IDLE STOP 1
- ELEC BAY COOLING EXHAUST1
- ELEC BAY COOLING RECIRC 2
- EMERG/PARKING BRAKE
- ENG 1 FUEL PUMP 1C
- ENG 1 T/R CMD
- ENG 1 LIP ANTI ICE
- FLAP POWER/CMD 1
- FLOOD/STROBE LIGHTS
- GROUND SPOILER OUTBD
- HYDR ELECT PUMP 2
- HYDR GEN SYS 2 INDICATION
- ICE DETECTOR 1
- INVERTER
- LANDING LIGHTS 1
- LAVATORY FLUSH
- LAVATORY LIGHTS
- LAVATORY SMOKE DETECTOR
- LAVAT WATER DRAIN HEATER
- LOGO/TYPE LIGHTS
- MAIN DOOR CONT 1
- NAV LIGHTS
- OVERHEAD PANEL LIGHTING
- PACK VALVE 1
- PASS CABIN LIGHTS 1
- PASSENGER SIGNS
- PITCH TRIM 1
- PITOT 1 HEATING
- PNEUMATIC HSV 1
- PRESSURIZATION CONT
- SPEED BRAKE
- STATIC PORT HEATING 1
- STROBE LIGHTS
- TAT 1 SENSOR HEATING
- TCAS 2000
- WINDSHIELD HEATING 1
- WINDSHIELD WIPERS SYSTEM
- WING ANTI-ICE SYSTEM
- YAW TRIM SYSTEM

AC POWER

INVERTER 115 VAC

115 VAC BUS
- TCAS II
- GPWS / WINDSHEAR

HOT BUS 1
- EMERGENCY LOCATOR TRANSMITTER (ELT)
- ENG 1 FIRE EXTINGUISHING (BTL A1)
- ENG 2 FIRE EXTINGUISHING (BTL A2)
- FUEL PRESSURE REFUELING 3
- FUEL SHUTOFF VALVES 1
- HYD SHUTOFF VALVES 1

BAT 1

BACKUP ESSENTIAL BUS
- AHRS POWER 1
- DISPLAY PRCS/CONT POWER 1
- DAU 1/2
- EICAS POWER

ESSENTIAL DC BUS 1
- ADC 1 POWER/CONT
- AHRS 1 POWER
- AIR/GROUND POSITION B
- APU BLEED
- AURAL WARNING SYSTEM 1
- BRAKE CMD/CONT OUTBD
- COCKPIT DOME LIGHTS
- EICAS DISPLAY POWER
- IC1 CONT POWER 1
- EICAS POWER (DAU 1A)
- ENG 1 FIRE DETECTION 1
- ENG 1 FUEL PUMP 1A
- ENG 2 FUEL PUMP 2B
- ENG 1 FADEC A POWER
- ENG 2 FADEC A POWER
- ENG 1 STARTING
- ENGs N2 SIGNALS 1A
- ENGs N2 SIGNALS 2A
- FDR MANAGEMENT
- FUEL QUANTITY INDICATION 1
- LANDING GEAR CONT (DOWN OVRD)
- LANDING GEAR NOSE IND 1
- PASSENGER O2 SYSTEM 1
- PILOT/COP AUDIO SYSTEM (INTPH 1)
- PILOTS CLOCK
- PILOTS PANEL LIGHTING
- PNEUMATIC 1 (EBV 1)
- RAM AIR DISTRIBUTION
- RMU 1 POWER/CONTROL
- RUDDER CONTROL SYSTEM 2
- SPS (SHAKER 1/CHANNEL 1)
- VHF SYSTEM 1

BACKUP BUS 1
- AHRS POWER 1

AVIONIC ESSENTIAL DC BUS 1
- ADF1
- VOR/ILS/MB 1

AVIONICS MASTER 1

AVIONIC DC BUS 1B
- FLUTEFONE
- *FMS SYSTEM DATA LOADER
- FMS SYSTEM COMPUTER
- FMS SYSTEM CDU
- RADAR SYSTEM
- TDR 1 POWER/CONT
- VHF SYSTEM 3

AVIONIC DC BUS 1A
- AUTOPILOT 1
- DME 1
- MFD2 POWER
- *MLS 1 POWER/CONT
- PFD1 POWER
- RADIO ALTIMETER 1

SHED DC BUS 2
- CABIN RECIRCULATION
- FLASHLIGHT
- GALLEY
- GALLEY COFFEE MAKER POWER
- READING LIGHTS/ATT CALL 2/3
- TAXI LIGHTS
- WINDSHIELD HEATING 2

(SBC 2)

DC BUS 2
- ADC POWER/CONTROL 2
- AHRS POWER 2
- AILERON CONT SYSTEM 2
- AIR/GND POSITION C
- AOA 2 SENSOR HEATING
- AURAL WARNING SYSTEM 2
- BAGAGE SMOKE DETECTOR
- BRAKE T° INDIC INDB
- CABIN RECIRCULATION
- COMPARTMENT LIGHTS
- COPILOTS CLOCK
- CREW SEAT ADJUSTMENT 2
- DEFUELING
- EICAS POWER (DAU 2B)
- ELECTRIC FLIGHT IDLE STOP 2
- ELEC BAY COOLING RECIRC 1
- ELEC BAY COOLING EXHAUST 2
- ENG 2 FUEL PUMP 2C
- ENG 2 T/R CMD
- ENG 2 LIP ANTI ICE
- ENGINE VIBRATION SENSORS
- FLAP POWER/CMD 2
- GASPER FAN
- GROUND SPOILER INDB
- HYDR ELECT PUMP 1
- HYDR GEN SYS 1 INDICATION
- ICE DETECTOR 2
- INSPECTION LIGHTS
- LANDING GEAR DOOR CMD
- LANDING LIGHTS
- OBSERVER AUDIO (INTPH 3)
- OVERHEAD PANEL LIGHTING
- PACK VALVE 2
- PASSENGER CABIN LIGHTS 2/3
- PITOT 2 HEATING
- PNEUMATIC HSV 2
- RED BEACON LIGHTS
- ROLL TRIM SYSTEM
- SENSOR HEATING CONT
- SPOILER INDICATION
- SPS (SHAKER 2/CHANNEL 2)
- SPS PUSHER
- STABILIZER ANTI-ICE SYSTEM
- STATIC PORT HEATING 2
- STEERING SYSTEM
- TAT 2 SENSOR HEATING
- WINDSHIELD WIPER SYSTEM

IC2 CONT POWER 2

HOT BUS 2
- COURTESY/STAIR LIGHTS 1
- ENG 1 FIRE EXTINGUISHING (BTL B1)
- ENG 2 FIRE EXTINGUISHING (BTL B2)
- HYDRAULIC SHUTOFF VALVES 2
- MAIN DOOR CONTROL 2

BAT 2

BACKUP HOT BUS
- APU GENERATION
- DC DISTRIBUTION
- DC GENERATION 2
- DC GENERATION 3
- DC GENERATION 4

BACKUP BATTERY

ESSENTIAL DC BUS 2
- AIR/GND POSITION D
- APU CONTROL
- APU FIRE DETECTION
- APU FIRE DETECTION
- APU FUEL FEED
- BRAKES CMD/CONT INDB
- COPILOTS PANEL LIGHTING
- CROSSBLEED
- EICAS POWER (DAU 2A)
- EMERGENCY LIGHTING CONT
- ENG 1 FUEL PUMP 1B
- ENG 2 FIRE DETECTION 2
- ENG 2 FUEL PUMP 2A
- ENG 2 FADEC B POWER
- ENG 2 FADEC B POWER
- ENG 2 STARTING
- ENGINES N2 SIGNALS 1B
- ENGINES N2 SIGNALS 2B
- FUEL CROSSFEED
- FUEL QUANTITY INDICATION 2
- LANDING GEAR CONT
- LANDING GEAR NOSE INDICATION 2
- PASSENGER O2 SYSTEM 2
- PEDESTAL PANEL LIGHTING
- PILOT/COP AUDIO SYSTEM (INTPH 2)
- PITCH TRIM 2
- PITOT HEATING 3
- PNEUMATIC 2 (EBV2)
- PUBLIC ADRESS
- RMU2 POWER/CONT
- RUDDER CONT SYSTEM 1
- STANDBY ALTIMETER
- STANDBY ATTITUDE INDICATOR
- VOICE RECORDER

BACKUP BUS 2
- AHRS POWER 2

AVIONIC ESSENTIAL DC BUS 2

AVIONICS MASTER 2

AVIONIC DC BUS 2A
- AUTOPILOT 2
- DME 2
- MFD1 POWER
- *MLS 2 POWER/CONT
- PFD2 POWER
- *RADIO ALTIMETER 2
- VHF SYSTEM 2
- TBCH

AVIONIC DC BUS 2B
- *ADF2
- *GPS
- *HF POWER/CONT
- *OMEGA
- TDR 2 POWER/CONT
- VOR/ILS/MB 2

Breaker/contactor labels: BTC 1, BC 1, EBC 1, EC 1, BBR 1, EIC, BTC 2, BC 2, BBC, EBC 2, EC 2, BBR 2

GPU		28VDC (**26..29V**). Does **not charge BATT** For APU start 1600A required, **300A** for maintenance/servicing Has priority over BATT or GEN (cannot be in parallel to GEN)
Buses	EDL	Controls power contactors, fault protection and load shedding
	Central DC bus	To connect APU GEN or GPU to DC buses via BTCs, and to connect DC buses in case of asymmetrical configuration
	GND service bus	Energized if GPU connected but no BATT/GEN online Interior lights, dome, baggage compartment light
	Shed buses	≥4 GEN: Normal operation, two independent networks (DC bus 1; central and DC bus 2)
		≥3 GEN: All buses energized, networks connected via BTC On **GND** only: 1 GEN+**OVRD** to power shed buses Or: GPU to energize all buses
		<3 GEN: Load shedding. Cabin: 'EMER PILOT' illuminated
		SHED BUSES AUTO if GPU online
		SHED BUS OFF **MC** → Check **GPU**
AC power		**115VAC**, **400Hz** through a static inverter (LH nose section) powered by **DC BUS 1** INV does not work on BATT only. MC if <108.5VAC
	Consumers	**TCAS**, **GPWS**, **W/S** detection
Failures	**Electrical EMG**	**Loss of all GENs, only on** (2) **BATT**. Still powered: **ESS DC** buses, **central DC** bus (to start APU), **HOT BATT** buses, **backup EMG** bus, **backup HOT BATT** bus (inner circle)
		→ **no DC BUS**, **no SHED BUS** (no DME depending on A/C configuration), **no AC** power
		→ Max A/S 250kts (nose gear doors could open)
	ESS PWR button	Overrides automatic transfer of the electrical system Connects **BATT directly to ESS buses**
	ELEC EMERG ABNORM **MC**	EDS has transferred to ELEC EMG condition without needing to do so. Check ESS PWR switch is off (out), start APU If APU GEN u/s: **40min BATT power** to land Only "**inner circle**" of displays available: EICAS, RMUs, ISIS
	ELEC ESS XFR FAIL **MW**	Loss of all 4 GENs but **no automatic transfer to ELEC EMG** condition (ESS interconnection contactor did not close) QRH: Press ESS PWR button
	Display units	**PFD** and **EICAS** must always be displayed Reversion of PFD to MFD or EICAS possible via rotary knob Each DU: Two fans and two sensors
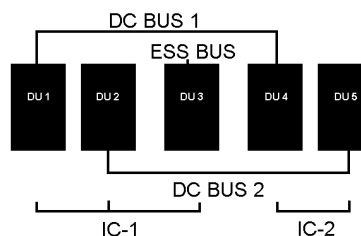
2-06 LIGHTING

Main Lights	TAXI	2, LH on nose gear, wide and narrow angle (only illuminate if gear down)	450W
	WING LDG	2	450W
	NOSE LDG	1, RH on nose gear (gear must be down and locked)	600W
	NAV	3, main and standby lamps, switch at PIC side	
	INSP, LOGO	each side	150W
	ACL	Strobes (3), red beacon (2)	

Other Lights		Nose cone, cockpit underfloor compartment, fwd electronic compartment, refueling/defueling panel, baggage compartment, rear electronic compartment, tail cone
	EMG lights	MC if not armed

2-07 FIRE PROTECTION

Engines		2 single loop detectors (engine accessory region, pylon region) consisting of **16 thermocouples** each ENG, ESS DC bus 1/2 These tubes contain gas, its pressure increases with heat Fire extinguisher halon 1301 bottles (tail cone), hot bus 1/2
	Fire handles	**Fuel** shutoff **Hydraulic** shutoff **Bleed** air shutoff **ENG air inlet A/I** valve shutoff Arm the cartridges → **First rotate outboard**
	Test	Press at least for **2sec**. 3 MW, 2 MC, Bagg comp fan goes off (on GND, if pressed >10sec, APU shuts down) To repeat: Wait ≥6sec If pressed ≤2sec: BAGG EXTG button may remain illuminated
APU		1 single loop detection, powered by ESS DC bus 2 **On GND** (only), **APU shuts down automatically after 10sec, but no fire extinguisher is automatically activated**
	EXTG	APU stop, Fuel S/O close, discharge bottle
	TST	APU shuts down if pressed more than 10sec
Lavatory		Detection system is powered by DC bus 1 Lavatory ceiling: **Smoke sensor** (indicated on EICAS) Fire extinguisher tubes tips (in the lavatory waste compartment) melt at **77°C** (no warning in cockpit), 9 cu inch 120g agent mass (auto discharge into waste compartment). **No indication for fire** in cockpit
	Test	Via smoke detection panel in fwd galley
Baggage Compartment		2 smoke detectors and temperature sensor to trigger BAGG SMOKE MW Button remains illuminated as long as there is smoke **2 bottles**: High rate and metering (re-ignition protection **60**min/ max. 75) Powered by ESS DC BUS 1 **Fan** goes **off** (also if test switch is pressed)

2-08 FUEL

Tanks	[kg]	135ER 145ER	135LR 145LR	135XR 145XR	Legacy 600	Legacy 650
	Wing tank	2 x 2087	2 x 2594	2 x 2594	2 x 2587	2 x 2722
	Fwd aux tank				2 x 900	2 x 900
	Aft aux tank				2 x 670	2 x 670
	Ventral tank			845		821
	Total	4174	5188	6033	8314	9405

	Aux tanks	2 aux tank systems; = 4 aux tanks
	Ventral tank	Between main LDG gear

System

Engines and APU are fed by the wing tanks only
Usable fuel may be reduced by 2x50l if pressure refueled
Unusable: **22**kg, any pump inoperative: **203**kg
Amber warning: 210..400kg (30min)

Density   0.785..0.811kg/l   (1000l ≈ 800kg)

Imbalance   Max **363**kg, MSG disappears if < 45kg
Start XFEED when imbalance ~100kg
When QRH asks for **XBLEED**: Consider **XFEED**
No T/O, LDG and G/A with XFEED!

Auxiliary tanks

AFT TANK (kg): 0, 100, 200, 300, 400, 500, 600, 700, 800
FWD TANK (kg): 0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1000
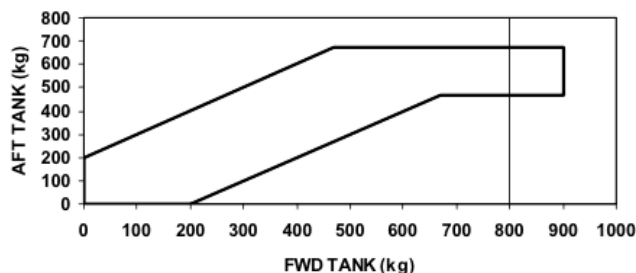
Fuel transfer   FUS 1   From lefthand fwd aux tank 1 to righthand wing tank and from lefthand aft aux tank 1 to lefthand wing tank
FUS 2   From righthand fwd aux tank 2 to righthand wing tank and from righthand aft aux tank 2 to lefthand wing tank
Legacy 650   Aux ventral tank can be transferred to both wing tanks simultaneously

Fuel transfer starts automatically when quantity in at least one wing tank achieves the starting level of 1900kg

Wing fuel pumps   3 centrifugal pumps per wing tank; 1 required (2 for T/O / G/A)
Fuel pumps **A** on respective **essential** DC bus, pumps **B** on **opposite essential** DC bus, **C** on respective **DC** bus
ELEC EMG: No pumps if **C** selected
Failure of 1 pump Remaining pumps alternate
Failure of 2 pumps MC FUEL LO PRESS
Failure of 3 pumps ABC steady indication

Aux fuel pumps   Fwd   **2 pumps** per tank
Aft   **1 pump** per tank plus **cabin air pressure** (>20000ft; "P")

Vtrl fuel pumps   **2 pumps**

Feeding   1. Level off fwd and aft aux tanks (feed fwd into wings 1+2)
2. Fwd aux tank into wing 2,
   Aft aux tank into wing 1 ("clockwise")

Operation   Wait 3sec when switching between FUS1/2
FUS1/2 on   XFER starts if wing ≤1900kg, stops if ≥2400kg
FUS1/2 off   EICAS FUEL XFER CHECK message 7sec after wing ≤1850kg

Indication	7 capacity-type sensors per tank
Mechanical	3 measuring points each wing (first read outboard, if no indication read root, then stub. **Do not add** values)
Ventilation	2 float valves, flame arrestor, NACA air inlet, vent tank
Collector box	Flap valves to keep pump inlets submerged
	Transfer ejector pump keep fuel in box
Temperature	Measured in **LH tank only**
	-40°C .. **+52**°C (FUEL TANK LO TEMP)
	Use **TAT** if fuel temperature sensor U/S
	Fuel without icing inhibitor: Fuel leaving FCOC ≥ 5°C
Freezing point	-40°C (JET-A), -47°C (JET-A1, JP8)
Pressure	**MC** if fuel press < **6.5**psi before FPMU inlet
	Two remaining pumps are energized
	Vent valve opens at 13psig fuel press

Refueling	Pressure **35**..**50**psi
	Drain fuel before refueling or if parked > 2h
	Procedure: BATT on if A/C not energized; WINGS, amount, connect, go, **wait** until valves closed, switch **ON**. Switch OFF. ~ **1**min / 100kg
	No APU start during refueling and **packs off** during refueling

De-Fueling	Pressure ≤4psi. Open de-fuel SOV; XFEED LOW1 for left tank
	If no suction on fuel truck: Fuel pumps on. ~ **3**min / 100kg

2-09 AUXILIARY POWER UNIT

APU	Sunstrand single stage centrifugal compressor, reverse flow annular combustion chamber, single stage radial turbine. Constant SPD gas turbine
	Does not contact in parallel to GPU
	Do **not start** while **refueling**
	Packs off while **refueling**
	Leave on if trip time less than **30min** and **GPU not** included
Fuel filter block	Unfiltered fuel flows through **bypass valve** to fuel pump
APU GEN	Starter/generator. 28VDC, 400A (**300A above 30'000ft**)
	On **DC bus 2** via **central bus**, but will replace any other GEN
	Elec load: 100% up to 39'000ft

Start	With **GPU**, with **BATT 2**, or with BATT 2 **assisted** by GENs
	Starter power from BATT bus **2**, BATT bus 1 is disconnected, supplying the avionics. Start with GPU requires **1600A** (300A for maintenance/servicing). Consider no APU start out of GPU because there is no AMPs indication
	APU **bleed** must be **closed** prior APU start
	Packs on after **3min**
ESU	Ignition at **0%** (inflight) / **3%** (on GND) RPM
	FF at 15%. Starter disengagement at 50% and ignition exciter de-energize at 70% RPM. **Online after 95% and 7sec**

Stop	Via STOP button; ESU sends **overspeed** signal
	APU **bleed on while stopping** APU
	Switch **off** when **≤5%**
Auto shutdown	GND only: Fire (**10**sec delay), overtemp, bleed valve opening, low oil press, high oil temp, oil press switch short, loss of EGT
	GND/inflight: over-/underspeed, failure to start/accelerate/light, loss of speed data, external short, loss of ESU signal, ESU failure

Limitations	Rotor speed	MW if > **108**% or ≤ **95**% (**auto shutdown**)
		(green: 96..104, amber: 0..95/105..110) (Display: OFF if less than 10%)
	EGT	Start EGT max **884**°C (925°C for 10sec above 25'000ft)
		Continuous **680**°C (**717**°C for 5min)
		(732°C for 3sec for APU assisted inlight ENG start)
	APU oil	MC if < 6psi or > **166**°C
	APU fuel	MC if < **6.5**psi
	Start limitations	Min BATT **23.5**V and **-20**°C. No APU start when **fueling**
		Max ALT 30'000ft (min -54°C up to FL250, then -30°C)
		TWND 34kts
	Starter	Max 15sec on
		Between 3 attempts: 1min off
		Between 2 series of 3 attempts: 30min off
	Pneumatic	APU bleed on after ≥**3**min warm-up
		Max ALT for bleed air: 37'000ft

2-10 POWERPLANT

Engine   Rolls Royce / Allison AE3007A1E, 2 x 8169lbs T/O thrust
High bypass, 2 spool axial flow turbofan, single stage fan driven by **3** stage **low** pressure turbine, **14** stage axial flow **high** pressure compressor gas generator (with inlet guide vanes and 5 variable-geometry stator stages) driven by 2 stage high pressure turbine. Pneumatically started
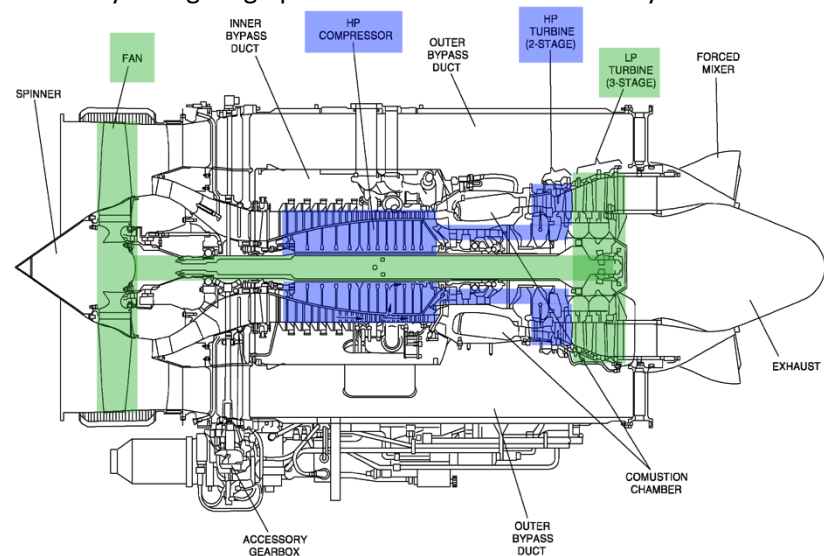
Green: Fan (N1)   Blue: Compressor (N2)
1-stage low press compressor   14-stage high-press compressor
3-stage low-press turbine   2-stage high-press turbine

Variants		135, 145	145LR, early 600	145XR, late 600	650
	Type	AE3007A1A	AE3007A1P	AE3007A1E	AE3007A2
	Thrust	3365kg	3705kg	3996kg	4208kg
	Modes	ALT-T/O-1	ALT-T/O-1	ALT-T/O-1	ALT T/O-1
		T/O-1	T/O	T/O	T/O
			T/O (RSV)	E-T/O	A2 TO
			ALT T/O-1	E T/O (RSV)	A2 TO (RSV)
			CON	T/O (RSV)	T/O (RSV)
			CLB	ALT T/O-1	ALT T/O-1
			CRZ	CON	CON
				(E) CLB	(A2) CLB
				CRZ	CRZ

Fuel System		FPMU, FCOC, CVG actuators, FF meter and fuel nozzles
	Routing	Tank - Centrifugal pump (increases pressure) - FCOC - Filter assembly (with a bypass if blocked) - High pressure pump (with overpressure relief valve) - Fuel metering valve (constant 70psi, excess is returned to gear pump inlet; operated by dual coil torque motor) - Fuel flow meter - Fuel flow nozzles - Combustion liner
	Fuel SOV	will remain in last position if contact to FADEC is lost

Oil System		For cooling (main purpose) and lubrication
	Components	Oil tank, lube and scavenge pump, oil filter, ACOC, FCOC, sumps
		In case of blockage: Oil filter **bypass valve** opens
	Quantity	**6**..14qts (green range; amber below)
	(MFD T/O page)	in oil tank
		Min dispatch — 8qts
		Min ENR — 6qts
	Temperature	**40°C .. 126°C** (at FCOC)
	(EICAS)	(green range: 21°C .. 126°C)
		-40°C — min temp for start
		21°C — min temp for T/O thrust
	Pressure	34..95psi — if N2 < 88% (green range)
	(EICAS)	50..**95psi** — if N2 ≥ 88%
		96..**155psi** — for max **2min**
		95psi (red range) — if oil temp < 21°C, only idle
	Quality	Impending bypass sensor;
		E1/2 OIL IMP BYP advisory message

Engine Components	AGB	Driven by **HP** spool (N2 shaft)
		Drives **FPMU** (centrifugal and gear pumps), **PMA**, **oil pumps**, **hydraulic pump**, **generators**, **pneumatic starter** (6)
	CVG	To prevent engine stall at low speed conditions
		Driven by servo fuel pressure from FPMU, controlled by a dual coil torque motor (commanded by FADEC)
	PMA	Primary electrical source for engine control
		Supplies **FADEC** (> **50% N2**) and **igniter** (> **10% N2**)
		(two coil windings) (else: ESS DC)
	Ignition system	2 ignition exciters, 2 high tension igniter leads, 2 igniter plugs
		FADEC A — Bottom igniter
		FADEC **B** — Top igniter (prefer if wet)
		OFF — No IGN, no FF (for motoring)
		Heavy turbulences: Switch ignition to ON (both IGN come on)
	ATS	Components: Air inlet assembly, impeller turbine, reduction gear set, clutch assembly, output shaft. Controlled by SCV
	Thrust reversers	3 locking systems to avoid inadvertent inflight deployment
		Electrically commanded/controlled,
		1, 2: hydraulically powered; 3: electrically powered
	FADEC	Dual lane FADEC (A, B), one in hot spare mode (stand-by)
		Initially powered by ESS DC bus, at 50% N2 by PMA
		FADEC controls FPMU (FF and CVG) and IGN
		Indication: A/B (FADEC), IGN A/B (IGN exciter)
		RESET — Reset the fault buffer
		ALTN — Automatically prior ENG start to other FADEC, not the one that attempted last GND start
		Inflight restart: FADEC in control will command own ignition ON and request other FADEC to command ignition ON too

Start		
		First start **RH** ENG. BAGG door must be closed
	Sources	**APU** bleed, **ENG** bleed, **GND** source (hatch near RH ENG)
	Sequence	N2 ($\rightarrow$ oil pressure) $\rightarrow$ IGN $\rightarrow$ FF $\rightarrow$ N1 $\rightarrow$ Light up

14% N2		IGN (if AUTO or ON)
31.5% N2 / **12sec** after IGN		**FF, after max 10sec ITT↑**
54..57% N2		IGN off
Stabilized		N1 **2**4, ITT **4**xx, N2 **6**4

	Motoring	IGN OFF $\rightarrow$ No FF, no IGN exciter - dry **motoring** possible
		After motoring, to STOP, then START again
	X-bleed	First start **LH** ENG. Requires ~**80% N2**. Close ENG bleeds (SOPM 2-63)
	LPU	SOPM 2-65
	Airstart	Check if ENG is eligible to being restarted (not if **N1/N2 zero** or **no ENG oil** - N2 could read zero below 160KIAS)
		Both IGN come on (FADEC requests other FADEC to ignite)
	Abort start if	**No N1/N2** acceleration to stable idle speed (hung start)
		N1 rotation is not confirmed or decreases
		No N2 increase **within 5sec** after START
		ITT rises rapidly towards or <u>approaches **800**°C</u> (hot start)
		Oil pressure stabilizes below minimum limit
		Intermittent elec/pneumatic or starter malfunction before starter diseng
		Abnormal noise, vibration, fire or smoke
		$\rightarrow$ ABNORMAL ENGINE START checklist
	Warm-up	Idle during **≥ 4min** for cold engines (off for >**90**min)
		≥ 2min for warm engines
		N2 above 83% only if oil temp ≥ 40°C, or
		run for 8min or complete a static run-up to 88% N2, oil pressure ≤ 83psi
	Spool-up	From idle: Up to 8sec
	Cool-down	**1min** <u>at idle</u> before shutdown

Thrust ratings		
	T/O-1	Max **5min**
	ALT T/O-1	Max 5min. ATTCS armed for T/O-1 if OEI
	GO AROUND	= T/O-1, but different N1, max 5min
	CON	OEI, severe icing, ...
		FADEC selects T/O-1 if T/O mode button is pressed, TL above THRUST SET, FADEC power up or power interruption, T/O-1 mode T/O data selected, gear down and locked below 15'000ft, disagreement between thrust mode selection on each engine for >350msec

Limitations				
		N1	Max 100%	
		N2	Max **102.4%**	
		Starter	1min on $\rightarrow$ 1 min off, after 5th cycle 5min off	
		Motoring	5min on $\rightarrow$ 5min off,	
	ITT	Measured by 16 open-tip thermocouples in 1st stage (LP)		
		ITT	210°C (no motoring needed)	
		Start ITT	max **800**°C	
		T/O	**948**°C (**5min**)	(Legacy: **970**°C)
		CONT	**901**°C	(Legacy: **935**°C)
		Normal ops:	790°C recommended. Accelerate to M 0.65 if higher	
	SE	**Max ALT**	**15'000ft**	
	Vibrations	HP indication	Turbine	max 1.1IPS
		LP indication	Top outer fan	max 1.8IPS
				<2.5IPS Monitor ENG
				>2.5IPS Reduce thrust
		Fan blade icing	ENG LP VIB; N1 max 60% 3..5sec	
		Vibrations on GND in icing conditions: Increase N1 to max. 75% N1		

2-11 HYDRAULIC

System **1**		**Gear**, **steering**, **door**; IB spoilers, OB brakes (more critical system, additional time required for gear operation, no steering on ground) **Priority valve** for flight controls **if on electric pump only** and gear is operated and pressure difference below **2400psi** (e.g. left ENG failure after T/O and gear retraction in a turn) (because of lower EMDP flow)
System **2**		**EMG brake** accumulator charging; OB spoilers, IB brakes
Components		Reservoir, EDP, EMDP, manifold, shut-off valve, filter Both systems have an accumulator
	EDP	**3000psi** **9.2**GPM (100% N2)at engine AGB De-selectable; requires maintenance action to re-engage
	EMDP (stby)	**2900psi** **1.5**GPM intermittently (smaller HYD lines) **0.7**GPM continuously **AUTO mode**: EMDP on if **<1600** ±100psi or **N2 < 56.4%**; advisory MSG
	Brake accumulator	For **6 brake applications**, or min 24h parking brake actuation
	Main door	Hydr sys 1 and accumulator for **4** closure operations If blocked (closing line remains pressurized after door closing / solenoid valve failure; **BLOCKED** inscription illuminates on entrance door panel), actuate alternative opening valve for **2min** clockwise
	HYD shut-off	In case of overheat or a leak
Limitations	Temperature	Thermal switch in reservoir if > **90°C**
	Qty indication	**6l** reservoir > **1l** Green ≤ 1l Amber, advisory MSG
	Press indication	Amber if < **1300**psi (HYD SYS FAIL MC) or > 3300psi

2-12 LANDING GEAR AND BRAKES

System		Hydraulically operated, electrically controlled, mechanically locked **Nose gear doors** are kept closed by HYD pressure **1** Doors of main landing gears are mechanically operated LG/LEVER DISAGREE MW after **20**sec **2 WOW** switches each main LDG gear, **1** on nose gear Nose gear switches for thrust reversers and nose steering
Indications		On EICAS and RMU, ENG backup page 2
	"Gear" if	- Flaps below 22, RA < **1200ft**, 1 TL < 45°, 1 TL < 59°; or - >F22
Controls	LG WRN CUTOUT	To cancel gear warning in case of RA loss
	DN LOCK REL	Mechanically releases gear handle down lock if the downlock solenoid fails (prevents raising the gear on GND). Wait 10sec, check LG AIR/GND FAIL, do not select gear up

Extension	3 ways to extend	- LG **lever** LDG gear electronic unit
		- Elec **override** NORMAL LGEU has control
		        DOORS Open nose LDG gear doors
		        GEAR/DOORS Extend LDG gear
		- **Freefall** lever Depressurizes LDG gear hydr line, releases gear uplocks

Steering		Hydraulically operated, electronically controlled **±71°** with wheel, **±5°** with rudder → max ±76° deflection **Radom** is limiting in narrow turns if steering fully deflected

Brakes

		Carbon brakes. Automatic gear retraction braking function	
		Wear is mostly related to number of applications rather than the energy applied. Do not pump the brakes	
	BCU	**TD protection**	Permits braking only 3sec after TD or when wheel speed 50kts
		Anti-skid	Triggered if Δspeed **30%**. Deactivated below 10kts
			Only relieves pressure (no increase)
			→ **Reduce brake pedal pressure opposite** side of turn instead of applying pressure to the desired side
		Locked wheel	Protection above 30kts
	Hydraulics	System **1 for OB** brakes, system **2 for IB** brakes	
	Parking brake (=EMG brake)	First fully apply pedal brakes, keep it, then set parking brake (to prevent fluid transfer between systems)	
		To release: As well first fully apply pedal brakes	
		Overrides TD protection / anti-skid / locked wheel protection (→ pull slowly, modulate manually)	
		MC if accumulator pressure < 2200psi (max 3700psi)	

2-13 FLIGHT CONTROLS

Trims		Trimming stops after 3sec actuation	
		Pitch trim: 2 systems/motors. Triggers aural warning if > 3sec	
Controls Disconnection		Reset of elevator/aileron disconnection requires maintenance	
Elevator		Only elevator operates fully mechanically	
	Elevator tabs	**Inner spring tabs**, opposite movement at high speeds, neutral at low SPD	
		Outer servo tabs, two-channel HSCU with motors	
Ailerons		Hydraulic. **Left:** Autopilot. **Right:** Roll trim, artificial feel unit	
Rudder		Hydraulic. **System 1 shuts off above 135kts** (**RUDDER OVER BOOST** else)	
		Yaw trim not available in mechanical reversion mode	
		Hardover protection: Mechanical reversion if rudder deflected > 5°±1°, pedal force > 59kg, both ENG > 56% N2 (disabled if OEI)	
Flaps		Double slotted fowlers, electrically driven by **2 motors**	
		FLAP LOW SPEED if FECU monitors that only one channel works	
		FLAP FAIL if both failed	
		Velocity sensors to detect flap panel asymmetry	
Spoilers	GND spoilers	Deploy if >**25kts** & (TL<30° or N2<56%), **both panels**	
	Speed brakes	Deploy if TL<**50°**, **F0** or **F9**, ob panels only (because of ENG)	
		Shall **not be used below 1000ft**/AGL	
		Leave **hand at control while deployed** (as a reminder)	
	Panels	Inboard	52° deflection
		Outboard	30° deflection
Gust Lock		Electromechanical. Check elevator travel each time after release	
		Wait ≥10sec after release	

2-14 PNEUMATICS, AIR CONDITIONING AND PRESSURIZATION

System	Inputs	Engine **9th** and **14th** HP compressor stage (N2 > 56.4%), APU or GND bleed air source (GND: 40..45psi) 14th stage HSV: At low power settings with A/I on ENG bleed air has priority over APU bleed air

		- White stripe in APU bleed	Button is pressed (⇔ ENG bleeds)
		- OPEN inscription	APU bleed is actually open
		X-bleed AUTO	CBV opens if A/I on or XBLD start selected

	Outputs	Engine starting, air conditioning (ventilation, temperature, humidity reduction), pressurization, wing/horizontal stabilizer/air intake thermal A/I protection
	Fans	RECIRC fan Located at wing root
		GASPER fan Located between cabin and cargo comp
	Pressurization	From forward to aft pressure bulkhead
	PACK	Dual heat exchanger. Pneumatic air conditioning kit
	Valves	High stage valve closes at 45.5 ±2.5psi
	Press sequence	Thrust set (TL > 75°) → descent 450FPM to 0.2psi below, until A/C ALT is lower or until 15min (so return is possible without having to set the panel) LDG: Cabin stays 300ft below (avoids pressure bumps), then climbs at 500..650FPM A/C rate of descent > 200FPM: Depressurization sequence

Indications	Temperature	Bleed air temperature downstream of the precooler
	MC	PACK OVLD if pack outlet > 55psi or compressor outlet > 243°C
		PACK OVHT if pack outlet > 93°C or downstream condenser > 95°C
		ELEKBAY OVTEMP Electronic compartment > 71°C
		MC if ventilation > 71°C
	"CABIN"	if cabin ALT > **10'000ft**

Controls	Temp control	Manual 3 .. 82°C
		Automatic **18 .. 29**°C (default 24°C if knob failed)
	Press control	Pneumatic outflow valve (manual)
		Electropneumatic outflow valve (automatic)
		CAB ΔP **-0.3 .. +8.4**psi, overpressure max **8.6**psi, target **8.1**psi
		(145 / 135BJ: slightly different values)
		Cabin ALT limiter at 14'000ft (valve closes)
	Manual press ctrl	12 o'clock position
	LDG ALT	If no LDG ALT is entered, the system takes 8'000ft
	Dump	AUTO mode Press **DUMP**. **Stops at 14'500ft**
		MAN mode Full up (full open)

Limitations		Max **10'000ft for unpressurized flight**, unless MEA higher
	Single bleed / single pack	**Max ALT with one bleed or pack closed 25'000ft** Exception: If bleed 1 u/s and APU bleed used for pack 1 Consider FF↑, use LRC tables in PIH **Max ALT for SE or single bleed in icing is 15'000ft** If both packs closed, ram air valve opens, providing ventilation
	Left pack	Is automatically **closed if A/I on below 24'600ft**
	Refueling	Packs must be off

2-15 ICE AND RAIN PROTECTION

System	Input	Engine 14th HP compressor stage
		APU bleed is not hot enough to provide flight A/I
	Output	Horizontal stabilizer fed by left pneumatic system
	Temperature	**-40**°C .. **10**°C (SAT)

Operation	Switch on	if **visible moisture** (VIS < 1 mile) and **≤10°C**
	Icing conditions	FADEC reduces maximum available T/O thrust, and gives
		minimum thrust setting (+20%) to ensure A/I as long as gear is
		up → **Do not extend gear above 3000ft/AGL in icing**
	On GND	Select override knob to **ENG**
	ENG AIR INLET	Valves open if - ICE DETECTION TEST to 1/2, or
		- ICE DETECTION OVERRIDE to AUTO and ice detected
		(**any** of the 2 ice detectors), or
		- ICE DETECTION OVERRIDE to ALL/ENG
	WING/STAB	Valves open if - ICE DETECTION TEST to 1/2, or
		- A/C on **GND**, GSPD ≥ **25**kts and ICE DETECTION
		OVERRIDE to AUTO (ice detected; **any** of the 2 ice
		detectors) or ALL, or
		- A/C inflight and ICE DETECTION OVERRIDE to AUTO
		(ice detected; **any** of the 2 ice detectors) or ALL
		Red MW ICE COND-A/I INOP if icing encountered below 25kts
		(will disappear during T/O roll when ≥ 25kts)

Test		TEST switch simulates icing conditions on the respective ice detector
		Must be carried out when icing conditions are prevailing/forecasted
		May be completed **on GND** (**A**) or **in 2 phases** (GND/AIR; **B**):
	A	Prevailing icing conditions: Test on GND, before T/O
		83% N2, ICE DET OVRD ALL, A/I buttons pressed, ICE DET TST 1 (10", <15")
		then 2 (10", <15"), check OPEN inscriptions / ICE DET 1/2 FAIL / BLD 1/2
		LOW TEMP / ICE CONDITION, idle, OVRD ENG
	B	No prevailing icing conditions, not anticipated for T/O / CLB;
		once a day: Test in two phases
		- GND before ENG start: Air cond packs open, APU/ENG bleeds close, A/I
		buttons pressed, ICE DET OVRD AUTO, ICE DET TST 1 (10", <15") then 2
		(10", <15"), check ICE DET 1/2 FAIL / BLD 1/2 LOW TEMP / ICE CONDITION
		- CLB: ENG bleeds open, 2000..23000ft, TAT < 10°C, before entering icing
		conditions, ICE DET OVRD ALL (20"), check OPEN inscr., NO ICE-A/ICE ON

SPS/ICE Speeds		Advisory message; higher stall and approach speeds
		SPS will activate at reduced AOA for F9/18/22
		Can't be reset inflight (on GND: Stall protection test)

Windshield		2 circuits, 1 normal, 1 OVTMP, 1 spare sensor each
		MC at 55°C

De-icing		SOPM 2-75, AOM 1-02-79 (229)
		Trim settings: Full down during de-icing (acc CL)

2-16 OXYGEN

Differences	145	Chemical oxygen generators for passengers
	135BJ	Oxygen cylinders for passengers

Limitations		Minimum pressure for dispatch **1100/1500psi** for 2/3 pilots at 21°C (normal: 1850psi)
		PAX OXY 1730psi
		MC if oxygen pressure < **400**psi (**12**min for pilots+observer)

Operation	Masks	NORM	Oxygen/air mixture (above 33'000ft: Pure oxygen)
		100%	(center position)
		EMERG	Overpress; to clear the mask from smoke. Consider mic cold
	Observer	No "blinker", on/off valve, test/shutoff slide	

Warnings	"**CABIN**"	if cabin ALT > **10'000ft**
		FSTN BELTS and NO SMKG come on

Portable Oxygen **5** cylinders **120l**. Min press **1'500psi**

HI:	**4 l/min**	**30min**	for 1st aid use
LO:	**2 l/min**	**60min**	for walk around

PBE **2** PBEs (**15min**) in cabin, **1** in cockpit

Passengers Masks	Masks are not suited in case of smoke
	(only for decompression; use a wet towel)

2-17 FLIGHT INSTRUMENTS

Primus P-1000

	Inhibit aural	MC - Steer Diseng - MC

ADS		ADC 1 (from static ports 1 and 4) and ADC 2 (ports 2 and 3)
		Static ports 1 and 3 on LH A/C side, 2 and 4 on RH side
	A/S indication	Red .. v_s .. amber .. **1.13**v_{S1g} .. white .. **1.23**v_{S1g}
		Switches to M if > 0.45M
		Trend vector — Situation in **10**sec
		Speed bugs — Removed at v_2 + 42kts / 230KIAS
		Comparison — Amber IAS if difference 5KIAS
		$\rightarrow$ Use lower indication, or PLIs in pitch mode
	ALT indication	Trend vector — Situation in **6**sec
		Comparison Amber ALT if difference 200ft (RVSM req.)
		RA low ALT band below 550ft
	PFD	**FMS** information — **Magenta**
		VHF NAV — **Green**
		On-side pointers — Blue
		Opposite side pointers — White
		CDI opposite — Yellow
	PLIs	Shown if ≤10° between pitch and stick shaker activation
	Limitations	PFD ALT indication — Δ max 50ft
		PFD ALT to ISIS ALT — Δ max 90ft
		HDG tolerance — 6° (12° if bank >6°)

RA		2 systems. 2 antennas each: Lower center and lower rear fuselage
		Connected to EFIS/IC-600, TCAS, GPWS, AWU, SPS
	Range	0..**2500**ft
		Brown awareness tape on ALT indicator if below 550ft
	DH	5..999ft
		Boxed in white if at or below 100ft above DH
		Amber if at or below DH
	Tests	Button on display controller

		First level test	Press for < 6sec (WoW, < 50kts)
		Second level test	Hold ~35sec until all green
		Inflight test	Displays 100 ±10ft

IC-600s	Test	RA 920, RA TST
	AWU	2 channels, channel B activated automatically if A failed
		4 levels: Emergency, abnormal, advisory, information
	NAV	Consider calculation time for CRS homing after new NAV freq
		No DME in ELEC EMER
	IRS	3 ring laser gyros and 3 accelerometers

		Align	Insertion of position (via FMS) is required
			Flashing ALIGN: Wrong LAT/LON entered
			A/C must remain stationary during alignment, no power interruptions
			Max LAT for alignment **78.25°** N and S
			Remaining align time NAV, POS SENSORS, STATUS
		ATT	Quick Attitude/HDG restart (like a free gyro)
		TEST	Only in ALIGN/NAV. Below 20kts, ALIGN.
			After 24sec original state

ISIS	On ESS DC bus 2
	Air data from **pitot/static 3**
	MAG HDG and slip from **IRS 1**

Reversionary		To select offside ADC, ARS or SG (symbol generator)
	SG REV	Changes as well ADC and IRS, and A/P changes CPL

Clock	On ESS DC bus 1 (clock 1) / DC bus 2 (clock 2)
	ET: Shows elapsed time
	Enter flight nr in lefthand clock (connected to CMC/CVR/FDR)

FDR	On ESS DC bus 1. Stores **25**h of data
	With tri-axial accelerometer
	De-energized if longitudinal acceleration >5g
	On if red beacon is on or aircraft is airborne

2-18 NAVIGATION AND COMMUNICATION

FMS *Universal*	*Nearest A/P*	*NAV DTO LIST [PLN LANG]*	
		XTK	*Will be canceled after each WPT*
		Extended centerline	*Via PVOR*

FMS		Honeywell CD-810 / NZ2000
	Tasks	Manage NAV sensors, high accuracy in NAV performance, position and guidance calculation
	Functions	Navigation, flight planning, data base, lateral and vertical navigation, performance, NAV display on EFIS
	Components	2 CDU (keyboard, CRT display, annunciators), 2 NAV computers (forward electronic compartment; for position computation and flight planning), 2 FMS configuration modules (forward electronic compartment), data loader (PIC side), FMS joystick
	Databases	Navigation, custom, aircraft, maintenance
	Dual FMS	4 modes (FMS Maintenance page):
		- Dual mode: Autotransferring active FPL, performance, pilot defined WPT, stored FPL, offside radio commands
		- Initiated XFER: Active FPL and performance on command
		- Independent mode: Autotransferring offside radio commands
		- Single mode: No data XFER
	Priorities	for sources for position determination: GPS, DME/DME, VOR/DME, IRS
	Messages	Alerting ("MSG" also on PFD) / Advisory (only on FMS panel)
		Message is displayed on scratch pad
		Clear with CLR (can**not** be recalled)
	MFD Buttons	NAV-APT (NavAid / Airport), DATA (WPT identifier), JSTK, SKP (skip), RCL (recall, set designator at A/C position), ENT
	Displays	Long range source, WPT data, wind vector, drift bug, WPT, lateral deviation, navaids, airport, designator bearing, range

		Colours		
		Vertical navigation	Cyan	
		Lateral navigation	**Green**	
		From	Yellow	
		To	Magenta	
		Prompts, titles	White	
		Flight plan names	Orange	
		Atmospheric data	Cyan	

	Initialization	Fast down alignment **1min**. NAV, ALIGN, insert POS, NAV
		DME must be out of hold
	1h on GND or error > 2NM	Do a fast alignment (do not move A/C, (un)loading is ok).
		If A/C is moved during alignment (takes 5..10min), IRS restarts 30sec after motion stopped. If ATT is selected inadvertently, make a new alignment
	FMS pages	NAV Tune: NAV-Tune. Auto Tune: Displayed in magenta
		NAV Ident: Default page. Active NDB (NAV DB). Possible to change on ground only
		POS Init: 3 methods to initialize: Load last POS; define and load reference WPT; **load GPS POS**.
		Maintenance: FMS mode, list of failed sensors / history, TRUE or MAG mode
		Data Load: Up-/download. NDB: Update every 28 days

Sub	PERF	Performance calculations: 3 modes: Current GS/FF (with default G/S), pilot SPD/FF (pilot entered), **full performance** (based on pilots' selection and learned values). Certain pages are only available in last mode
		Fuel reserve: NBAA considering DEST to ALTN but minimum 200NM and 30min at 5000ft
		What-if and stored flight plan (to estimate fuel for next flight) functions
		Fuel management and single engine
		FF: PERF - NEXT - FUEL MGT - NEXT
		FMS is **not linked to FF meters**
		LDG mass: PERF - PERF DATA - NEXT
	NAV	FMS considers A/C inflight if G/S above 50kts or above 80kts IAS of WOW
		Following entries cannot be made: Temporary WPT, SID, Alternate FPL with DEST, another stored flight plan
		ATIS: NAV - DATALINK - ACARS - RETURN - ATS MENU - ARRIVAL/DEPART - REQUEST
		NAV - NEXT - CROSS PTS - PT **ABEAM**
	PROG	DIST/ETE/FUEL to DEST or WPT
		Page 3: Offset can be entered (L/R...)
		Navigation DB (VOR frequencies) on PROG page
		T/O time: PROG - NEXT - FLT SUM
		Autotune: PROG - DEL - TUNE

GPS STATUS		RAIM	Receiver autonomous integrity monitoring
			Predictive RAIM (yes/no at point/time)
			"/ETD" on FPL, NAV - POS SENSORS - NEXT - GPS STATUS - PRED RAIM
		FOM	Figure of Merit
		H/VDOP	Horizontal/vertical dilution of precision

Patterns		Hold **H**, Flyover **F**, Procedure Turn **P**
		Holdings over a fix: To remove, DEL, then LSK
		Turn left **L**, turn right **R**
		1min over fix: Exit Hold prompt appears
GND Operation		Check NDB date
	POS INIT	Reference WPT: Ramp WPT or A/P WPT within 3NM is chosen. Otherwise enter Reference WPT. Positions are not transferred, so
		both FMS have to be initialized
	PERF	Initialize fuel reserve data, transition ALT and CRZ ALT, WND, Temp, speed restrictions, weights
		Climb 270 / 0.65
		Cruise 290 / 0.76
		Descent 290 / 0.76 / 3.0°
	FPL	Activate DEP RWY, SID, Transition
		Within 200NM of DEST: Arrival prompt appears. Within 25NM of DEST: Alternate prompt appears
		Before: Enter via NAV page
		Check **no discontinuity**, connect to **ALTN**
	After LDG	Flight summary page appears
		Can be cleared when prompt appears after 30sec

ENR Operation	Information about airports: NAV, DATA BASE	
Patterns	Press DIR / or NAV - NEXT - PATTERNS	
SLOP PROG 3/3 - OFFSET		
Holdings	Insert latest 5NM before fix	
	Delete hold: DEL, LSK	
APP	During APP, MISSED APRCH prompt appears; will display MAP on MFD	
Sensor fail	IRS will be used as a reference (degraded mode)	
	De-select sensors: POS SENSORS page (DEL, LSK)	
Pt insertion	LAT/LON, P/B/D or P/B/P/B (place bearing distance)	
	Postfix "T" for true bearings	
	x NM prior to a point Pt // x	
	[First WPT "."] AWY name "." last WPT	
Diversion	On FPL, change DEST	
Horizontal	Restricted bank on direct-to turns towards points that are not on the flight plan, but ≥ 30° off	
Vertical	FLx y NM before PtPt // y / x	
NDBs	xx**NB**	
	ADF standby frequency: First stby, then actual freq	
Edit	- PREV, then PREV/NEXT/CLR/DEL	
Del scratch	- DEL	
Default val	Press **DEL** and the desired LSK	
Tune	**Always tune COM from same FMS**	
Auto tune	NAV, TUNE, DEL, LSK (NAV 1/2)	
Space key	Press twice '/' (CD-820 would have a space key)	
Parallaxis	Type PX.	
Ext centerl	DIR, Pt, DIR, Intercept LSK, Pt, IB CRS, HDG SEL LSK, YES	
	Overlay APP: Both NAV SRC to FMS, RMU to NAV page	
ACARS	NAV - DATALINK - ACARS - PRE FLT - INITIALIZE (DEP, DEST)	
	Flight times: NAV - DATALINK - ACARS - NEXT - FLT TIMES	

HGS	DC bus 1. Fail-passive. BIT - built-in tests. Own built-in IRS.	
Data entry	Threshold ELEV APP chart: **RWY ELEV**	
	RWY LEN 10-9 chart: **Beyond threshold**	
Symbols	Refer to HGS manual appendix A	
PRI	Use **PRI** mode except **AIII** for CAT III APP or	
	IMC to monitor a CAT II APP (no APCH WARN)	
	FGS guidance source, except LVTO submode (when ILS freq is tuned)	
AIII	HGS guidance source. ILS must be captured, within limits for 5sec, diff magn track and detected CRS <15°, RA > 500ft	
	RWY data is displayed for 5sec after AIII mode is selected or whenever values are changed	
NO AIII	APCH WARN if below **500ft**	
G/S	**-2.50° .. -3.00°** for AIII APP	
APP	Speed bug changes to v_{APP} when	
	- RA<**1300ft**, gear down, A/C in air, FD: T/O mode	
	- no WSHR / G/A ("SPD" symbol changes to "VAP")	
	300ft RA **RWY** symbol appears.	
	95ft AGL AIII flare command symbol	
	Below 70ft G/S deviation raw data no longer displayed	
	Below 60ft No RWY edges displayed any more	
	45..55ft AGL **Flare** maneuver	
	35ft **IDLE** message	
	Rollout RWY remaining from touchdown until <20kts	

DAP	ID/VOICE	ID for identification, VOICE (unlatched) to reduce the morse code signal
	ST	Sidetone, to prevent undesirable feedback of speaker into microphone
	MUTE	To control sensitivity or to temporarily mute the marker audio
	EMER	LSP is connected to COM1 / NAV1
		RSP is connected to COM2 / NAV2
		OBS is disconnected
		No intercom
ICU	BACKUP INPH	If normal mode failed. Both CABIN and CAB EMER illuminate
MIC Switch	on yoke	PTT - HOT - OFF
RMU		On ESS DC bus 1/2
		NAV page source is always **NAV 1**
		Can store 12 COM and 6 NAV frequencies
		Dashes when the radio system fails to respond to commands
		Test: Cursor into subsystem, then press and hold TST
TBCH		On DC bus 2
		Alternative mean of tuning COM **2** and NAV **2** if RMU 2 failed
	EMRG	to take control: RMU2 commands are ignored, AUX indication on RMU 2
		NAV AUDIO to identify NAV

2-19 AUTOPILOT

System		Primus P-1000, autopilot and flight guidance
		3-axes autoflight system and automatic pitch trim
		Incorporated in **IC-1**. **Fail-passive FD**
		Hold thumb overhead DISC button when ordering to engage
	Subsystems	2 FD, 1 autopilot (incl. YD), comparison monitor module
		(located in IC-600, can disengage the autopilot)
		Only IC-600 1 has an (enabled) autopilot
	Inputs	ATT, HDG, air data, RA, NAV, pilot inputs
Limitations		Min engagement height (**MEH**) **1000**ft
		Min use height (**MUH**) **160**ft, **80**ft if CAT II
		300ft for non-precision
		Off for **SE GA**, rudder manual reversion, yaw damper engagement with
		rudder in manual reversion, aileron manual reversion
		APP mode selection during LLZ capture only when IB
		G/A in basic modes allowed if wings LVL
Modes	Basic modes	**Roll and pitch**
		Entered when changing CPL, changing NAV source on VOR/LOC/ILS, pitch
		wheel or TURN knobs on autopilot controller, TOGA buttons, invalid
		sensor signals, changing SG or an armed mode is captured
	ALT mode	Maintains barometric ALT at the time of selection
		Entered after ASEL capturing (25ft, <5FPS)
	IAS mode	IAS below **25'000**ft, Mach number if above
		SPD bug is synchronized when engaged
		Does not cancel GS captured mode
	V/S mode	Descent: Brakes rate if approaching red line speed
		(as well valid for FLC in descent)
	GS mode	canceled if GS signal is invalid for >5sec

	FLC mode	Climb speed	FL100 and below	**240**KIAS
			FL120..FL170	**270**KIAS
			FL170 and above	M **0.56**
		Descend rate	FL370..FL120	**-2000**FPM
			FL100 and below	**-1000** FPM

Max acceleration 0.1G, overspeed protected

Difference to IAS mode in climb: **FLC won't descend** to catch up speed

| | G/A | equals ROL-TO. Will level wings |
| | | Transitions to SPD hold if <1.23v_S or 20sec after G/A and >170KIAS |

	Non-prec APP	VOR	APR mode (more accurate)
		LLZ	NAV mode
		NDB	HDG mode

Once LLZ established, bank is limited to 8°..10°

| | Roll mode | Engaged from HDG mode via TCS or TURN knob on center pedestal |
| | | Canceled if bank <6° |

| | **Half bank** | **14°** instead of **27°**. **Only** available **in HDG** mode |
| | | Automatically when climbing through **25'000**ft and cancelled when descending through 24'750ft |

| YD | | Disengages when red button is pressed |

| A/P Failure | A/P, YD FAIL MC | Pull IC-1 CB (3↑, 3→) |
| | | BACKUP BATT off |

TCS		to manoeuvre the airplane without disengaging the autopilot
		When TCS is released:
		- primary servos re-engage
		- new pitch attitude and vertical modes are synced (except in APR mode)
		- lateral control is returned to the previously selected mode

G/A buttons		On GND, <80kts, or <400ft	Put FD into T/O submode (14° ANU)
		During a windshear	Put FD into W/S mode, switch A/P off
		Otherwise	Put FD into G/A mode

2. OPERATIONAL

FLIGHT PLANNING

Planning on GND		**VIS** (not RVR) required at **ETA ±1h**; plus **ceiling for non-prec**
		METAR with NOSIG: VIS is valid for 2h, but RVR is **not**
		If both VIS+RVR is given with a NOSIG, then
		- RVR overrules VIS for current situation
		- VIS however is valid for 2h
		(trend appended to a METAR/SPECI overrules the TAF for that period)
		Snowtam: 2h prior A/D opening; MOTNE: With METAR
	WND	Only consider mean X/WND (w/o gusts)
	VIS APP / Circling	**600ft MDH, VIS 2400m (Cat C** A/C)
	CAT I and NPA	CRVR := f(VIS) acc **conversion table**:
		HIALS/RWY lights x 1.5 (day) / x 2 (night)
		other lights x 1.5 (night)
		no lights / day x 1
		(VIS: Prefix "V"; equal to RVR if no prefix)
		(**not for T/O, CAT II/III , circling**)
	Low VIS T/O	if RVR < **400**m (MIN **125**m, 90m visually [slant range])
		RVR<150m: High intensity runway centre line lights spaced 15m or less apart and high intensity edge lights spaced 60m or less apart; 90 m visual segment that is available from the flight crew compartment at the start of the take-off run; required RVR value is achieved for all of the relevant RVR reportings
		Start T/O roll at threshold (caution: displaced threshold)
	LVP in force	Use **monitored APP**
	T/O ALTN	If not possible to return, considering OEI
		Max 60min OEI CRZ SPD (270kts max CONT)
	No T/O	if moderate or heavy freezing rain
	Closed DEST	2nd ALTN required; calculate with the higher ALTN fuel
	ALTN	Must be open for lower APP category:
		CAT II/III → CAT I → Non-prec → Incr **200ft / 1000m RVR**
	No DEST ALTN	required if **two separate RWYs**,
		CEIL ≥ 2000ft / circling height + 500ft, whichever is higher at
		ETA ±1h and flight time **≤ 6h**
		Add 15min holding at 1500ft for 2nd APP
	Max dist to adequate A/D: 2h @ 333kts (OEI CRZ SPD)	

Inflight		Req Wx **at ETA (no ±1h margin)**
		Ceiling/VV not required (only **VIS**). ALTN must be open
		(no lower APP category req as during planning on GND)
		APP may be started irrespective of RVR when there is a reasonable chance for a success
		APP may be startet, but **continue beyond OM / 1000ft only if latest RVR ≥ RM chart**
		CAT I: Required RVR is **550**m/**125**m/**75**m. CAT II: **300**m/150m
		If RVR drops after having passed OM: Look and see
	A/P	ILS, DH 300ft / RVR/VIS ≥800m May be flown raw data
		ILS, DH 200ft / RVR ≥700m FD compulsory
		ILS, DH 200ft / RVR ≥550m/300m AP, RSP flies, LSP lands
	MDA	Must not be undershoot; **add 50ft**
	DA	Altitude at which the decision to land / G/A has to be taken
	Contact	if at least **3 consecutive lights** in sight (one of which with a central row)

Airports	**Fire fighting**	For DEP/DEST	4
		For ALTN	3
	Class B	Self-briefing airport	
	Class C	SAAA airport	

RWY	Factored LDG distance (for planning)	**DEST**	unfactored x **1.67** for dry RWY
			unfactored x **1.92** for wet RWY
		ALTN	unfactored x **1.67** for both dry and wet RWY
	Inflight	Use unfactored LDG distances (dry) / QRH tables/factor (wet)	
	WED	Slush	0.85
		Wet snow (loose)	0.40
		Dry snow (loose)	0.20
	T/O	Max **8**mm WED	
	LDG	Max **20**mm WED	
	Wet	**Wet if ≥50% shiny and water coverage <3mm**	
	Grooved RWY	May be considered **dry**	
	Contaminated	**≥3mm** (but <13mm)**;** Plan at least with **wet**	
		No ALT-T/O. IGN on	
	BA	**BA unreliable** does not imply a poor BA	

Balanced T/O

T/O dist to 35ft (w/ENG failure at v_1) = ASD (dry RWY)
(by adjusting v_1 within v_{MCG} .. v_R to obtain max TOM)
- Wet RWY: v_1 is reduced to compensate for longer ASD; screen height reduced from 35ft to 15ft, usage of reversers is allowed for ASD
- Reduced acc (deposits, uphill, density ALT, OAT, ... $\rightarrow$ increase v_1) and reduced stopping capability (e.g. slippery, downhill, ... -> reduced v_1, 15ft margin only)
  No v_1 correction if RWY is covered with roll-resisting deposits
- Contaminated RWY: v_R/v_2 are increased for better climb

Unbalanced T/O   Only if **not RWY limited** (2..2.5km)

T/O Segment		Ground roll	v_1 - v_R - v_{LOF}
		1st segment clb	Gear in transit, 35ft at v_2
		2nd segment clb	Up to acceleration ALT (400ft)
		3rd/acceleration	Flaps up
		4th/final segm clb	v_{FS} or 1.25v_S, max cont power, up to 1500ft

Climb Gradient   Indicated on APP chart only if >**2.5%**; then brief OEI MAP

Dispatch	MEL	Minimum Equipment List, for systems, on GND as long as A/C is not operating under own power
		If a system is not listed, then it has to be ok
		After off-blocks **QRH** applicable, not MEL any more
	CDL	Configuration Deviation List
		No time frame given for rectification
	HIL	Maintenance has to transfer tech log entries to HIL
		(or pilot with assistance of maintenance, if pilot is trained)

RVSM		FL**290** to FL**410** (both inclusive)	
		Operator, crew and aircraft must be approved	
		Check blue documents booklet and ATC FPLN (10/equip 'W')	
		MEL: 2 independent primary ALT, 1 A/P w/ALT hold (±65ft), 1 ASEL (alerting deviations >300ft), 1 XPDR w/ALT enc	
		ΔALT GND max **75**ft (in between and compared to known ALT) Inflight max **200**ft	
		XCHK and log on OFP prior entering and **every 60**min	
		ALT changes: Do not over-/undershoot by more than 150ft, Reduce to max 1500FPM the last 1000ft	
		"**Affirm**/negative RVSM" / "**Unable** RVSM **due eq / turb**" / "Ready to resume RVSM"	
	Non-RVSM	**odd**	FL290 FL330 FL370
	Non-RVSM	**even**	FL310 FL350

Jeppesen Charts	MSA	Clearance by 1000ft within 25NM
	MOCA ("T")	Min obstruction clearance ALT. Radio NAV signal coverage only within 22NM from the VOR (⇔ MEA)
	MORA ("a")	Min off-route ALT (grid/route). Obstacle clearance le/ri 10NM by 1000ft (<7000ft/MSL) or 2000ft respectively
	JeppView PLN	24.WOOD1B HELEN HELE1A.27

SWC		WND speeds ≥ 120 kts: ALT of WND is being indicated
		80kts isotachs (from LVL / to LVL)

OFP	Fuel	Trip fuel	3.5kg / NM air
			3.2kg / NM air for longer flights
		Rule of thumb	# kg / 20 = # minutes
			1st hour **1500kg** trip
			2nd hours and ff **1200kg**
		Contingency fuel	5%, or 3% with fuel ALTN
		Diversion fuel	Dest ALTN fuel + company fuel + final res = fuel from MAP to dest ALTN + final res
		Final reserve	15min holding at 1500ft
			Calculate **+20%** for 180KIAS instead of v_{Hold}
		Target: Arrive w/**2000kg fuel** onboard	
		Fuel checks at least once an hour	
	Icing conditions	Climb fuel	Increase by **10%** (ISA or below)
			Increase by **20%** (above ISA)
		Holding fuel Increase by **20%** (ISA)	
	CRZ LVL	Optimum	1.4 x trip NM
		Fastest	Around **FL258**; where v_{MO} **meets** M_{MO}
		Lower LVL	Add **3%** to trip fuel for **each 1000ft**

Loadsheet	**Min fuel**	18'500 - 16'000 = 2500	
		Burnoff + 2500 with full house	
		Taxi/APU	**70**kg
		Trip fuel	DEST with burn-off correction
		a)	ZFM + ramp fuel - taxi/APU
		b)	MTOM/RTOM
		c)	MLM/RLM + trip fuel
		Underload	Lowest of a/b/c - actual TOM

Dangerous Goods		Articles/substances capable of posing significant risks to health, safety, environment, property
		"No Carry Operator" if no approval

Blue Booklet

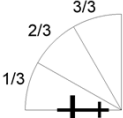EASA Regulation (EU) 965/2012 on air operations, CAT.GEN.MPA.180; customs regulations, OFCOM
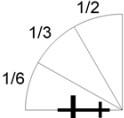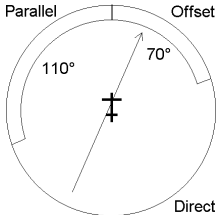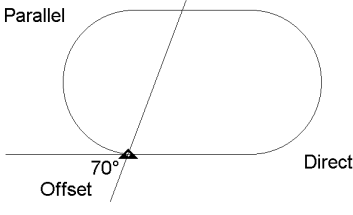Originals of:
- Aircraft flight manual (AFM)
- Certificate of registration
- Certificate of airworthiness
- Noise certificate
- Air operator certificate (AOC)
- Operations specifications
- Aircraft radio station operating licence
- Third party liability insurance certificate
- Journey log
- Technical log
- ATS flight plan, charts
- Procedures and visual signals information for interceptions
  (ICAO Annex 2)
- Information concerning search and rescue (AIP)
- Operations manual (relevant parts)
- MEL
- OFPNOTAMs, briefing documentation, MET
- Passenger/cargo manifests
- M&B

NORMAL PROCEDURES

Manuals	AFM	Certified document, must be strictly applied
	AOM	Additional details of applicable procedures
	SOPM	Proposed sequence of actions with appropriate CRM in order to best cope with the situation

Priorities   **Stall warning** → **EGPWS** → **TCAS**

	FGS	Always follow FD, except TCAS RA, EGPWS hard warnings, or when in doubt about correctness

CRM	MCDU	**Below FL100, PF orders all MCDU entries**. PM enters, PF confirms
	Closed loop	Simplified: PF executes and calls out, PM: "Checked"
		Extended: PF orders, PM executes silently, PF checks silently
	A/P	Below 1500ft/AGL Always one hand at yoke
	Call-outs	"On/Off" or Change of system status
		"Engage/Disengage"
		"**Select**" Including mode change
		"**Set**" Change of a value, but same mode
		"NAV1 … active, CRS …, preset …"
		"Insert" FMS; PM: "Inserted" - PF: "Checked"
		"Select FL ..." PM: "**FL ... armed**"
		"Gear" / "Flaps" Only silent check
		"LLZ / G/S **alive**" But no capture call-out
		Deviations Call out "guidance", "speed" (+10/-5), "sink" (-900FPM), "pitch", "thrust", "LLZ" - PF: "Checked"
		Guarded switches Always need confirmation
	ALT	"CLD FL/ALT ..., STD/QNH, passing FL/ALT ...",
		"CHKD, ±...ft, STBY ±...ft"
		"FL100"
	Handover	*"Ready for handover?"*, "Ready"
		Call out actual modes, "Checked"
		"Your controls", "My controls"
		*"**NAV source** to **FMS**" on (new) PF DCP*,
		CPL AP, "AP on your side"
		Re-engage and call out modes, "Checked"
		*"**NAV source** to **NAV**" on PM DCP*
		TCAS *page on PF side,* **FUEL** *page on PM side*
	Cabin	**T** - ime available
		E - mergency type
		S - ignals to be used
		T - ransmit additional instructions

Areas of Responsibility	LSP	Glareshield panel incl. middle part, control pedestal
	RSP	Overhead panel, RH RMU, RH CDU
	PF	Spoilers
	PM	Gear, Flaps

Lights	NAVIGATION	Whenever A/C is energized
	LOGO	Sunset to sunrise and during low VIS operations
	RED BEACON	When engine(s) running or when A/C is moved
	TAXI (nose)	On GND when moving (together with **parking brake**)
	STROBE	When on active RWYs
	LDG	During T/O / LDG, after **clearance** received, <FL100 / in congested areas
	INSP	For visual wing surfaces inspection

Shoulder Harness		May be removed between TOC and TOD
		Lock in case of turbulence, expected crash, pilot incapacitation

ENG Start-Up		BATT min 24V	
	LPU	Low press unit	AOM 1-02-81 1 01 (273)
	XBLEED	Cross start	AOM 1-02-81 3 01 (275)
		Bleeds closed (non-operating ENG) and open (other ENG)	
		N2 > 80%	

T/O	LSP	Hand on TL until v_1
	Low VIS	Use **T/O-1**
		Start T/O on **green line** (taxi forward if displaced threshold)
	Profiles	v_2+15, when outbound HDG established consider v_{FS}. Acc ALT: 210kts
		NADP-1 / ICAO A: v_2+10 until 800ft (NADP-1) / 1500ft (ICAO A),
		then CLB thrust, maintain v_2+10 until 3000ft, then v_{FS}
		NADP-2 / ICAO B: v_2+10 until 800ft (NADP-2) / 1000ft (ICAO B),
		then CLB thrust, v_{FS} until 3000ft

Climb		Do not use V/S mode for climb (much shorter time until stall after engine failure than with **pitch mode**)
		Good climb performance at **4°..5° ANU**
		When CAB ΔP reaches 7.8psi, select max 1500FPM
	Approaching	**Max 1000FPM** 1000ft before cleared ALT/LVL
	Endurance	**240**KIAS to FL100, **270**KIAS to FL174, then M **0.56 (FLC)**
		(high TWND ENR or climb fast through turbulences)
	High speed	240KIAS to FL100, **290**KIAS to FL216, then M **0.65**
	Climb gradient	e.g. 383FPM: Multiply by [GS]
	Intermediate LVL	Max **240**KIAS ≤ FL100, **300**KIAS > FL100
		Maintain CLB thrust mode
	Cruising LVL Select **CRZ mode** when speed exceeds M **0.70**	

Pitch - Thrust	ISA, 18t, CG 25%	T/O		F9	v_{F0}	14°	T/O thrust
		LVL		clean	180KIAS	5°	59%
		LVL		clean	210KIAS	4°	62%
		LVL		clean	240KIAS	4°	70%
		LVL	30° bank	clean	210KIAS	4°	64%
		LVL	45° bank	clean	210KIAS	5°	68%
		LVL		F9	160KIAS	5°	59%
		LVL		F9	180KIAS	3°	61%
		LVL		F22, gear down	160KIAS	3°	71%
		LVL		F45, gear down	140KIAS	3°	80%
		3° G/S		F9, gear down	180KIAS	1°	64%
		3° G/S		F22, gear down	160KIAS	0°	57%
		3° G/S		F22, gear down	140KIAS	3°	52%
		3° G/S		F45, gear down	140KIAS	0°	67%
	OEI	*LVL*		*clean*	*180KIAS*	*5°*	*75%*
		LVL		*F9*	*160KIAS*	*5°*	*76%*
		3° G/S		*F22, gear down*	*160KIAS*	*0°*	*73%*
		3° G/S		*F22, gear down*	*140KIAS*	*3°*	*70%*

XWND	T/O	SOPM 3-15-05 4	Positive rudder, small control wheel inputs
	LDG	SOPM 3-40 7f	4 Methods (sideslip, crab, de-crab, crab and sideslip)
	WCA	[kts]	

$$XWND = \boxed{++} \times WND \qquad \mathbf{WCA} = \boxed{++} \times WND = \tfrac{1}{2}\, XWND$$

(left diagram fractions: 3/3, 2/3, 1/3; right diagram fractions: 1/2, 1/3, 1/6)

for 120KIAS. At 150KIAS, decrease corrections by 30%, at 90KIAS, increase corrections by 30%

	m/s → kts	multiply by 2

Timed Turns

Bank = $^{TAS}/_{10}$ + 7 for a rate-one turn. 10sec for 30°
(TAS = ½ FLT LVL + KIAS = 6 x Mach Number)

Turn Radius

$^{GS}/_{100}$ = Turn radius [NM]

Descent Planning

Normal	**3NM each 1000ft + 10NM** margin (or: FL x 3)
Eco	4NM each 1000ft, 3000FPM, until FL110, idle
WND	TOD **2NM** earlier **per 10kts** TWND
	TOD 2NM later per 10kts HWND
A/I	FADEC ensures min 55% N1 → Shallower descent

Procedure	Until FL130	**Maintain 310KIAS**
		The lower the ALT, the more thrust necessary to maintain constant M, the less thrust necessary to maintain constant IAS
	At **FL130**	**FLC**, thrust↑ to maintain **V/S of 5xGS**
	At FL100	250KIAS
	At FL80	240KIAS
	At 4000ft	200KIAS
	LLZ intercept	180KIAS

Corrections	**5% N1 ≈ 1000FPM**
Idle descent	Glide angle 1:18
Mach	Angle of descend x Mach number x 1000 = Desc rate [FPM]
	10 x Mach number = #NM per minute

Rates	Recommended	Within last 2000ft ASEL max rate 1500FPM
	Within TMA	V/S ≤ 1000FPM within last 1000ft,
		V/S ≤ 1500FPM within last 1500ft

Holdings

Standard RT

(end of OBS needle)   (Offset = Teardrop, 30° for 1min)

Outbound leg: 1min if ≤ 14'000ft/MSL, 1½min if above

Course Intercepts

90°/45° intercept if **QDM more than 20°**
30° intercept otherwise

FD

Always follow, except for TCAS RA, EGPWS hard warnings, or if in doubt
VIS APP: FD OFF

ILS	LLZ signal	± 35° to 10NM
		± 10° to 18NM
		Full deflection 2.5° (VOR: 10°)
	G/S	1000ft after threshold
		3° → 50ft/ARTE
	DME	Carefully check DME identification with chart

CAT II — **AEO** only. Requires 2 ILS set to frequency, F22, RA set to MIN
Both DU on RSP side must be working
RSP flies down to MIN, "CTC / LDG" → H/O; G/A otherwise
Use **F22 ice speeds**

Malfunctions — Any malfunction requiring crew action
>1'000ft/AFE — G/A if not completed prior 1'000ft/AFE
<1'000ft/AFE — G/A
500..1'000ft/AFE — Downgrade (new MIN)

CAT III — **OEI** possible. PF: LSP, PM: RSP
Use **F22 ice speeds**
Arm AIII
No troubleshooting / system downgrading below 1000ft/AGL
APPR warning before T/D: G/A

Setup — PF: "AIII armed", PM: "Checked"
500ft — PM: "500", PF: "AIII checked"
PM: "Flare/Idle"

RNP APP		RNP is a type of PBN
		AOM 1-02-80 9ff
	Required eq	1 FMS, 1 GPS, 1 DME*, 1 VOR/LOC*, 1 ADF*, 4 DU, 1 FD, 1 MCDU
		(* for conventional NAV backup)
	Procedure	Check NAV DB validity
		Perform predictive RAIM
		FMS PROG 1/3 — FMS NAV mode GPS, LRN MIN 3
		FMS ACTIVE FPLN — APP WPT, CRS DIST, ALT constraints, final APP angle
		2NM before FAF — Check APP annunciation

Non-Precision APP	General	Use **FMS overlay**
	RNAV	GPS only: **No overlay** required
	Required **VIS** — **DH x 6**	= VIS [m] required to see RWY
	Required V/S — **5 x G/S**	= V/S [FPM] for 3° descent, max 1500FPM
	VDP — **DH / 300ft**	= Dist [NM] for 3° descent
	Timed VDP — **DH / 10**	= time [sec] from VDP to RWY
		Deduct from given time from FAF to RWY

Circuits	400ft	SPD 180, CLB Thrust, F0
	1500ft	Start turn, After T/O CL
	Begin downwind	F9, APP Briefing (T/G / Full Stop), Config
	ABM THR	TC, Gear down, F22, SPD 160
	45sec	Start turn, descent, SPD 140 (or: **3 x ALT / 100** = time [sec])
	T/G	Instructor: F9, Pitch Trim 8, "Go"

Steep APP		GS of **4.5° or more** (Legacy: **max. 5.5°**)
		Max TWND **5**kts

Stabilized APP		SPD (-0/+20), flight path, sink rate (max 1000FPM exc. steep APP), thrust stabilized
	In VMC	500ft/AFE
	In IMC	1000ft/AFE
	Exceeding v_{REF}	10% increase in v_{REF}: 20% increase in LDG distance

High SPD APP		Mind: Not stabilized at 500ft (F45)
	Final	**F9**, **240**KIAS
	1500ft	TL idle, gear down (mind "GEAR" warning at 1200ft)
	200KIAS	F22
	145KIAS	F45, set 62% N1

RTF Phraseology	Readback	Readback QNH and RWY
	Acknowledge	"[Roger], C/S"
		"Wilco" only to confirm a reporting instruction
	HDG	All headings should be expressed in single digits
	SPD	All speeds should be expressed in single digits
	ALT	Specify ".. FEET" and "FLIGHT LEVEL ..."
		10'000ft can be expressed as "one zero thousand feet"
		FL can be expressed in hundreds
	Request	"Request FL360" (not: "any chance" / "is available")
	Yes	Affirm
	No	Negative
	Clearance	"C/S, information hotel, stand E43, request clearance to..."
	Cleared	The word "cleared" shall only be used in connection with an ATC clearance at the gate, a T/O, an APP or a LDG clearance, but not for crossing or L/U "RWY 28 cleared for T/O"
	Conditional	"BEHIND landing traffic, line-up RWY 28 and wait BEHIND"
	H/O	Only repeat the frequency, not the station for the hand-over

ABNORMAL PROCEDURES

Always		**Check CBs first**, reset if at all after 3min cooling period
		Never reset CBs of fuel pumps / quantity indication systems
	MW	Requires immediate crew action
	MC	Requires immediate crew awareness

Worksplit	PM	Acquisition: "MC/MW, …"
	PF	"Cancel warning/caution"
		Fly, navigate, ATC
		"**Check thrust**, **check performance**"
		"BHI", *PM: "BHI completed"*
		"Abnormal CL"
		Analyse, "Worksplit: I fly, my ATC, your CL. **Check CBs**."
		(*e.g. request "delaying actions"*)
	< 400ft/AGL	"**Check thrust, check performance**" (gear, flaps, spoilers)
		(only MC/MW cancel and flight controls disconnect if stuck/trim runaway)
	≥ 400ft/AGL	**BHI**, **Worksplit** (**no BHI <400ft/AGL or after 4NM final**)
		(non-major EICAS MSG are inhibited v_1-15 .. 400ft)
		ACL/ECL only if above 1500ft/AGL,
		if on APP: G/A if below, except blocked controls / trim runaway
	Wording	*PM: "**TL confirm**"*, PF: "L/R TL confirmed" etc.
		(hand on respective control to have it confirmed, don't make suggestion)
		ECL: Read, then action: "**Pumps off, off**"
		Status reports after checklist work

QRH	Smoke	Baggage smoke, lavatory smoke;
		smoke evacuation, **smoke/fire/fumes** (non-annunciated)
	Non-annunciated	No EICAS annunciation:
		(all items are as well listed in the TOCs of the system-specific chapters)
		aileron runaway, APU overtemperature, ditching, dual engine failure, emergency descent, emergency evacuation, engine fire / severe damage or separation, engine oil low pressure, forced landing, fuel leak, inadvertent spoiler open, jammed aileron, jammed elevator, jammed rudder, pitch trim inoperative, pitch trim runaway, rapid cabin depressurization, roll trim runaway, smoke evacuation, smoke/fire/fumes; abnormal engine start, abnormal landing gear extension, ADS-B out fail or degraded, aileron artificial feel inoperative, approach warning, asymmetric rudder operation, cabin depressurization, cabin rate abnormal fluctuations, CAS message miscomparison, CDU data bus fail FMS annunciation, cracked windshield, display failure, emergency/parking brake handle disagree, engine abnormal vibration, engine airstart, engine control failure, engine failure/shutdown, engine high oil pressure, engine high oil temperature, engine low oil level, engine oil low pressure, engine overtemperature, engine tailpipe fire, erroneous stall protection actuation, gear lever cannot move up after takeoff, gust lock failure, IC bus failure, IC failure, impaired or cracked windshield, IRS/MSU failure annunciation, loss of engine indications, loss of pressurization indication, main door blocked, NAV/flight instruments failure, one engine inoperative approach and landing, overweight landing, oxygen leakage, partial or gear up landing, pressurization automatic system failure, radio altimeter fail, rudder artificial feel inoperative, rudder runaway, single engine bleed operation in icing conditions, steering system inoperative, stiffened elevator, structural damage, transponder fail, uncommanded aileron disconnection, uncommanded elevator disconnection, uncommanded swerving on ground, unreliable airspeed, volcanic ash, yaw trim runaway

Message Index	Warning - Caution - Advisory
1	Air conditioning, pneumatics & pressurization
2	Autopilot, flight instruments & navigation
3	Auxiliary power unit
4	Doors
5	Electrical & lighting
6	Engine
7	Fire protection
8	Flight controls
9	Fuel
10	Hydraulics
11	Ice & rain protection
12	Landing gear & brakes
13	Oxygen
14	Warning system

Performance — Wind, pitch trim, flap speeds, unreliable airspeed, T/O / APP / reference / holding speeds, drift-down tables, LDG distances

Appendix — Emergency evacuation

Pilot Incapacitation
SOPM 3-05-10 11f

= Failure to respond to a **second request,** or e.g. impairment by gastrointestinal illness or laser strikes. Is always an **emergency**
1. Fly
2. Restrain (assisted by cabin crew)
3. ATC: "Mayday x 3, pilot incapacitation"
4. Cabin crew to assist in CL reading
5. APP briefing (verbal), consider two-loop briefing with ATC
With increasing stress level, hearing/attentiveness is impaired
→ Start a normal dialogue, touch other pilot

T/O Abortion
SOPM 3-15-05 1ff

Beyond 80kts — High energy, only abort with **ENG failure**, **fire**, **unflyable condition** (flap retraction, spoilers extension) or **pilot incapacitation**
Do not vacate RWY, except on high speed TWY
Try to turn A/C into WND. Set parking brake
PM: Watch spoilers, **"TWR, ... aborted T/O RWY ... request fire brigade"**
CMD: **"Cabin crew and PAX, keep your seats"**

"GO minded" — Short RWY, low VIS

Cabin call — **Always abort T/O**

Engine Failure
SOPM 3-15-10

1. **Maintain wings LVL with ailerons,**
2. **add rudder gently until ailerons neutral,**
3. **trim** (remember 3sec trim cutout), use **ISIS**
Add 10% N1, pitch remains same
F22 for OEI LDG
Always **start APU**, always start **XFEED**
Neutralize trim before LDG

PF — Handles TL

PM — Handles Start/Stop selectors

After v_1 — Pilots tend to pull yoke. Make sure that elevator remains down

At 14° ANU — Pitch down to **10° ANU**

CL — After bird strike, vibrations, ...: "**ENG Severe Damage CL**"
BHI only for fire, severe damage, separation

ENG fail **on final** — Consider continuation and **retract to F22**, add 10kts SPD increment

Dual ENG out — ~**1200FPM** ↓. Check HYD page if pumps on
Use F22/F45 for G/S adjustments
APU start limit: **FL300**

COMM Failure	VMC		Squawk 7600, maintain VMC, land asap
	IMC		Squawk 7600, maintain assigned SPD/LVL for **7min**, then resume FLP

LDG Gear Malfunctions   During gear cycle: Consider leaving gear↓ if down and locked; no retract

Pitch Trim Runaway
Declare EMG, request ALT band and traffic separation
Avoid over-use of trim, press DISC button (overheating)
Use reduced flap setting for LDG, land w/o flare
Try not to change configuration

Both hydraulic Systems inoperative   Use **half bank**, use asymmetric thrust, use **rudder**
Final APP: Copilot is "verbal autothrottle"
Braking: Use parking brake smoothly;
do not taxi to stand (request push-back)

TCAS	TA	PF	Look out; hands on yoke
SOPM 3-05-10 3ff		PM	All external lights on, FSTN BELTS on
	RA	PF	**A/P off**, set thrust. Call out position of intruder
			If in a turn: **Wings LVL**
		PM	"**TCAS RA**" to ATC, when "Clear of conflict": "**resuming cleared FL/ALT** ..."
			File report

Unreliable Airspeed	PF	**Disengage A/P**, switch off FD, do **not use SPD brakes**
SOPM 3-25 17, QRH NAP-36		Refer to Pitch-Thrust values. Consider GPS GND SPD and ALT
		Annoying **high SPD aural warning** (instead of pulling AWU CBs):
		Consider pulling ADC CB and use ADC reversion

Turbulences
SOPM 2-80 1, 3-25 5f
Pitch and roll A/P modes (disengage actual modes)
During climb: Maintain thrust, climb faster

Windshear Recovery / EGPWS		Any "G/S" or "W/S" callout: **G/A**
SOPM 2-83 1, 3-15-05 10f, 3-40 11f		**TL max**, **G/A button**, wings LVL, pitch up **20° or PLI**
		(remain between FD [stable] and PLI [nervous])
		Do not change config (only once terrain cleared)
		(reasons: Safer with LDG gear down when **touching GND**;
		flaps retraction could lead to a **stall**)
		PM monitors V/S and calls out if A/C is descending
		In W/S mode: **No ASEL** will be armed
	MC	"Positive" W/S. Pilot's decision to continue or to G/A
	MW	"Negative" W/S; downdrafts

Upset Recovery	First	**Unload the wings** (for aileron effectiveness) (even with AND)
SOPM 3-25 18f	ANU	First adjust **pitch**, then **wings LVL**
		If pitch is too high: Bank to 45..60° until pitch is lower
	AND	First **wings LVL**, **throttle idle**, **adjust pitch**
	High SPD buffeting	Thrust idle. **Do not use speed brakes**
	Dutch Roll	Use YD. Use **ailerons**. **Do not use rudders**

Stall Recovery		**Nose down**, **wings LVL**, **TL max**
SOPM 3-25 20		No trimming below top of white speed arc (1.23v_S)
	Approaching v_{MCA}	Reduce thrust, lower nose, increase thrust

Driftdown	after ENG failure	$v_{FS} \approx v_{DD}$. NAV reception is not guaranteed
SOPM 3-25 6ff		**ALT hold, max <u>cont thrust</u>, at v_{DD} engage SPD**

EMG Descent *SOPM 3-25 13ff*	after rapid depr	**BHI**. Fly 5..10NM parallel (**turn 30° off to leave AWY**) Inform ATC, ASEL to FL100 / MEA. Initiate descent with TCS Squawk 7700, turn on exterior lights "Attention crew, EMG descent" ALT callouts every 10'000ft 4000ft before target FL: Add thrust to decrease rate At target FL: Retract gear (v_{LOR} 200KIAS) "Attention crew, we have reached safe ALT"	
	PACK fail	Immediately EMG descent	
	Press problems	Immediately stop climb	
	Decompression	- Slow >1min - Rapid - Explosive <1sec	Whistling sound, may feel ear problems Explosive noise, fog, flying objects, dizziness, pain
	TUC	FL300 **1min** FL350 **30sec** FL400 **15sec**	
Overweight LDG *SOPM 3-40 17f*		ROD max 300FPM	
Ditching *SOPM 3-40 21ff*		Refer to QRH (non-annunciated). Squawk 7700, cabin signs on, ELT on PACKs / BLEEDs out, max available flaps, gear up, reduce onboard fuel Land parallel to waves	
Fire / Smoke *SOPM 3-10 18f*	On GND On final **Smoke** in cabin	In case of any fire, even if extinguished: **EMG EVACUATION** Continue, land, EMG EVACUATION **Always put on mask** (even if not visible in cockpit)	
EMG Evacuation *SOPM 3-10 20ff*	 Rapid deboarding	Switch off ENG first "Crew at station" / "EMG evacuation" not via ICU but via **PA** Using stairways. SOPM 3-05-01 7	

EXPANDED CHECKLIST

INTERNAL SAFETY INSPECTION

Every crew's FFD on a particular A/C
Performed by RSP according CL

	CBs	Also behind seats
	Electrical	All ON/AUTO except GPU, BATTs, ESS PWR, AVIONICS
	A/C	RECIRC/GASPER in, PACKs/BLEEDs out (closed)
	EMG/PKG brake	Push pedals while applying/releasing to avoid fluid transfer
	ALTN gear ext	NORMAL

POWER UP

Every crew's FFD on a particular A/C or after SHUTDOWN
Performed by RSP according CL

	Electrical	BATTs AUTO, "Aural unit ok"
		Min temp -20°C. Replace BATT if <**19**V
		BATT Voltage for APU start: **23.5**V
		If recharging, BATT 1 off before APU start, AUTO after 3min
		Min recharging time 30min
	GPU	**26**..**29**V
	Fire detection	2x pushed out.
		TEST for ≥**2se**c: **3 MW**, **2 MC**, BAGG COMP **FAN** OFF (to repeat: wait ≥6sec)
	APU	Do not start APU before 30sec after energizing airplane (IRS)
		Do not start APU while refueling
		Fuel pump 2. Wait **3sec on ON**. TC (**3**min for APU bleed)
		SHED BUS OVRD (for galley power)
	Avionics master	Release BACKUP BATT momentarily, check ISIS
		→ **IRS**: To NAV asap

BEFORE START

Performed by LSP/RSP according areas of responsibility

	OVHD	EMER LT	ON, then ARM
		PB LT	TEST
		FIRE panel	2x pushed out
		APU FUEL SHUTOFF	Pushed out
		POWERPLANT	Store T/O data (local temperature)
		FLIGHT CONTROLS	4x pushed in
		HYDRAULIC	SHUTOFFs pushed out
			Pumps AUTO, then OFF
			Check 2900±200psi and fluid level
			(do not test if on BATT only)
		PASS SIGNS	FSTN BELTS on after refueling
		ICE PROTECTION	All in/AUTO, except W/S as req (defog)
		A/C	As req, APU BLEED on if available
	Oxy masks	Oxygen mask, regulators, mic (MASK/BOOM),	
		1100/1500psi (crew), 1150psi (pax)	
	Glareshield	WX RADAR	TEST (WX on MFD), then STBY
	A/P	Release gust lock, AP, check AP/YD, DISC, set gust lock	
		Modes: **ROL - TO**, CPL to PF	
	Clock	LSP	Enter flight number, enter date according GMT
	Instruments	Flag free, set ASEL (cleared ALT - 100ft / MSA), x-check ALT, set NAV / CRS	
		/ HDG bug (ISIS: Airplane must not be moved 90sec after power-up)	
	MFD	Select **WX**, **NAV**, **APT**	
	SYS	ENG **OIL LEVEL**	Check
	PF	**TCAS** page	
	PM	**FUEL** page	
	RMU	TCAS	Press TEST for **5**..7sec
		XPDR	Insert call sign

Control pedestal	When **IRS aligned**	Release gust lock, SPS TEST (ICE/SPS ADVANCED msg)		
	Trims	Check 3sec protection		
	TBCH	Normal, copying RMU 2		
	Pressurization	DEST A/P ELEV, DUMP/AUTO out, manual full down		
	FMS	Check NAV DB expiry date		
		Load GPS POS. PF sets route		
		PERF INIT: CRZ WINDS, ISA DEC,		
		INIT CRZ ALT = AT ALT		
		M&B: BOM, block fuel, cargo 0, #PAX		

PF **PROG** page
PM **FPL** page

RSP "**Before start CL complete down to the line**"

SPD bugs

$\boxed{V1}$	$\boxed{VR}$	$\boxed{V2}$	$\boxed{AP}$	$\boxed{Bug}$
v_1	v_R	v_2	v_{AP}	v_{FS} ($\approx v_{DD}$)
			$(v_{REF45}+5)$	or **v_2+10** (noise)

Briefing   LSP Any failure before v_1, you call it out or point at it.
I decide whether to break, TL to idle, reverse.
When we stop, you inform the **ATC**. I decide on **evacuation**.
Beyond **80kts**: High speed T/O abortion only for
ENG failure, **fire**, pilot **incapacitation** or **unflyable** condition

PF After v_1, we fly SID, **accelerate** at ..., (A/P elevation + 3000ft; climb to MSA), power reductions, WX, terrain/MSA, noise abatement, low VIS, inoperative airplane components, RWY in use / condition, return ALTN A/P, NOTAM, ops procedures

RSP **Pumps**, **red beacon**, safety pins on board
"**Before start CL complete**"

LSP "**Starting ENG** 2 (1)", **RUN for 2sec**
LSP TC **START**   Check **10sec N2**↑, **12sec FF**, oil pressure
RSP TC **FF**   Check (5 -) **10sec ITT**↑
LSP "**Normal start**", "**Set F9**, **Flight Ctrl Chk, after start CL**"

AFTER START

RSP **SHED BUS**   AUTO
APU   OFF
FADEC   RESET/ALTN **650**: Confirm ALTN
                 Check N1 target remains within ±0.2%
HYDRAULIC **ELEC HYD PUMPS** AUTO
ICE DET OVRD   **ENG** (icing conditions only)

A/C	ALT T/O	**ENG** bleed	~~APU bleed~~	X-bleed AUTO
	(E) T/O-1	~~ENG bleed~~	**APU** bleed	X-bleed OPEN
	(E) T/O-1, ice	**ENG** bleed	~~APU bleed~~	X-bleed AUTO

RSP "**After start CL completed**"

LSP "**Left side clear**"
RSP "Right side clear"
LSP Ailerons into wind. **TAXI** LT on, check brakes, check FD

Single engine taxi: Use ENG1 (higher TLA available with gust lock set; steering is on HYD SYS 1)

Ice detection test: 83% N2, OVERRIDE to ALL, TEST to 1, then 2 (min 10sec/ max 15sec), check 4 inscriptions, BLD LOW TEMP MC

BEFORE T/O		RSP	Advise **cabin** crew, **lights** on, check **brake temp**, MFD 2x**TCAS** page, EICAS, TCAS/**XPDR** TA/RA, gust lock, **T/O config**
		LSP	During line-up: "**Before T/O CL**" STROBE LT on, RADAR on (4xSTAB), center HDG bug LDG LT on (with T/O clearance)
		MFD	WX and TERRAIN

T/O			**40%** N1, brakes release, thrust set
		PF	"**Check thrust**" - PM: "Thrust checked"
		PM	"**80kts**" - PF: "**Checked**"
		PM	"v_1, **rotate**, **positive rate**"
		PF	"**Gear up**", **trim down** to **14° ANU** before 160 KIAS use **TCS** if SPD < v_2+10 Fly v_2**+20** (noise abatement)

	Any failure	LSP	*"**Reject**" / "**Go**"*
	Abortion	LSP	*Idle, reversers*
		RSP	*"60kts", to ATC: "Stopping" [, "Fire"]*
		LSP	*Decide on further proceeding, inform cabin "Attention crew, wait for instructions"*

AFTER T/O	**400**ft	PF	"Select **NAV**"
	1000ft	PF	"Engage **autopilot**"
	1500ft	PF	"Select **CLB thrust**"
		PM	Check packs
	3000ft	PF	"**CLB sequence**"
		PM	v_{FS}. At v_{F0} (**v_2+15**): F0, "**Flaps 0**"
		PF	"**After T/O CL**"
		PM	Do CL silently; APU as required, "**After T/O CL completed**"
	Trans ALT	PM	"**Transition ALT**". ALT set and x-check
	FL100 PM		External lights, cabin signs

ENG Failure after v_1		*Any*	*"**ENG ... failure**"*
(loss of thrust)		*PF*	*"**Check thrust**" - PM: "Thrust checked"*
		PF	*Climb at v_2 (**10° ANU**) (use **TCS**) Yaw trim until system automatically stops after 3sec (¾dot)*
	400ft	*PF*	*"**Select HDG, bank, SPD v_2**" (full bank protection if ≥v_2+10) In case of fire: "Check recall items"*
	1000ft	*PF*	*"**Select ALT hold, engage autopilot**"*
	v_{F0} (v_2+15)	*PF*	*"**F0**" - PM: "**F0, v_{FS}**" (SE best ROC clean)*
		PF	*"**Select SPD v_{FS}, continuous thrust, bank off, recall items**, applicable abnormal CL, **after T/O CL**"*

Climb		PF	Max 240kts / 300kts (above FL100) Reduce ROC (≤1500FPM) if cabin Δp reaches 8.1psi

Cruise		PF	CRZ thrust when reaching 300kts / M0.7

| **DESCENT** | | PF | FLC mode. Maintain 310kts with TL. FL110: Idle |
| | | PM | Windshield heating on |

	Briefing	PF	**NAV setting**, **charts**, **SPD bugs**, **FMS**, **fuel**
			(inoperative airplane components, WX, fuel/delays, RWY condition,
			low VIS, terrain/MSA, descent profile, MAP, taxi in)

SPD bugs

AEO			OEI			
$\boxed{V1}$	$\boxed{VR}$	=	$\boxed{V2}$	$\boxed{AP}$	=	$\boxed{Bug}$
v_{FS}	v_{REF}		v_{APPCLB}	v_{APP}		v_{APP}
$(\approx v_{DD})$						

$v_{APP} = v_{REF}$ + ½HWND + GustΔ

SPD increment:
F45	5 .. 15kts
F22	5 .. 20kts
Ice/OEI	0 .. 15kts
	(HWND ≤ 10kts incl)

OEI: F22, $v_{REF} = v_{REF45} + 10$

| | | PM | Set LDG data, pressurization |
| | | PF | **"Descent CL"** |

	FL100	PM	**"10'000"** - PF: "10'000 checked"
		PM	External lights on, cabin signs on
			"Attention crew, prepare for LDG"

| **APPROACH** | Trans LVL | PM | **"Transition LVL"**. ALT set and x-check |
| | | PF | **"Approach CL"** |

Precision APP	RA		Set **RA DH to 0** (CAT I) / DH (CAT II/III)
	Intercept HDG		**APR** mode, "**F9**", 210KIAS
		PM	"LLZ alive", "G/S alive"
	1dot G/S	PF	**"LDG gear down, F22"**
	FAF		**"Set G/A HDG and ALT"**
			"F45, before landing CL" (latest at 500ft/AGL)
			TL **64%** N1
	1000ft	PM	"1000" - PF: "Checked"
			CAT II/III: Check "CAT II" / "AIII" engaged
	500ft	PF	"500" - PF: "Checked"
	OM		"OM check", ALT / MIN / G/A ALT, "OM check completed"
	100ft/MIN	PM	"Approaching minimums", "Minimums"
		PF	"Landing / G/A"

Non-Precision APP			Set **RA DH to 0**
		PM	"CDI alive" - PF: "Checked"
	0.3NM	PF	"LDG gear down, F22"
			Select **V/S 0**, set **ASEL to <u>missed APP ALT</u>** / <u>disarm</u> ASEL
	FAF	PM	"FAF"
		PF	V/S **-700**FPM (max 1500FPM),
			(MDA = VDP = MAPt)
		PM	Call-out ALT at every NM
		PF	"Landing / G/A"
			ASEL to G/A ALT as soon as visual

Circling APP	Final		LDG **gear down**, **F22** *(as well for OEI)*
	MIN	PF	"Select **HDG** and **ALT hold**"
			Break off: **45°** for **30sec** (protected area: 4.2NM; do not break off before)
	Abm LDG thresh		TC, **20sec**
	Base	PF	"**F45**, before LDG CL"
	G/A		Initial climbing turn towards landing RWY and overhead A/D
			Intercept published MAP for **APP** RWY
Steep APP			**Fully configured** before capturing glide
	After F45		Push **steep APP button**, "**Steep APP green**" (inhibits EGPWS warnings)
			$v_{APP} = v_{REF}$
			A/P off latest at 200ft/AGL (or earlier)
	LCY		Land within first 300m (lamps), G/A otherwise
G/A		PF	"**G/A, F9**" (if above v_{REF}), **G/A button**, TL MAX, **10°** ANU
		PM	"**Positive rate**", check thrust (silently)
		PF	"**Gear up**"
		PM	Select SPD $\underline{v}_{FS}$ and advice ATC
		PF	"**NAV SRC FMS, select NAV**" / "Select HDG"
		v_{FS}-5	"CLB sequence", "After T/O CL"
	OEI G/A		*Fly v_2 (= v_{REF}) / $\underline{v}_{APPCLB}$*
			*1000ft: "v_{FS}", **Select SPD, continuous thrust, half bank off***"
		v_{FS}-5	"CLB sequence", "After T/O CL"
	CAT II		Prefer A/P off (late G/A rotation with A/P on)
BEFORE LDG	*OEI LDG*		*Anticipate yaw with rudder*
			Autopilot and XFEED must be off
			ENG failure on final: Retract to F22, re-brief speeds
	A/P off		Silent item; press TCS to cancel warning
	Flare		Increase pitch by 2°..3°
			Do not apply brakes prior nose gear touchdown
			F22: If RWY wet, do not flare, positive T/D, brake early
	60kts		Min reversers
	30kts		Close reversers
AFTER LDG	Vacating		**WX radar STBY**
		LSP	"**After landing sequence**"
			LDG and STROBE LIGHTS off
		RSP	**APU**, WINDSHIELDS, **RADAR** stby, **XPDR** ATC,
			F0, **TRIM** 7, gust lock
SHUTDOWN			*Performed by LSP/RSP according areas of responsibility*
		LSP	TAXI LIGHT off
			PRK brake: Check **brake temp**
			If amber: Chocks, release PRK brake soon
			ENG BLEEDs close prior engine stop
			ENG min 1min idle before shutdown
			RED BCN off, FSTN BELTS off
			APU bleed and packs on while APU shutdown
			APU master off when **below 5%**
LEAVING THE AIRPLANE			*Performed by LSP/RSP according areas of responsibility*
		IRS	Off
		A/C	All out except RECIRC/GASPER

RECALL ITEMS

Baggage Smoke	*Legacy*	*BAGG ACCESS OPN MC*		*Not displayed on EICAS*
		Fire Extg Bagg Button		Push in
Smoke / Fire / Fumes,		Crew oxygen **masks**		Don, 100% (center pos)
Smoke Evacuation		Smoke goggles		Don
		Crew **communication**		Establish, **also with ATC**
	Legacy	*Recirculation fan*		*Push out*
Aileron / Rudder Trim Runaway		Quick **DISC button**		Press and hold
		AILERON / RUDDER SHUTOFF 1+2 Push out		
		Control attitude manually with control wheels and rudder		
Legacy: Airplane Overspeed		*Airspeed*		*Max v_{MO}/M_{MO}*
Emergency Descent		Cabin Crew		**"Attention crew, EMG descent**"
		FSTN Belts		On
		Thrust Levers		**Idle**
		Speed Brakes		Open, check
		A/S		MAX 250KIAS (v_{LOE})
		LDG Gear		Down, check
		Descent		Initiate
	Legacy	*Transponder*		*7700*
		ALT		**MEA of 10'000ft** if higher
				"Attention crew, we've reached safe ALT"

Emergency Evacuation	LSP	Parking **Brake**		Apply	
		Cabin Crew		**"Attention crew, wait for instr**"	
	RSP	(**3**) Top OVHD row	Fire Extinguishing **Handles**	Pull	
			APU Fuel Shutoff Valve	Push	
			ENG/APU Fire Ext **Bottles**	**Disch** (if req)	
		(**2**) Med OVHD row	Fuel **Pumps** Pwr 1 and 2	Off	
			Hydr Elec **Pumps** 1 and 2	Off	
		(**1**) Bottom OVHD row	**EMERG LT**	ON	
		(**1**) Cabin	**Depressurize**		
	LSP	Evacuation		**"EMG, open seat belt, evac**"	

Jammed Aileron / Elevator		Aileron / elevator **DISC** handle	Press and pull	
Pitch Trim Runaway		Quick **DISC button**		Press and hold
Rapid Cabin **Depressurization**		Crew oxygen **masks**		Don, 100% (center pos)
		Crew **communication**		Establish, **also with ATC**
Abnormal ENG Start	To abort	Associated TL		**IDLE**
		START/STOP selector		**STOP**
Erroneous Stall Protection Actuation		Quick DISC button		Press
		Stall Protection Cutout 1+2		Push out
		Quick DISC button		Release
APU Fire		APU **fuel SOV**		Push in
		APU **MASTER**		OFF, (**TC**)
Battery Overtemperature		Affected **battery**		**OFF**

ELEC ESS XFR FAIL MW	ESSENTIAL POWER	Push in	
ATTCS Failure	Thrust levers	Max	
Dual Engine Failure	Oxygen masks	As required	
	Fuel Pump Power Tank 1+2	On	
	Fuel Pump Sel 1+2	A or B	
	APU	START (max FL300)	
	A/S for windmilling	Above 10'000ft MIN 250KIAS	
		Below 10'000ft 220..250KIAS	
ENG Fire, severe Damage, Separation	Associated TL	**IDLE**	
(no BHI for ENG failure)	START/STOP selector	**STOP**	(LSP)
(e.g. after bird strike, vibrations, ...)	Fire ext handle	**Pull** (do not rotate)	(RSP)
	Legacy 600: Fuel Fus Tk XFER	*OFF*	
	Legacy 650: Fuel XFER master knob	*OFF*	
	Fuel XFER OVRD button	*Pushed in (off)*	
Inadvertent Spoiler Open	SPEED BRAKE	CLOSE	
Steering System inoperative /	Steering handwheel	Do not use	
uncommanded Swerving on GND	Steering disengage button	Press	
	Use differential brakes / rudder		
Legacy: Stall Protection inoperative	*Affected Stall Protection Cutout*	*Push out*	
Stick Pusher Failure	Control column	Toward neutral	

3. ABBREVIATIONS

A/S	Airspeed
ACOC	Air Cooled Oil Cooler
ADC	Air Data Computer
ADS	Air Data System
AFE	Above Field Elevation
AFM	Airplane Flight Manual
AGL	Above Ground Level
AND	Attitude Nose Down
ANU	Attitude Nose Up
AOM	Airplane Operations Manual
APP	Approach
APU	Auxiliary Power Unit
ASD	Accelerate-Stop Distance
ATS	Air Turbine Starter
AWU	Aural Warning Unit
BCU	Brake Control Unit
BHI	By-Heart Item (Memory Item)
BIT	Built-In Test
BTC	Bus Tie Contactor
C/S	Callsign
CAS	Calibrated Airspeed
CB	Circuit Breaker
CMC	Central Maintenance Computer
CPAM	Cabin Pressure Acquisition Module
CRS	Course
CVG	Compressor Variable Geometry
DA	Decision Altitude
DAP	Digital Audio Panel
DAU	Data Acquisition Unit
DB	Database
DMA	Daily Meal Allowance
DU	Display Unit
EDL	Electrical Distribution Logic
EGPWS	Enhanced Ground Proximity Warning System
EICAS	Engine Indication and Crew Alerting System
ELT	Emergency Locator Transmitter
ESU	Electronic Sequence Unit
FADEC	Full Authority Digital Engine Control
FCOC	Fuel Cooled Oil Cooler
FD	Flight Director
FDC	Flight Data Computer
FFD	First Flight of the Day
FLC	Flight Level Change
FLP	Filed Flight Plan
FMS	Flight Management System
FPM	Feet Per Minute
FPMU	Fuel Pump and Metering Unit
G/A	Go-Around
GCU	Generator Control Unit
GMT	Greenwich Mean Time
GPU	Ground Power Unit
HGS	Head-up Guidance System
HIL	Hold Item List

ICU	Integrated Communication Unit
ICU	Intercommunication Control Unit
INU	Integrated Navigation Unit
ISIS	Integrated Standby Instrument System
L/U	Line-Up
LPU	Low Pressure Unit
LSP	Left Seat Pilot
LVP	Low Visibility Procedures
LVTO	Low Visibility Take-Off
MC	Master Caution
MCDU	Multifunction Control Display Unit (FMS)
MDA	Minimum Descent Altitude
MFD	Multi Function Display
MW	Master Warning
NAV	Navigation
NPA	Non-Precision Approach
OEI	One Engine Inoperative
OVHD	Overhead
PAX	Passenger
PBE	Protective Breathing Equipment
PBN	Performance Based Navigation
PF	Pilot Flying
PFD	Primary Flight Display
PLI	Pitch Limit Indicator
PM	Pilot Monitoring
PMA	Permanent Magnet Alternator
POB	Persons On Board
QRH	Quick Reference Handbook
RA	Radio Altimeter
RA	Resolution Advisory
RAIM	Receiver Autonomous Integrity Monitor
RMU	Radio Management Unit
RNP	Required Navigation Performance
RSP	Right Seat Pilot
RTF	Radiotelephony
SCV	Starter Control Valve
SOPM	Standard Operating Procedures Manual
SOV	Shut-Off Valve
SPC	Stall Protection Computer
SPS	Stall Protection System
TA	Traffic Advisory
TBCH	Tuning Backup Control Head
TCAS	Traffic Collision Avoidance System
TCS	Touch Control Steering
TOC	Table Of Contents
TUC	Time of Useful Consciousness
UFN	Until Further Notice
ULB	Underwater Locator Beacon
V/S	Vertical Speed
W/S	Windshear
WED	Water Equivalent Depth
WOW	Weight On Wheels
WPT	Waypoint
XPDR	Transponder