

1. TECHNICAL	1-1
2-00 Limitations	1-1
2-01 Airplane Description	1-3
2-02 Equipment and Furnishings	1-5
2-03 Emergency Equipment	1-6
2-04 Crew Awareness	1-7
2-05 Electrical	1-9
2-06 Lighting	1-12
2-07 Fire Protection	1-13
2-08 Fuel	1-14
2-09 Auxiliary Power Unit	1-16
2-10 Powerplant	1-17
2-11 Hydraulic	1-20
2-12 Landing Gear and Brakes	1-21
2-13 Flight Controls	1-22
2-14 Pneumatics, Air Conditioning and Pressurization	1-23
2-15 Ice and Rain Protection	1-24
2-16 Oxygen	1-25
2-17 Flight Instruments	1-26
2-18 Navigation and Communication	1-28
2-19 Autopilot	1-32
2. OPERATIONAL	2-1
Flight Planning	2-1
Normal Procedures	2-5
Abnormal Procedures	2-10
Recall Items	2-14
Expanded Checklist	2-16
3. ABBREVIATIONS	3-1



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 between information that is mandatory to adhere to, and other information that is more facultative and thus not compulsory to be followed.

Written initially to cover the EMB-145LR, it has been augmented with the EMB-135BJ Legacy variants and different operating procedures. It was finally completed to cover all ERJ 145 family members 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 information 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.

The document may be distributed without permission by the author, as long as it is not altered. In order to enable continuous improvement, I kindly ask any reader to provide me with identified errors and improvement opportunities. Updates of this document are available on www.flite.ch.

Christoph Regli
[linkedin.com/in/christoph-regli](https://www.linkedin.com/in/christoph-regli)
christoph.regli@flite.ch
www.flite.ch

QUICK ACCESS LINKS

TECHNICAL

2-00 Limitations	2-01 Airplane Description	2-02 EQ and Furnishings	2-03 EMG Equipment	2-04 Crew Awareness
2-05 ELEC	2-06 Lighting	2-07 Fire Protection	2-08 Fuel	2-09 APU
2-10 Powerplant	2-11 HYD	2-12 Gear Brakes	2-13 Flight Controls	2-14 PNEUM, A/C, PRESS
2-15 Ice and Rain Protection	2-16 OXY	2-17 Instruments	2-18 NAV COMM	2-19 Autopilot

OPERATIONAL

Planning	Airports RWY	T/O CLB	RVSM	Charts
OFP M&B	Dispatch	Normal Procedures	CRM	T/O CLB
Pitch Thrust XWND	Descent Holdings	APP	RNP APP	Expanded CL

ABNORMAL

Abnormal Procedures	Worksplit	QRH	Incapacitation	Fire Smoke
T/O Abortion	TCAS	ENG Failure	Pitch Trim	HYD Inop
Unreliable A/S	EGPWS	Upset	EMG Descent	Recall Items

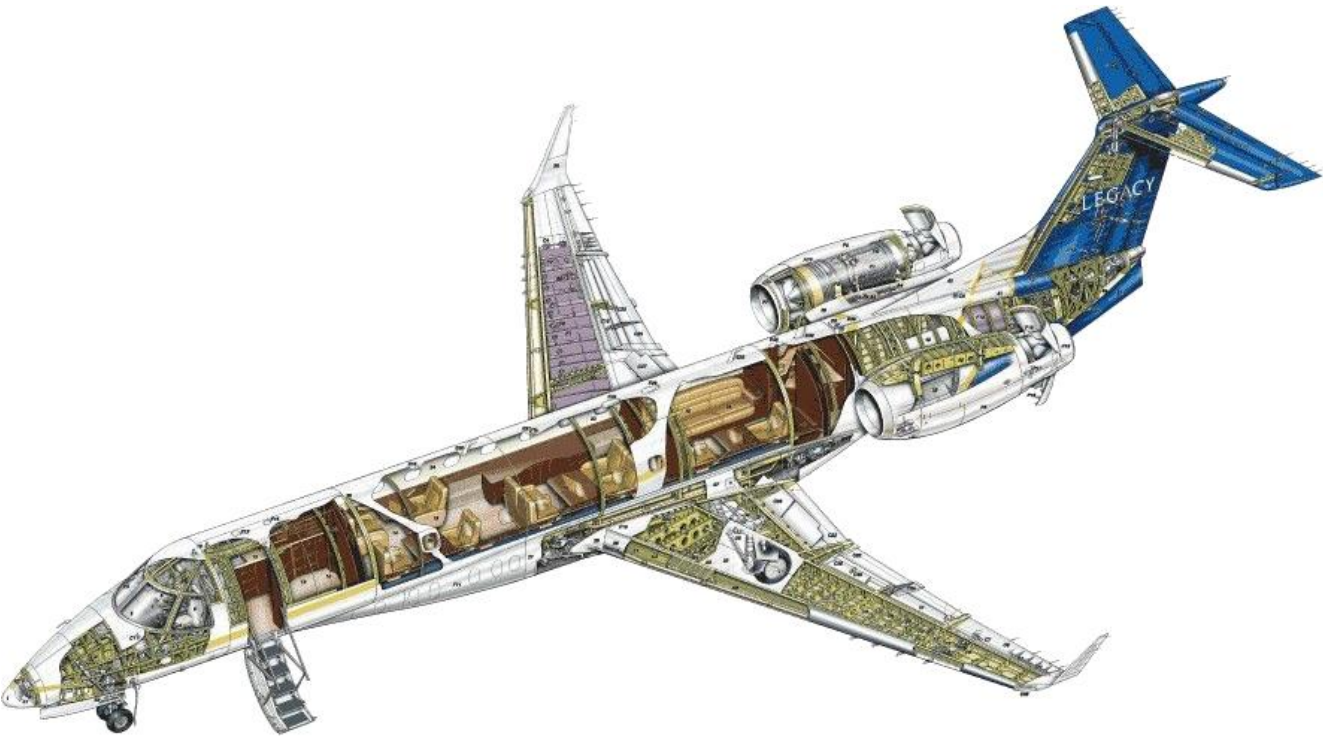
1. TECHNICAL

2-00 LIMITATIONS

Operation		Area of operation		60°S .. 80°N					
		Extended overwater ops		120min					
Masses			<u>135LR</u>	<u>140LR</u>	<u>145LR</u>	<u>145XR</u>	<u>600</u>	<u>650</u>	
	MTOM	[kg]	20'000	21'100	22'000	24'100	22'500	24'300	
	MLM	[kg]	18'500	18'700	19'300	20'000	18'500	20'000	
	MZFM	[kg]	16'000	17'100	17'900	18'500	16'000	16'400	
	Pax		37	44	48-50	48-50	13-16	13-16	
	Range	[NM]	1'750	1'650	1'550	2'000	3'400	3'900	
	Max CGO	[kg]			1'200kg		454kg		
					≤ 400kg per section		≤ 390kg/m ²	tighten if ≥ 125kg/m ²	
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_{SO}	= 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 9/18/22/45}	250/200/200/145KIAS				
				V _{FE 45}	160KIAS (650)				
				ALT _{FE}	max 20'000ft				
		Manoeuvring speed		V _A	200KIAS				
		(full aileron and rudder deflection protected)							
		Best angle of climb		v_X	≈ v_{FS}	(clean)			
		Best rate of climb		v_Y	≈ v_{FS} + 50	(clean)			
		Clean speed		V _{Pclean}	180 / 200 (ice) KIAS				
		(30° bank protected;		V _{P9}	160KIAS				
		flap manoeuvring speeds)		V _{P22, V_{P45}}	140KIAS				
				(150 w/F22 after ice)					
		Turbulent air speed		V _{RA}	200KIAS ≤ 10'000ft				
					250KIAS > 10'000ft,				
					then M 0.63 if lower				
	Max operating speed		V _{MO}	250KIAS < 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	160KIAS					
	Windshield wiper operation		max	170KIAS					
	Direct vision window remove		max	140KIAS					

		Hydroplaning speed (typical)	T/O	113kts
		Taxi speed	LDG	97kts
			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 YD disengaged Max airport ALT	FL 370 (145), FL 410 (135BJ) FL350 (> M 0.70) 8'500ft		
Temperature		Temp above FL250 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	30kts 25kts 20kts 15/11kts 10kts "Critical engine"	dry / wet RWY recommended compacted snow or for CAT II standing water / slush CAT III (AEO/OEI) ice (not melting) On luv side (for XWND LDG)	
	TWND	10kts		
	HWND	5kts 60kts	for steep APP (max. 5.5°)	
		23kts 25kts	CAT II 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 Load factor	max ANU Flaps 0 Any flaps	20° up to 3000ft/MAA -1.0 .. +2.51g 0.0 .. +2.0g	

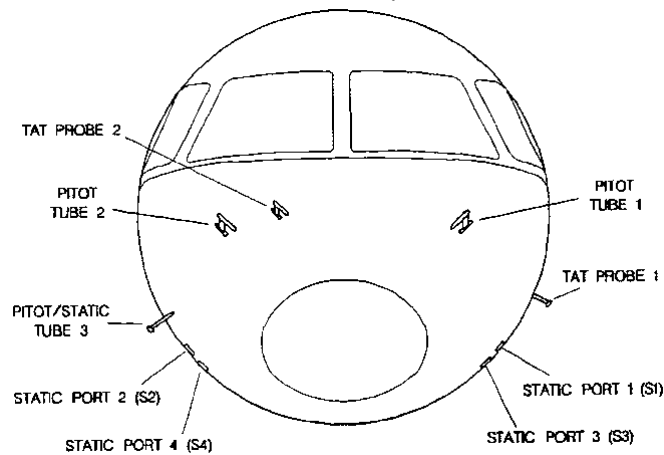
2-01 AIRPLANE DESCRIPTION



Dimensions	<u>135</u>	<u>140</u>	<u>145</u>	<u>145XR</u>	<u>135BJ</u>
					
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 width	18.54m	20.02m	21.21m	21.21m	18.54m
Turning radius	14.94m	16.05m	17.01m	17.01m	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 (auxiliary antenna on side of ELT when used as portable unit)
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		Indications on MFD T/O page (and EICAS in case of MC/MW) 2 overwing exits, can be opened from inside and outside (MC) Baggage door cannot be opened from inside 135BJ No service door, only one overwing exit (RH) Aft baggage compartment accessible via swing door (MC in cockpit)
Hatches	Fwd	AOM 2-02-40 Cockpit underfloor access hatch door
	LH	Battery compartment
	RH	Hydraulic compartment
	Aft RH	Rear electronic compartment access hatch (rudder servo, cables)
Connections		AOM 1-12-05
	ELEC	LH fuselage nose
	LPU	RH of rear fuselage
	A/C	RH wind root

2-02 EQUIPMENT AND FURNISHINGS

Water	20l potable water	
	Heated drains	
	Cold WX	Drain water to prevent freezing
Toilet	135BJ	6l "blue water"

2-03 EMERGENCY EQUIPMENT

Operator specific.

2-04 CREW AWARENESS

EICAS

	DAUs 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 v_1 -15kts until RA > 400ft or CAS < 60kts or after 1min LDG 200ft RA until on GND for ≥ 3 sec 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 shaker, 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 $1.0 \dots 1.13 v_s$
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 Servo motor on LSP side
SPS advanced	AOA disagree, flaps/spoilers disagree, SPC/ADC/IRS fail
Amber AOA	Loss of PLI indication due to an invalid stall protection computer signal

EGPWS

Updrafts	Includes windshear detection and escape guidance function	
Downdrafts	MC , yellow WINDSHEAR on PFD, 1x "Caution windshear"	
	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 ; DC-550 control panel	(no CAT II if RA1 failed)
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 dev (1.3 dots) "glideslope"
	Mode VI	VIa $10^\circ/30ft \dots 55^\circ/\geq 2450ft$ "Bank angle"
	VIb	DH "minimum"
	VIc	APP "500", "200", "100"
Enhanced GPWS	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

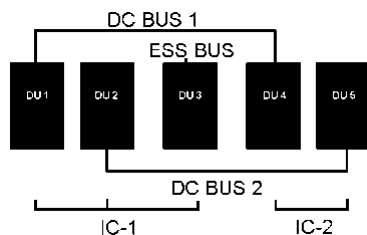
Range indication	Normal range -27..+27 , above/below: ±70 Climb: Above; Cruise: Normal; Descent: Below			
Inner ring	2NM, removed if range above 20NM			
TA	Inform ATC , do NOT perform an escape manoeuvre			
RA	Preventive ("Monitor V/S") / corrective ("Climb, climb now") Has priority over instructions from ATC			
RA inhibited	During descent	400ft/AGL	During climb	600ft/AGL
RA DESC inhibited	During descent	1000ft/AGL	During 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..45sec	amber "Traffic"
	■	RA	20..30sec	red "Monitor" (preventive)
				"..." (corrective)
	Rate of intruder is only indicated if > 500FPM			

Weather radar

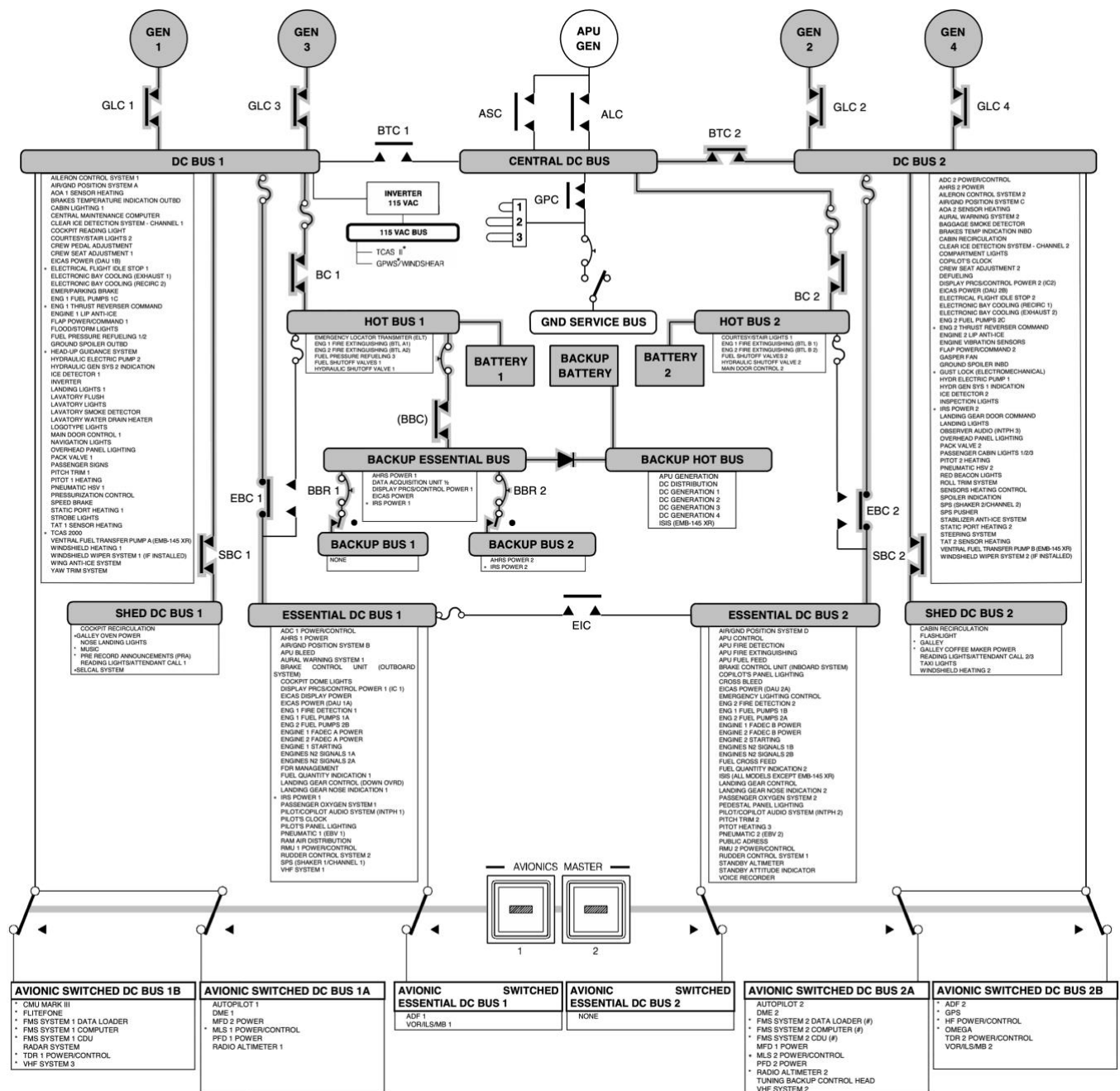
	12" flat type antenna, tiltable ±15°	
	Avoid storm cells by 5..10NM (recommended: 25NM), divert to luv side	
	Adjust tilt regularly (no GND echoes)	
Limitations	300ft from refueling operations 15ft from personnel or flammables	
Tilt	T/O	8° , manual tilt selection
	5000ft	5°, for each additional 5000ft 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)	
TRB	Turbulence detection	
STB	Antenna stabilization	
	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°	
GAIN	Calibrated (pushed) / variable (pulled)	
RCT	Cyan where further compensation is not possible	
FP	Flightplan mode. Radar STBY	
ACT	Auto tilt based on barometric ALT, ±2°	

2-05 ELECTRICAL

Batteries	BATT 1/2	2 NiCad 24VDC 44Ah. 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 must be switched off 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) Connected to hot buses 1/2. Hot bus 1 powers backup buses ELEC EMG: Power supply via BATT 1/2 for 40min (ESS PWR)
	Backup BATT	1 lead-acid 24VDC 5Ah Stabilized power for hot bus 1 / backup ESS bus; for GCUs Charged if BACKUP button is in
Generators		Primary ELEC source inflight. 4 ENG GEN, 1 APU Starter/GEN Max load 400A, except APU GEN above 30'000ft: 300A 28VDC. All brushless, except APU GEN
	ENG GEN	GEN 1, 3: LH ENG; GEN 2, 4: RH ENG Online when N2 reaches 56.4% GND: Cooled by a fan. Inflight: Via NACA air inlet. BEARING FAIL advisory: 20h on auxiliary bearings possible
	APU GEN	Starter/generator Supplies DC BUS 2 via central DC bus, can also replace a DC BUS 1 GEN Online 7sec after 95% RPM GND: Air cooled. Inflight: Via NACA air inlet.
	GCU	GEN control (voltage regulation, line contactor control, parallel ops, current limiting to 400A [e.g. APU start]), system protection, BIT To reset GCU: Cycle GEN button
GPU		28VDC (26..29V). Isolated if > 32VDC (only if BATT 1 is installed) Does not charge BATT For APU start 1600A required, 300A for maintenance/servicing Has priority over BATT or GEN (cannot be in parallel to any GEN)
Buses	EDL	Controls power contactors, fault protection and load shedding Left and right distribution systems (EDS 1/2)
	≥ 4 GEN	Normal operation, two independent networks left/right (DC bus 1; central and DC bus 2) BATT 1: DC bus 1, parallel to GEN 1/3 BATT 2: Via central DC bus to DC bus 2, parallel to GEN 2/4
	≥ 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
	0 GEN	ELEC EMG. Only "inner circle", no DC BUS 1/2
	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	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	
	Consumers	INV does not work on BATT only. MC if < 108.5VAC 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) → ISIS, RMU 1, EICAS available No MCDU, no flaps operation, manual gear extension	
	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	
		 <pre> graph TD DCBUS1[DC BUS 1] --- DU1[DU1] DCBUS1 --- DU2[DU2] DCBUS1 --- DU3[DU3] ESSBUS[ESS BUS] --- DU3 ESSBUS --- DU4[DU4] DCBUS2[DC BUS 2] --- DU4 DCBUS2 --- DU6[DU6] IC1[IC-1] --- DU1 IC1 --- DU2 IC2[IC-2] --- DU4 IC2 --- DU6 </pre>	

Durations	Flashlights	45min	6VDC NiCad. Switch off while in assembly
	ELT	48h	(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	



(subject to variant-specific changes)

2-06 LIGHTING

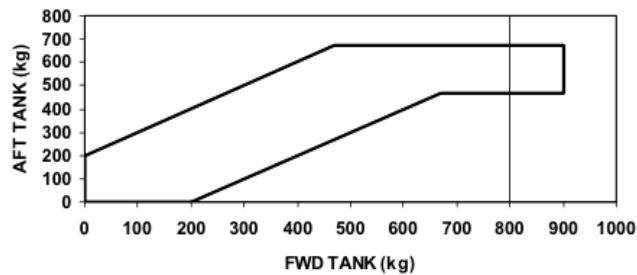
Main Lights	TAXI	2, LH on nose gear, wide and narrow angle (gear must be down and locked)	450W
	WING LDG	2. Wing leading edge, close to fuselage	450W
	NOSE LDG	1, RH on nose gear (gear must be down and locked)	600W
	NAV	3, main and standby lamps each NAV LT STBY switch on PIC side maintenance panel	
	INSP, LOGO	each side (fuselage / under vertical stabilizer)	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	
	Cockpit	2 dome lights (ESS DC bus 1 - available in ELEC EMG), 3 reading lights, 2 chart holder lights (7 lamps each), 3 floodlight assemblies (below glareshield) 6 dimmers, 9 potentiometers	
	Cabin	PAX cabin lights (ceiling, sidewall), PAX warning signs, reading lights (PSU), ATTND call lights, courtesy/stair, lavatory, gallery	
	FSTN BELTS/NO SMKG	automatically on if > 14'000ft (mask deployment)	
	EMG cabin lights	4 dedicated batteries, recharged by essential bus, 6 static INV converting 6VDC → 130VAC, 450Hz Come on when ESS DC power is lost (15min) MC if not armed F/A may switch them on regardless of cockpit switch	

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 (lip) A/I shutoff valves Arm the cartridges → First rotate outboard
	Test	Press at least for 2sec . 3 MW, 2 MC, Baggage 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 TST	APU stop, Fuel S/O close, discharge bottle (not automatically) On GND, APU shuts down if pressed more than 10sec
Lavatory	Smoke detection	Lavatory ceiling: Smoke sensor (indicated on EICAS), DC bus 1 Test via smoke detection panel in fwd galley N/a on 135BJ
	Fire extinguisher	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
	135BJ	Additional fire extinguisher of this type in galley
Baggage Compartment		2 smoke detectors + 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 min 60min / 75min on 135BJ) Powered by ESS DC BUS 1 Fan goes off (also if test switch is pressed)
	135BJ	Close baggage access swing door if smoke in baggage compartment before discharging baggage fire extinguisher bottle

2-08 FUEL

Tanks	[kg]	<u>135ER</u>	<u>135LR</u>	<u>135XR</u>	<u>Legacy</u>	<u>Legacy</u>
		<u>145ER</u>	<u>145LR</u>	<u>145XR</u>	<u>600</u>	<u>650</u>
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
Auxiliary tanks	2 aux tank systems (fwd, aft); = 4 aux tanks					
Fwd	Front section of wing to fuselage fairing					
Aft	Inside rear area of fuselage, aft of baggage compartment (pressurized)					
Ventral tank	Between main LDG gear (650 only)					



System	Engines and APU are fed by the wing tanks only (APU by RH tank)	
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	
135BJ	Wing, fwd aux and ventral tank vented by NACA air intake	
	Aft aux tank	vented by cabin air pressure
Collector box	Flap valves to keep pump inlets submerged	
	Transfer ejector pump keep fuel in box	
Fuel pumps	Wing	3 ELEC centrifugal pumps per tank ; 1 req (2 for T/O / G/A) Fuel pumps A on respective essential DC bus, pumps B on opposite essential DC bus, pumps C on respective DC bus ELEC EMG No pumps if C selected Failure of 1 pump Remaining pumps alternate of 2 pumps MC FUEL LO PRESS of 3 pumps ABC steady indication ENG driven fuel pump : Suction feed, only up to 25'000ft Avoid rapid TL movements and unusual A/C pitch
	Auxiliary	Fwd 2 pumps per tank (1 on stby; A/B selectable) Aft 1 pump per tank plus cabin air pressure (automatically if > 20'000ft; "P" indication)
	Ventral	2 pumps (1 on stby; A/B selectable)
Shut-off valves	ENG	28VDC brushless motor, controlled by fire handle
	APU	Closed by APU master switch, FUEL SHUTOFF or APU EXTG

Operation	Normal	ENG1 from LH wing tank, ENG2/APU from RH wing tank
	135BJ	Auxiliary tanks and ventral tank feed wing tanks
	XFEED	Wing imbalance max 363kg , FUEL IMBALANCE MC disappears if < 45kg Start XFEED when imbalance ~100kg When QRH asks for XBLEED : Consider XFEED <u>No T/O, LDG and G/A with XFEED</u>
	XFER (aux/ventr)	Transfer from auxiliary fuel tanks to wing tanks 2 independent fuel transfer systems: 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 Operation Wait 3sec when switching between FUS1/2 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") FUS1/2 on XFER starts if wing ≤ 1900kg , stops if ≥ 2400kg FUS1/2 off EICAS FUEL XFER CHECK message 7sec after wing ≤ 1850kg Aux ventral tank can be transferred to both wing tanks simultaneously <u>No T/O, LDG and G/A with XFER</u>
	Refueling	Pressure 35..50psi 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 OPEN . Switch CLOSED ~ 1min / 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 ~ 3min / 100kg
Limitations	Density	0.785..0.811kg/l (1000l ≈ 800kg)
	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)
	Level	FUEL 1/2 LOW LEVEL MC: 210..400kg (30min), MW if below Unusable: 22kg , any pump inoperative: 203kg Usable fuel may be reduced by 2x50l if pressure refueled
	Pressure	MC if fuel press < 6.5psi before FPMU inlet Two remaining pumps are energized Vent valve opens at 13psig fuel press

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 Fed by RH tank 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
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% RPM Starter disengagement at 50%/70% (depending on APU model) Ignition exciter de-energize at 70% RPM <u>Online after 95% and 7sec</u>
Stop		Via STOP button; ESU sends overspeed signal APU bleed on while stopping APU Switch off when ≤ 5%
	Auto shutdown	GND only: Fire (10sec 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, red if above)
	EGT	Start EGT max 884°C (925°C for 10sec above 25'000ft) Continuous max 680°C (717°C for 5min) (732°C for 3sec for APU assisted inflight ENG start)
	APU oil	MC if < 6psi or > 166°C (APU OIL HI TEMP MC)
	APU fuel	MC if < 6.5psi (APU FUEL LO PRESS MC)
	Start limitations	Min BATT 23.5V 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 ≥ 3min warm-up Max ALT for bleed air 37'000ft

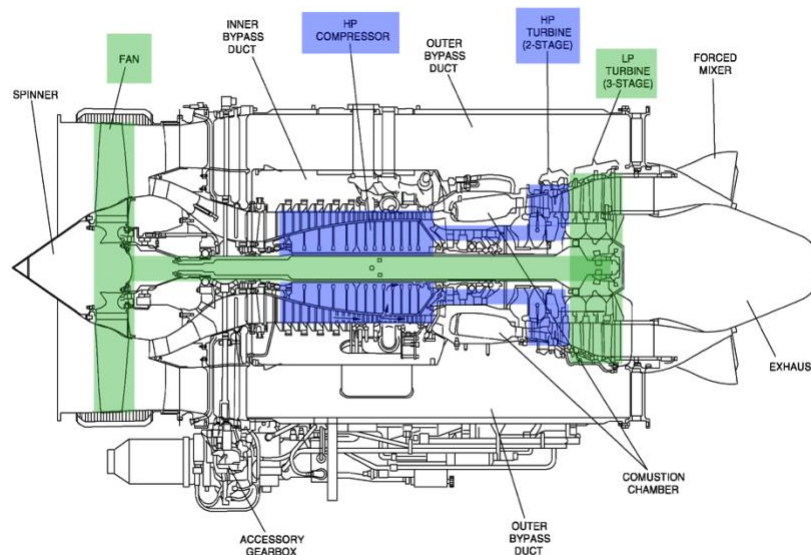
2-10 POWERPLANT

Engine

Rolls Royce / Allison AE3007A1E (T406 engine core)

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)

1-stage low press compressor

3-stage low-press turbine

Blue: Compressor (N2)

14-stage high-press compressor

2-stage high-press turbine

Variants

Type

Thrust

Modes

135, 145

AE3007A1A

3365kg

ALT-T/O-1

T/O-1

145LR, early 600

AE3007A1P

3705kg

ALT-T/O-1

T/O

T/O (RSV)

ALT T/O-1

CON

CLB

CRZ

145XR, late 600

AE3007A1E

3996kg

ALT-T/O-1

T/O

E-T/O

E T/O (RSV)

T/O (RSV)

ALT T/O-1

CON

(E) CLB

CRZ

650

AE3007A2

4208kg

ALT T/O-1

T/O

A2 TO

A2 TO (RSV)

T/O (RSV)

ALT T/O-1

CON

(A2) CLB

CRZ

Fan blades

24 (A1) / 22 (A2)

Fuel System

Routing

FPMU, FCOC, CVG actuators, FF meter and fuel nozzles

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

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 (MFD T/O page)		6..14qts (green range; amber below) in oil tank Min dispatch 8qts Min ENR 6qts
Temperature (EICAS)		40°C .. 126°C (at FCOC) (green range: 21°C .. 126°C) -40°C min temp for start 21°C min temp for T/O thrust
Pressure (EICAS)		34..95psi if N2 < 88% (green range) 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
ENG Components		
AGB		Driven by HP spool (N2 shaft) Drives FPMU (centrifugal and gear pumps), PMA , oil pumps , hydraulic pump , electrical 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 Fuel SOV is not connected to FADEC

Start		First start RH ENG. BAGG door must be closed
Sources		APU bleed, ENG bleed, GND source (hatch near RH ENG)
Sequence		N2 (→ oil pressure) → IGN → FF → N1 → 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 24 , ITT 4xx , N2 64
Motoring		IGN OFF → 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) (new FADEC B8.0 will shut-down automatically) Oil pressure stabilizes below minimum limit Intermittent ELEC/pneum or starter malfunction before starter diseng Abnormal noise, vibration, fire or smoke → ABNORMAL ENGINE START checklist
Warm-up		Idle during <u>≥ 4min</u> for cold engines (off for > 90min) <u>≥ 2min</u> 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		Before shutdown 1min at idle
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% Fan speed N2 Max 102.4% Core speed Starter 1min on → 1 min off, after 5 th cycle 5min off Motoring 5min on → 5min off, ITT Measured by 16 open-tip thermocouples in 1 st stage (LP) ITT 210°C (no motoring needed) Start ITT max 800°C T/O 948°C (5min) (135BJ: 970°C) CONT 901°C (135BJ: 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	System 1	Gear, steering, door (incl accumulator); IB spoilers, OB brakes (more critical system, more time req for gear operation, no steering on GND) Priority valve for flight controls (only minimum flow for gear retraction, which will operate through accumulator pressure) if on EMDP only and gear is operated and pressure difference below 2400psi (e.g. ENG 1 fail after T/O and gear retraction in a turn) (lower EMDP flow)	
	System 2	EMG/park brake accumulator charging; OB spoilers, IB brakes	
Components		Reservoir (pressurized by high-pressure HYD system fluid), EDP, EMDP, manifold, shut-off valve, filter	
	EDP	3000psi	9.2GPM (100% N2) at engine AGB De-selectable; requires maintenance to re-engage
	EMDP (stby)	2900psi	1.5GPM intermittently (smaller HYD lines) 0.7GPM continuously
		AUTO mode	EMDP on if < 1600 ±100psi or N2 < 56.4% ; advisory msg
	Accumulators	Sys 1 LDG gear + main door	For 4 closure operations If blocked (closing line remains pressurized after door closing / solenoid valve failure; BLOCKED inscription illuminates on entrance door panel), actuate altn opening valve for 2min clockwise
Limitations			Sys 2 EMG/prk brk For 6 brake applications , or min 24h parking
		HYD shut-off	Between reservoir and and EDP Closed by buttons on OVHD panel or by fire handles Used in case of overheat or a leak
	Temperature	Thermal switch in reservoir if > 90°C	
	Qty indication	6l reservoir	> 1l Green ≤ 1l Amber, advisory MSG
	Press indication	Amber if	< 1300psi (HYD SYS FAIL MC) or > 3300psi

2-12 LANDING GEAR AND BRAKES

System		Hydraulically operated, electrically controlled, mechanically locked		
		Nose gear doors	Kept closed by HYD pressure 1 , LDG gear door command via DC bus 2	
		Doors of main landing gears	Mechanically operated/linked to gear LG/LEVER DISAGREE MW after 20sec	
		2 WOW switches each main LDG gear, 1 on nose gear		
		Nose gear switches for thrust reversers and nosewheel steering		
Indications	"Gear" if	On EICAS and RMU, ENG backup page 2 - Flaps below 22, RA < 1200ft , 1 TL < 59°, 1 TL < 45° or OEI; or - F22 or more If flaps < 22°: Voice message can be cancelled		
Controls	LG WRN CUTOUT DN LOCK REL	To cancel gear warning in case of RA loss 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	LGEU	
		- ELEC override	NORMAL	LGEU has control
			DOORS	Open nose LDG gear doors
			GEAR/DOORS	Extend LDG gear
		- Freefall lever	Depressurizes LDG gear HYD 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 Accumulator for 24h brakes engagement Overrides TD protection / anti-skid / locked wheel protection (→ pull slowly, modulate manually, accumulator for 6 full applications) MC if accumulator pressure < 2200psi (max 3700psi)		

2-13 FLIGHT CONTROLS

Elevator	Elevator tabs	Only elevator operates fully mechanically Inner spring tabs , opposite movement at high SPD, neutral at low SPD Outer servo tabs , two-channel HSCU with motors
Ailerons		Hydraulic. Left: Autopilot. Right: Roll trim, artificial feel unit
Rudder		Hydraulic via PCU Fwd/aft rudder, aft rudder deflected depending on fwd rudder System 1 shuts off above 135kts (RUDDER OVERBOOST MC else) If SYS 2 fails, SYS 1 takes over Yaw trim not available in mechanical reversion mode Hardover protect Mechanical reversion in case of rudder runaway, if - rudder deflected $> 5^{\circ} \pm 1^{\circ}$, - pedal force $> 59\text{kg}$ (=excessive pedal inputs), and - both $\text{ENG} > 56\% \text{N}_2$ (disabled if OEI)
Trims	Pitch trim	Trimming stops after 3sec actuation 2 systems/motors. Triggers aural warning if $> 3\text{sec}$ No priority between main and backup trims (first activation counts), Main LH trim has priority over main RH trim
Aileron/Rudder Shutoff		Manual reversion in case of HYD problems/runaway
Controls Disconnection		Reset of elevator/aileron disconnection requires maintenance action
Flaps		Double slotted fowlers, electrically driven by 2 ELEC motors FLAP LOW SPEED if FECU monitors that only one channel works Position indication shows every degree Consider early configuration and F22 LDG FLAP FAIL if both failed Velocity sensors to detect flap panel asymmetry
Spoilers	GND spoilers	Deploy if $> 25\text{kts}$ & ($\text{TL} < 30^{\circ}$ or $\text{N}_2 < 56\%$), both panels (anticipate SPOILER FAIL MC if taxi speed around 25kts)
	Speed brakes	Deploy if $\text{TL} < 50^{\circ}$, 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 $\geq 10\text{sec}$ 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, or with A/I on ENG bleed air has priority over APU bleed air - White stripe in APU bleed Button is pressed ($\Leftrightarrow$ ENG bleeds) - OPEN inscription APU bleed is actually open X-bleed AUTO CBV opens if A/I on or XBLD start sel	
	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 $\pm$ 2.5psi	
	Press seq	T/O	Thrust set (TL > 75°) $\rightarrow$ descent 450FPM to 0.2psi below, until A/C ALT is lower or until 15min (so return is possible without having to change the LDG field elevation)
		LDG	Cabin stays 300ft below (avoids pressure bumps), then climbs at 500..650FPM A/C rate of descent > 200FPM: Depressurization seq
	More thrust	T/O	Close ENG bleeds; use APU bleed for A/C
Indications	Temperature	Bleed air temperature downstream of the precooler	
	MW	BLEED OVTMP	ENG BLD and XBLD valves close
	MC	PACK OVLD	if pack outl > 55psi or compressor outlet > 243°C
		PACK OVHT	if pack outl > 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 Δ P -0.3 .. +8.4psi , overpressure max 8.6psi , target 8.1psi (145 / 135BJ: slightly higher 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	To open pneumatic outflow valve	
		AUTO mode	Press DUMP. Stops at 14'500ft Rate 2000FPM
		MAN mode	Select full up (full open) Rate 2500FPM
Connections	A/C SRC	RH wing root	Indication on A/C / pneumatics panel: GND CONN
	LPU SRC	Aft right side	
Limitations		Max 10'000ft for unpressurized flight , unless MEA higher 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 $\uparrow$, 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	
	Single bleed / single pack		
	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 14 th HP compressor stage APU bleed is not hot enough to provide inflight A/I		
	Output	Horizontal stabilizer fed by left pneumatic system (no A/I for vertical stab)		
	Temperature	-40°C .. 10°C (SAT)		
	Indications	ICE CONDITION, SPS ADVANCED, CROSS BLD OPEN		
Operation	OVDERRIDE knob	ENG	< 25kts	ENG air inlet
			> 25kts	WING/STAB as well if ice detected
		ALL	≥ 25kts	ENG/WING/STAB; ENG only if < 25kts
	Operation Icing conditions	On GND	Switch to ENG if visible moisture (VIS < 1 mile) and ≤ 10°C 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 > 3000ft/AGL in icing (not applicable on 135BJ)	
	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 ≥ 25kts 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		SOPM 2-75 9ff, AOM 1-02-79 10ff 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"), chk OPEN inscr / 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 press, 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 COND		
	-	CLB: ENG bleeds open, 2000..23000ft, TAT < 10°C, before entering icing conditions, ICE DET OVRD ALL (20"), chk OPEN inscr., NO ICE-A/ICE ON		
Ice Detection		Ice detection on any of the two sensors: Signal to activate A/I SYS, EICAS advisory message		
	SPS/ICE Speeds	Advisory message; higher stall and approach speeds SPS will activate at reduced AOA for F9/18/22		
	Reset	Can't be reset inflight (on GND : Stall protection test)		
Windshield		2 circuits, 1 normal, 1 OVTMP, 1 spare sensor each On if icing cond or windshield fogging anticipated, and during descent 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

Systems	Crew OXY	Cylinder	Composite, high PRESS. RH side of A/C Delivers 300l/min if cylinder PRESS 200..1850psi
		3 Masks	NORM OXY/air mixture (above 33'000ft: Pure OXY) 100% (center position) EMERG Overpress; to clear the mask from smoke Observer No vent-valve system, "blinker", on/off valve, test/shutoff slide MIC Push BOOM/MASK button on DAP Consider MIC cold if mask to EMERG
		Smk goggle	Right of observer seat
	PAX OXY	145	36 chemical oxygen generators for passengers 60 continuous-flow masks For 12min Masks drop if ESS buses energized, PAX OXY AUTO , > 14'000ft . FSTN BELTS and NO SMKG come on Masks are not suited in case of smoke as chemically generated OXY is mixed with ambient air (only for decompression; use a wet towel) 2 tools near ATTND stations to open manually
		135BJ	1 or 2 oxygen cylinders for passengers
	Portable OXY	Cylinders	5 cylinders 120l . Min press 1'500psi . 2 outlets: HI 4 l/min 30min for 1st aid use LO 2 l/min 60min for walk around
		PBE	2 PBEs (15min/ 20min) in cabin, 1 in cockpit
Limitations	Crew OXY	Minimum pressure for dispatch 1100/1500psi at 21°C for 2/3 pilots (normal: 1850psi) OXY LO PRESS MC if oxygen press < 400psi (12min for pilots+observer) Disc bursts if > 2700psi at 21°C	
	PAX OXY (135BJ)	Min dispatch PRESS 1730psi PAX OXY LOW PRESS MC if < 750psi	

2-17 FLIGHT INSTRUMENTS

General	Inhibit aural	Primus P-1000 MC - Steer Diseng - MC
ADS	A/S indication	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 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 $v_2 + 42$ kts / 230KIAS Comparison Amber IAS if difference 5KIAS → Use lower indication, or PLIs in pitch mode
	ALT indication	Trend vector Situation in 6 sec Comparison Amber ALT if difference 200ft (RVSM requirement) 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 $\leq 10^\circ$ 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	Range	2 systems. 2 antennas each: Lower center and lower rear fuselage Connected to EFIS/IC-600, TCAS, GPWS, AWU, SPS 0..2500ft 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	RA TST button on display controller (inflight) First level test Press for < 6sec (WoW, < 50kts) Second level test Hold ~35sec until all green Inflight test Displays 100 $\pm$ 10ft
	RA1	Required by GPWS (therefore required for CAT II)
	Amber RA1	RA1 is source, RA2 has failed
IC-600s	Test	RA 920, RA TST (on GND)
	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	SG REV	To select offside ADC, ARS or SG (symbol generator) Changes as well ADC and IRS, and AP 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		Stores 25h of data, solid state On if red beacon is on or aircraft is airborne On ESS DC bus 1 In rear electronic compartment With tri-axial accelerometer, de-energized if longitudinal acc > 5g
CVR		Stores 2h Power cut at 5g Erasable on GND only with parking brake on

2-18 NAVIGATION AND COMMUNICATION

FMS Universal	Nearest A/P	NAV DTO LIST [PLN LANG] XTK Extended centerline	Will be canceled after each WPT Via PVOR
FMS Honeywell		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, perf, pilot defined WPT, stored FPL, offside rdo cmds - 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 (cannot 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	
	Range	WX Via arrow keys on weather radar TERR Via rotary knob (n/a on SPD bug page)	
	WX+TERR	displayed simultaneously: WX MAP TERR PLAN then push 1x MAP, 1x WX, 2x MAP, → WX MAP TERR PLAN	
	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, start a new align	

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 ways 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
Sub	PERF	Data Load Up-/download. NDB: Update every 28 days 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 min 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 > 50kts or IAS > 80kts 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 1 EPU 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 - <u>DEST</u>
		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	Restr bank on direct-to turns towards points that are not on the flight plan, but $\geq 30^\circ$ off
Vertical	FLx y NM before PtPt // y / x
NDBs	xxNB 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)
Parallax	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 NAV - DATALINK - ACARS - PRE FLT - INITIALIZE (DEP, DEST) Flight times: NAV - DATALINK - ACARS - NEXT - FLT TIMES
ACARS	

HGS

Data entry	DC bus 1. Fail-passive. BIT - built-in tests. Own built-in IRS. 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)
AIII	FGS guidance source, except LVTO submode (when ILS freq is tuned) HGS guidance source. ILS must be captured, within limits for 5sec, diff magn track and detected CRS $< 15^\circ$, RA $> 500\text{ft}$ 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 $< 1300\text{ft}$, 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 $< 20\text{kts}$

DAP	Volume knobs	Unlatch to connect source to headphone/speaker
	BOOM/MASK	To select microphone. SPKR goes un if unlatched (MASK)
	ID/VOICE	ID (latched) for VOR/ADF identification VOICE (unlatched) to reduce the morse code signal (ADF audio unaffected)
	ST	Sidetone, to prevent undesirable feedback of speaker into microphone Unlatch to switch on SPKR
	MUTE EMER	To control sensitivity, or push to temporarily mute the marker audio In case of power loss LSP is connected to COM1 / NAV1 RSP is connected to COM2 / NAV2 OBS is disconnected No intercom
RMU		On ESS DC bus 1/2 Can store 12 COM and 6 NAV frequencies Dashes when the radio system fails to respond to commands
	PGE	NAV page source is always NAV 1
	Test	Cursor into subsystem, then press and hold TST
TBCH		Alternative mean of tuning COM 2 and NAV 2 if RMU 2 failed On DC bus 2
	EMRG	to take control: RMU2 cmds are ignored, AUX indication on RMU 2 NAV AUDIO to identify NAV
MIC Switch		For intercom, both switches must be in HOT position
	on yoke connector panel	PTT – HOT – OFF PTT – OFF – HOT
ICU	BACKUP INPH	If normal mode failed. Both CABIN and CAB EMER illuminate
Ramp Interphone Stations		2 (fwd lh, aft rh)

2-19 AUTOPILOT

System	Primus P-1000, autopilot and flight guidance, GC-550 control panel 3-axes autoflight system and automatic pitch trim Incorporated in IC-600 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)		
Inputs	Only IC-600 1 has an (enabled) autopilot (coupled to FD1 or FD1) ATT, HDG, air data, RA, NAV, pilot inputs		
Modes	Basic modes	Roll and pitch Entered when changing CPL, changing NAV src 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	
	Roll	Engaged from HDG mode via TCS or TURN knob on center pedestal Canceled if bank < 6° (wings level) Use TURN knob to determine bank angle	
	Pitch	Use PITCH wheel to determine pitch angle	
	Half bank	14° instead of 27° . Only available in HDG mode Used for OEI and for PAX comfort Automatically when climbing through 25'000ft and cancelled when descending through 24'750ft	
	ALT mode	Maintains barometric ALT at the time of selection Entered after ASEL capturing (25ft, < 5FPS)	
	SPD mode	IAS below 25'000ft , 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)	
	FLC mode	Climb or descend depending on ASEL ALT	
		Climb speed	FL100 and below 240KIAS FL120..FL170 270KIAS FL170 and above M 0.56 145XR/600/650 290/M 0.6/M 0.65, different ALT (depending on EICAS version)
		Descend rate	FL370..FL120 -2000FPM FL100 and below -1000 FPM
		Max acceleration 0.1G, overspeed protected Difference to SPD mode in climb: FLC won't descend to catch up speed canceled if GS signal is invalid for > 5sec GS mode does not capture ASEL ALT	
	Non-prec APP	VOR	APR mode (higher gain, more accurate)
		LLZ	NAV mode (prevent inadvertent GS capture)
		NDB	HDG mode
		Once LLZ established, bank is limited to 8°..10°	
	G/A	equals ROL-TO. Will level wings Transitions to SPD hold if < 1.23v _s or 20sec after G/A and > 170KIAS	
	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 AP off
		Otherwise	Put FD into G/A mode

YD		Is engaged when AP is engaged Disengages when red QUICK DISC button is pressed
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 (exc in APR mode) - lateral control is returned to the previously selected mode
AP Failure	AP, YD FAIL MC	Pull IC-1 CB (3↑, 3→) BACKUP BATT off
Limitations		Min engagement height (MEH) 1000ft Min use height (MUH) 160ft, 80ft if CAT II 300ft for 2D APP 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

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
Only consider mean X/WND (w/o gusts)

WND

VIS APP / Circling

CAT I and 2D

600ft MDH, VIS 2400m (Cat C A/C)
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)

Low VIS T/O

(not for T/O, CAT II/III, circling)
if RVR < **550m** (MIN **125m**, 90m visually [slant range])
Consider **T/O-1 T/O**
RVR < 150m: High-intensity RWY centerline lights spaced ≤15m apart,
high-intensity edge lights spaced ≤60m apart; 90m visual segment from
flight crew compartment at the start of the T/O run; required RVR
value is achieved for all of the relevant RVR reportings
Start T/O roll at threshold (in case of **displaced threshold**)

LVP in force

T/O ALTN

Perform **monitored APP**
If not possible to return, considering OEI
Max 60min OEI CRZ SPD (270kts max CONT)

No T/O

Closed DEST

ALTN

if moderate or heavy freezing rain
2nd ALTN required; calculate with the higher ALTN fuel
Must be open for lower APP category:

No DEST ALTN

CAT II/III → CAT I → Non-prec → Incr 200ft / 1000m RVR
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)

Planning 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

AP

CAT I: Required RVR is **550m/125m/75m**. **CAT II: 300m/150m**
If RVR drops after having passed OM: Look and see
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

DA

Must not be undershoot; **add 50ft**
Altitude at which the decision has to be taken (land / G/A)

Contact

if at least **3 consecutive lights** in sight (one of which with a central row)

Airports	Fire fighting	For DEP/DEST 4 other sources: 6 (145/140) / 5 (135) For ALTN 3 XCHK with dispatch 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
	Inflight	ALTN unfactored x 1.67 for both dry and wet RWY
	WED	Use unfactored LDG distances (dry) / QRH tables/factor (wet)
		Slush 0.85
		Wet snow (loose) 0.40
		Dry snow (loose) 0.20
	T/O	Max 8mm WED
	LDG	Max 20mm WED
	Wet	Wet if $\geq 50\%$ shiny and water coverage $< 3\text{mm}$
	Grooved RWY	May be considered dry
	Contaminated	$\geq 3\text{mm}$ (but $< 13\text{mm}$); 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 $v_{MCG} \dots v_R$ 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, ... $\rightarrow$ reduced v_1 , 15ft margin only) No v_1 correction if RWY is covered with roll-resisting deposits
	Unbalanced T/O	- Contaminated RWY: v_R/v_2 are increased for better climb 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
CLB Gradient		Indicated on APP chart only if $> 2.5\%$; then brief OEI MAP
RVSM		FL 290 to FL 410 (both inclusive; six additional FL)
		Operator, crew and aircraft must be approved
		Check blue documents booklet and ATC FPLN (10/equip ' W ') MEL 2 independent primary ALT, 1 AP w/ALT hold ($\pm 65\text{ft}$), 1 ASEL (alerting deviations $> 300\text{ft}$), 1 XPDR w/ALT enc
		ΔALT GND max 75ft (in between and compared to known ALT) Inflight max 200ft . XCHK and log prior entering A/S / every 60min (ATC interferes latest at 300ft)
		ALT changes Do not over-/undershoot by more than 150ft , Reduce to max 1500FPM the last 1000ft
		" Affirm /negative RVSM" / " Unable RVSM due to 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 ($\Leftrightarrow$ MEA)	
	MORA ("a")	Min off-route ALT (grid/route). Obstacle clearance left/right 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
		1 st hour	1500kg trip
		2 nd 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	70kg
		Trip fuel	DEST with burn-off correction
		a)	ZFM + ramp fuel - taxi/APU
		b)	MTOM/RTOM
		c)	MLM/RLM + trip fuel
Dangerous Goods		Underload	
		Lowest of a/b/c - actual TOM	
Dispatch	MEL	Articles/substances capable of posing significant risks to health, safety, environment, property	
		"No Carry Operator" if no approval	
	CDL	Minimum Equipment List, for A/C 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	
		(O): specific operations procedure, (M): specific maintenance proc	
Dispatch	HIL	Rectifying intervals: A (specific), B (3 days), C (10 days), D (120 days)	
		After off-blocks QRH applicable, not MEL any more	
		Configuration Deviation List, outside parts of A/C	
Dispatch		No time frame given for rectification	
		Maintenance has to transfer tech log entries to HIL (or pilot with assistance of maintenance, if pilot is trained)	

EASA Regulation (EU) 965/2012 on air operations,
CAT.GEN.MPA.180; customs regulations, OFCOM

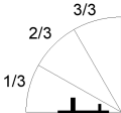
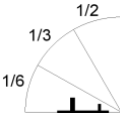
Originals of:

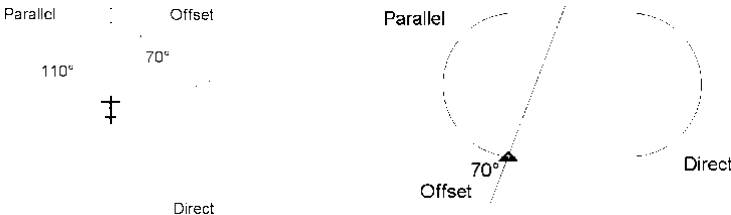
- Aircraft flight manual (AFM)
- Certificate of registration
- Certificate of airworthiness
- Noise certificate
- Air operator certificate (AOC)
- Operations specifications
- Aircraft radio station operating licence
- Third party liability insurance certificate
- Journey log
- Technical log
- ATS flight 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 AOM SOPM	Certified document, must be strictly applied Additional details of applicable procedures Proposed actions/CRM in order to best cope with a situation
Priorities	FGS	Stall warning → EGPWS → TCAS Always follow FD , except TCAS RA, EGPWS hard warnings, or when in doubt about correctness - switch off otherwise
CRM	MCDU FGS Closed loop AP Call-outs	Below FL100, PF orders all MCDU entries. PM enters, PF confirms If flying manually or OEI (even if AP is engaged): Order all settings Simplified PF executes and calls out, PM: "Checked" Extended PF orders, PM executes silently, PF checks silently Below 1500ft/AGL Always one hand at yoke "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 N - ature of problem T - ime available I - ntentions or E - mergency type T - ime S - ignals to be used S - pecials T - ransmit additional instructions
Areas of Responsibility	LSP RSP PF PM	Glareshield panel incl. middle part, control pedestal Overhead panel, RH RMU, RH CDU Spoilers Gear, Flaps
Shoulder Harness		May be removed between TOC and TOD Lock in case of turbulence, expected crash, pilot incapacitation
FD		Always follow, except for TCAS RA, EGPWS hard warnings, or if in doubt VIS APP: FD OFF

Lights	NAVIGATION LOGO RED BEACON TAXI (nose) STROBE LDG INSP	Whenever A/C is energized Sunset to sunrise and during low VIS operations When engine(s) running or when A/C is moved On GND when moving (together with parking brake) When on active RWYs During T/O / LDG, after clearance received, < FL100/in congested areas For visual wing surfaces inspection
RTF Phraseology	Readback Acknowledge HDG SPD ALT Request Yes No Clearance Cleared Conditional H/O	Readback QNH and RWY "[Roger], C/S" "Wilco" only to confirm a reporting instruction All headings should be expressed in single digits All speeds should be expressed in single digits Specify ".. FEET" and "FLIGHT LEVEL ..." 10'000ft can be expressed as "one zero thousand feet" FL can be expressed in hundreds "Request FL360" (not: "any chance" / "is available") Affirm Negative "C/S, information hotel, stand E43, request clearance to..." 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" "BEHIND landing traffic, line-up RWY 28 and wait BEHIND" Only repeat the frequency, not the station for the hand-over
ENG Start-Up	LPU XBLEED	BATT min 24V Low press unit SOPM 2-65, AOM 1-02-81 1 01 (273), 1-12-05 2 40..45psi Cross start SOPM 2-63, AOM 1-02-81 3 01 (275) Bleeds closed (non-operating ENG) and open (other ENG) N2 > 80%
T/O	LSP Low VIS Profiles	Hand on TL until v_1 Use <u>T/O-1</u> Start T/O on green line (taxi forward if displaced threshold) 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	Approaching Endurance High speed Climb gradient Intermediate LVL Cruising LVL	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 Max 1000FPM 1000ft before cleared ALT/LVL 240KIAS to FL100, 270KIAS to FL174, then M 0.56 (FLC) (high TWND ENR or climb fast through turbulences) 240KIAS to FL100, 290KIAS to FL216, then M 0.65 e.g. 383FPM: Multiply by [GS] Max 240KIAS $\leq$ FL100, 300KIAS > FL100 Maintain CLB thrust mode Maintain CLB thrust mode 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 =		WCA =	x WND	
					= ½ XWND		
		for 120KIAS. At 150KIAS, decrease corrections by 30%, at 90KIAS, increase corrections by 30%					
	Conversion	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]					
Course Intercepts		90°/45° intercept if QDM more than 20° 30° intercept otherwise					
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	Entries:  (end of OBS needle) (Offset = Teardrop, 30° for 1min)
	Outbound leg	1min if ≤ 14'000ft/MSL, 1½min if above
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, RA test Both DU on RSP side must be working, GPWS (+RA1) must be working RSP flies down to MIN, "CTC / LDG" → H/O; G/A otherwise Use F22 ice speeds AP MUH 80ft Callouts 1000 ("stabilized") - 500 ("CAT II engaged") - approaching MIN - MIN 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"
2D 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

RNP APP		AOM 1-02-80 9ff
Required eq		LNAV, LNAV/VNAV, LP, LPV (SW6.1+). RNP is a type of PBN
		1 FMS, 1 GPS, 1 DME*, 1 VOR/LOC*, 1 ADF*, 4 DUs** , 1 FD, 1 MCDU
		(* for conventional NAV backup; ** PFD-DUs must be working)
		LP/LPV SBAS required
Indications		LPV 2D, angular, not subject to low TEMP corrections
		Gets linear when approaching the RWY threshold
		Linear instead of angular
		RNP value equals 2 dots deviation horizontally, indicated number equals 2 dots deviation vertically
Procedure		Amber /blinking if deviation of ≥ 1 dot
		Check NAV DB validity
		Initialize PERF
		Perform predictive RAIM (not req for LPV, consider for downgradings)
3D		Check TEMP limitation for LNAV/VNAV APP (or compensate TEMP)
		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
Temp corrections		Arm NAV, then arm APR
		Only for 2D approaches, only from FAP/FAF to RWY
		(delete corrections for other WPTs on FMS, incl missed approach)
		Manual correction: 4% / 10°C ISA deviation for ALT AGL
EPU		MCDU - PROGRESS PAGE 1
Circlings	Downwind	Airport environment must be visible
	Base	Before initiating descent: Threshold must be visible
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 (135BJ: max. 5.5°) Max TWND 5kts
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
	G/A	if deviation > 1 dot
High SPD APP		Mind: Not stabilized at 500ft (F45)
Final		F9, 240KIAS
	1500ft	TL idle, gear down (mind "GEAR" warning at 1200ft)
	200KIAS	F22
	145KIAS	F45, set 62% N1

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

Worksplrit

PM Acquisition: "MC/MW, ..."
 PF "Cancel warning/caution"
Aviate, navigate, communicate
 < 400ft/AGL **"Check thrust, check performance"** (gear, flaps, spoilers, *trims*)
 (non-major EICAS MSG are inhibited v_{1-15} .. 400ft)
 (only MC/MW cancel and flight ctrls disconnect if stuck/trim runaway)
(no BHI < 400ft/AGL or after 4NM final)
 ≥ 400ft/AGL **Analyze**, action: "BHI", "BHI complete"
 > 1500ft/AGL "Worksplrit: I fly, my ATC, your **ACL/ECL. Check CBs.**"
(e.g. request delaying vectors)
 If on APP: G/A if below, except blocked controls / trim runaway
 Wording PM: "**TL confirm**", PF: "Number 1/2 confirmed" etc.
 (hand on respective ctrl to have it confirmed)
 QRH: 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

ENG Failure

SOPM 3-15-10

1. **Maintain wings LVL with ailerons,**
 2. **add rudder gently until yoke is neutral,**
 3. **trim** (remember 3sec trim cutout), use **ISIS** slip indicator
 - Initial CLB 1dot
 - CLB/CRZ ½dot
 - APP/LDG ¼dot
- Add 10% N1**, pitch remains same
F22 for OEI LDG
 Always start APU, always start XFEED
Leave rudder trim during 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**
Dual ENG out Maintain v_{FS} ($\approx v_{DD}$); **~1200FPM** ↓. Check HYD page if pumps on
 Use F22/F45 for G/S adjustments. **APU** start limit: **FL300**
ENG fail on final < 4NM: *Consider* continuation and **retract to F22**, add 10kts SPD incr
 In general: **G/A**
 CL After bird strike, vibrations, bang/noise, **N1 or N2 zero**, ...:
"ENG Severe Damage CL". BHI only for fire, severe damage, separation

Fire / Smoke

SOPM 3-10 18f

- | | |
|-----------------------|---|
| On GND | In case of any fire, even if extinguished: EMG EVACUATION |
| LSP | START/STOP selector to STOP |
| RSP | Fire ext handles pull ; ENG fire, sever damage, separation CL |
| On final | Continue, land, EMG EVACUATION |
| Smoke in cabin | Always put on mask (even if not visible in cockpit) |

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 |

Windshear Recovery / EGPWS
SOPM 2-83 1, 3-15-05 10f, 3-40 11f

Any "G/S" or "W/S" callout: "**Windshear**" (any pilot), **G/A AP off, TL max, G/A button**, PF: "**Max**", wings LVL, pitch up: Follow FD (announced) / **20° or PLI** (unannounced) (remain between FD [stable] and PLI [nervous])
Do not change config (only once terrain cleared and **above 1500ft/AGL** or after WDSHEAR label disappears) (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, **FSTN BELTS** on In W/S mode: **No ASEL ALT** will be captured
MC "Positive" W/S. Pilot's decision to continue or to G/A
MW "Negative" W/S; downdrafts

TCAS TA PF Look out; hands on yoke
SOPM 3-05-10 3ff PM All external lights on, FSTN BELTS on
RA PF **AP off**, set thrust. Call out position of intruder
If in a turn: **Wings LVL**
PM "**TCAS RA**", "**Clear of conflict, returning to ...**" / "**... resumed**"
Contradicting instructions: "**Unable, TCAS RA**"
File report
SOPM 3-05-10 4 Cases with insufficient performance to follow TCAS commands

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

Upset Recovery
SOPM 3-25 18ff PF Pitch values beyond -10 .. +25°, bank > 45° / any undesired A/C state
First "**Upset**, I have control", disconnect AP/FD
Stall PF **Unload the wings** (for aileron effectiveness) (even with AND)
"Stall". Nose down, wings LVL, TL max
No trimming below top of white speed arc (1.23v_s)
ANU Approaching v_{MCA} Reduce thrust, lower nose, increase thrust
Push to unload. Then, first adjust **pitch**, then **thrust**, then **wings LVL**
(simultaneous elevator/aileron inputs could induce a dutch roll)
If pitch is too high: Bank to 45..60° until pitch is lower
AND Push to unload. Then, first **wings LVL**, then **throttle idle, adjust pitch**
High SPD buffeting Thrust idle. **Do not use speed brakes**
Dutch Roll Use YD. Use **ailerons. Do not use rudders**

Unreliable Airspeed PF **Disengage AP**, 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

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)

Driftdown <i>SOPM 3-25 6ff</i>	after ENG failure	$v_{FS} \approx v_{DD}$. NAV reception is not guaranteed ALT hold, max <u>cont thrust</u>, at v_{DD} engage SPD
EMG Descent <i>SOPM 3-25 13ff</i>	after rapid depr	BHI . Fly 5..10NM parallel (turn 30° off to leave AWY) ASEL to FL100 / MEA, initiate descent with TCS Inform ATC (declare EMG) Squawk 7700, turn on exterior lights "Attention crew, EMG descent" ALT callouts every 10'000ft, "2000ft", "1000ft" 2000ft before target FL FLC 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 Whistling sound, may feel ear problems - Rapid Explosive noise, fog, flying objects, - Explosive < 1sec dizziness, pain TUC FL300 1min FL350 30sec FL400 15sec
LDG Gear Malfunctions		During gear cycle: Consider leaving gear↓ if down and locked; no retraction
Overweight LDG <i>SOPM 3-40 17f</i>		ROD max 300FPM
Ditching <i>SOPM 3-40 21ff</i>		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
EMG Evacuation <i>SOPM 3-10 20ff</i>		Switch off ENG first "Crew at station" / "EMG evacuation" not via ICU but via PA
	Rapid deboarding	Using stairways. SOPM 3-05-01 7
COMM Failure	VMC	Squawk 7600, maintain VMC, land asap
	IMC	Squawk 7600, maintain assigned SPD/LVL for 7min , then resume FLP
Pilot Incapacitation <i>SOPM 3-05-10 11f</i>		= Failure to respond to a second request , or e.g. impairment by gastrointestinal illness or laser strikes. Is always an emergency 1. Fly, "I have control", best use of equipment 2. Restrain (assisted by cabin crew). Removing from seat: difficult 3. ATC: " Mayday x 3, pilot incapacitation" + request medical assistance 4. Consider 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

RECALL ITEMS

Smoke / Fire / Fumes, Smoke Evacuation		Crew oxygen masks Smoke goggles Crew communication Recirculation fan	Don, 100% (center pos) Don Establish, also with ATC <i>Push out</i>
	135BJ		
APU Fire		APU <u>fuel SOV</u> APU <u>MASTER</u>	Push in OFF, (TC)
Baggage Smoke	135BJ	BAGG ACCESS OPN MC <u>Fire Extg Bagg</u> Button	Not displayed on EICAS Push in
Abnormal ENG Start	To abort	Associated TL START/STOP selector	IDLE STOP
ATTCS Failure		Thrust levers	Max
ENG Fire, severe Damage, Separation (no BHI for ENG failure) (e.g. after bird strike, vibrations, ...) Legacy 600 Legacy 650		Associated TL START/STOP selector	<u>IDLE</u> <u>STOP</u> (LSP)
		Fire ext handle	<u>Pull</u> (do not rotate) (RSP)
		Fuel Fus Tk XFER	OFF
		Fuel XFER master knob Fuel XFER OVRD button	OFF Pushed in (off)
Dual Engine Failure		Oxygen masks Fuel Pump Power Tank 1+2 Fuel Pump Sel 1+2 APU A/S for windmilling	As required On A or B START (max FL300) Above 10'000ft MIN 250KIAS Below 10'000ft 220..250KIAS
Battery Overtemperature		Affected battery	OFF
ELEC ESS XFR FAIL MW		<u>ESSENTIAL POWER</u>	Push in

Steering System inoperative / uncommanded Swerving on GND	Steering handwheel Steering disengage button <i>Use differential brakes / rudder</i>	Do not use Press
Pitch Trim Runaway	Quick DISC button	Press and hold
Aileron / Rudder Trim Runaway	Quick DISC button <u>AILERON/RUDDER SHUTOFF</u> 1+2 <i>Control attitude manually with control wheels and rudder</i>	Press and hold Push out
Jammed Aileron / Elevator	Aileron / elevator DISC handle	Press and pull (after confirmation)
Inadvertent Spoiler Open	SPEED BRAKE	CLOSE
Erroneous Stall Protection Actuation	Quick DISC button Stall Protection Cutout 1+2 Quick DISC button	Press Push out Release
Stick Pusher Failure	Control column	Toward neutral
<i>135BJ: Stall Protection inoperative</i>	<i>Affected Stall Prot. Cutout</i>	<i>Push out</i>
<i>135BJ: Airplane Overspeed</i>	<i>Airspeed</i>	<i>Max V_{MO}/M_{MO}</i>

Rapid Cabin Depressurization	Crew oxygen masks Crew communication	Don, 100% (center pos) Establish, also with ATC
Emergency Descent <i>135BJ</i>	Cabin Crew FSTN BELTS / NO SMKG Thrust Levers Speed Brakes A/S LDG Gear Descent <i>Transponder</i> ALT	"Attention crew, EMG descent" On Idle Open, check MAX 250KIAS (V_{LOE}) Down, check Initiate 7700 MEA of 10'000ft if higher "Attention crew, we've reached safe altitude"
Emergency Evacuation	LSP Parking Brake ENG Cabin Crew RSP (1) Cabin (3) Top OVHD row (2) Med OVHD row (1) Bottom OVHD row (1) PTT LSP Evacuation	Apply Idle, STOP "Attention crew, wait for instr" Depressurize Fire Extinguishing Handles Pull APU Fuel Shutoff Valve Push ENG/APU Fire Ext Bottles Disch (if req) Fuel Pumps Pwr 1 and 2 Off HYD ELEC Pumps 1 and 2 Off EMERG LT ON ATC Notify "EMG, open seat belt, evac", EVAC CL

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 < 19V BATT Voltage for APU start: 23.5V If recharging, BATT 1 off before APU start, AUTO after 3min Min recharging time 30min
GPU	26..29V
Fire detection	2x pushed out. TEST for ≥ 2sec : 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 (3min 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 of 2/3), 1150psi (pax)	
Glareshield	WX RADAR	TEST (WX on MFD), then STBY
	AP	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: A/C 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 ADV 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	<u>PROG</u> page
	PM	<u>FPL</u> page

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

SPD bugs	V1	VR	V2	AP	Bug
	V ₁	V _R	V ₂	V _{AP}	v₂+20 (max)
				(V _{REF45} +5)	

Briefing LSP Any failure before v₁, you call it out or point at it.
I decide whether to reject, TL to idle, reverse.
Up to 80kts We stop for any failure
Beyond **80kts** High speed T/O abortion only for **ENG failure, fire,**
pilot **incapacitation** or **unflyable** condition
When we stop, you inform the **ATC**. I decide on **evacuation**

PF After v₁, 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 1..3sec**
LSP TC START Check **10sec N2**↑, **12sec FF**, oil pressure
RSP TC FF Check (5 -) **10sec ITT**↑
LSP **"Normal start", "Set F9, flight control check, APU off", "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; VIS < 1 mile , ≤ 10°C TAT)
	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	" v₁, rotate, positive rate "
		PF	" Gear up ", trim down to 14° ANU before 160 KIAS use TCS if SPD < v ₂ +10 Fly v₂+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	400ft	PF	"Select NAV "
	1000ft	PF	"Engage AP "
	1500ft	PF	"Select CLB thrust "
		PM	Check packs
	3000ft	PF	" CLB sequence "
		PM	v _{FS} . At v _{F0} (v₂+15): F0, " Flaps 0 " (F18 T/O: v ₂ +10 F9, v ₂ +30 F0)
		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 (loss of thrust)		Any	" ENG ... failure "
		PF	" Check thrust , check performance" - PM: "Thrust checked"
		PF	Climb at v ₂ (10° ANU) (use TCS) Yaw trim until system automatically stops after 3sec (¾dot)
	400ft	PF	"Select SPD v₂, HDG, BNK " In case of fire : "Check recall items"
	1000ft	PF	"Select ALT hold, engage AP "
	v _{F0} (v ₂ +15)	PF	" F0 " - PM: " F0, v_{FS} " (SE best ROC clean)
	v _{FS}	PF	"Select SPD (v _{FS}), BNK off, CON thrust, recall items , applicable abnormal CL, after T/O CL " (full bank protection if ≥ v ₂ +10)
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
		$\boxed{V1}$	$\boxed{VR} = \boxed{V2} \quad \boxed{AP} = \boxed{Bug}$
		V_{FS}	$V_{REF} \quad V_{APPCLB} \quad V_{APP} \quad V_{APP}$
		($\approx V_{DD}$)	
		$V_{APP} = V_{REF} + \underbrace{\frac{1}{2}HWND + Gust\Delta}_{\text{SPD increment:}}$	
			F45 5 .. 15kts
			F22 5 .. 20kts
			Ice/OEI 0 .. 15kts
			(HWND $\leq$ 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"
3D 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"
	FAP		"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 engaged" / "AIII engaged"
	500ft	PF	"500" - PF: "Checked"
2D APP	OM		"OM check", ALT / MIN / G/A ALT, "OM check completed"
	100ft/MIN	PM	"Approaching minimums", "Minimums"
		PF	"Landing / G/A"
			Set RA DH to 0
		PM	"CDI alive" - PF: "Checked"
	0.3NM	PF	"LDG gear down, F22"
			Select V/S 0, disarm ASEL (see below)
	FAF	PM	"FAF"
		PF	"Set G/A ALT and HDG " for CDFA (else: ASEL to MDA; SOPM 3-35-10 7f) V/S -700FPM (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 MIN	PF	LDG gear down, F22 (as well for OEI) "Select HDG and ALT hold " Break off: 45° for 30sec (protected area: 4.2NM; do not break off before)
	Abm LDG thresh Base G/A	PF	TC, 20sec , AP off, descend " F45 , before LDG CL". Completed latest at 500ft/AFE Initial climbing turn towards landing RWY and overhead A/D Intercept published MAP for APP RWY
Steep APP	<u>After F45</u>		Fully configured before capturing glide Push <u>steep APP button</u> , " Steep APP engaged " (inhibits EGPWS wngs) V_{APP} = V_{REF} AP 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}), <u>G/A button</u> , TL MAX, 10° ANU
		PM	" Positive rate ", check thrust (silently)
		PF	" Gear up "
		PM	Select SPD v_{FS} and advice ATC
		PF	" NAV SRC FMS, select NAV " / "Select HDG"
		v_{FS}-5	"CLB sequence"
		PM	F0, CLB thrust, SPD (210 or FLC), "F0"
		PF	"After T/O CL"
	OEI G/A		AP off , CLB with v_{APPCLB} (= v_{REF}) to <u>G/A ALT</u> (SOPM: ACC ALT) "Select SPD, HDG, BNK ", " ALT hold "
	CAT II	v_{FS}-5	F0 , "Select SPD (v_{FS}), CON thrust, BNK off " Prefer AP off (late G/A rotation with AP on)
BEFORE LDG	OEI LDG		Anticipate yaw with rudder; prefer trimmed yaw for LDG Autopilot and XFEED must be off ENG failure on final: Retract to F22, re-brief speeds
	AP off		Silent item; press TCS to cancel warning
	50ft		TL idle
	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

3. ABBREVIATIONS

A/C	Airconditioning	EPU	Estimated Position Uncertainty
A/C	Aircraft	ESU	Electronic Sequence Unit
A/D	Aerodrome	FADEC	Full Authority Digital Engine Control
A/P	Airport	FCOC	Fuel Cooled Oil Cooler
A/S	Airspeed	FD	Flight Director
ACL	Abnormal Checklist	FDC	Flight Data Computer
ACOC	Air Cooled Oil Cooler	FDR	Flight Data Recorder
ACT	Altitude Compensation Tilt	FFD	First Flight of the Day
ADC	Air Data Computer	FGS	Flight Guidance System
ADS	Air Data System	FLC	Flight Level Change
AFE	Above Field Elevation	FLP	Filed Flight Plan
AFM	Airplane Flight Manual	FMS	Flight Management System
AGL	Above Ground Level	FPM	Feet Per Minute
ALC	APU Line Contactor	FPMU	Fuel Pump and Metering Unit
AND	Attitude Nose Down	G/A	Go-Around
ANU	Attitude Nose Up	GCU	Generator Control Unit
AOM	Airplane Operations Manual	GLC	Generator Line Contactor
AP	Autopilot	GMT	Greenwich Mean Time
APP	Approach	GPC	Ground Power Contactor
APU	Auxiliary Power Unit	GPU	Ground Power Unit
AR	Authorization Required	GPWS	Ground Proximity Warning System
ASC	APU Starting Contactor	HGS	Head-up Guidance System
ASD	Accelerate-Stop Distance	HIL	Hold Item List
ATS	Air Turbine Starter	HSCU	Horizontal Stabilizer Control Unit
AWU	Aural Warning Unit	IC	Integrated Computer
BBC	Backup Battery Contactor	ICU	Integrated Communication Unit
BBR	Backup Bus Relay	ICU	Intercommunication Control Unit
BC	Battery Contactor	INU	Integrated Navigation Unit
BCU	Brake Control Unit	ISIS	Integrated Standby Instrument System
BHI	By-Heart Item (Memory Item)	L/U	Line-Up
BIT	Built-In Test	LGEU	Landing Gear Electronic Unit
BTC	Bus Tie Contactor	LH	Lefthand
C/S	Callsign	LPU	Low Pressure Unit
CAS	Calibrated Airspeed	LRN	Long Range Navigation
CB	Circuit Breaker	LSP	Left Seat Pilot
CDFA	Continuous Descent Final Approach	LVP	Low Visibility Procedures
CGO	Cargo	LVTO	Low Visibility Take-Off (< 550m)
CL	Checklist	MC	Master Caution
CMC	Central Maintenance Computer	MCDU	Multifunction Control Display Unit (FMS)
CPAM	Cabin Pressure Acquisition Module	MDA	Minimum Descent Altitude
CRS	Course	MFD	Multi-Function Display
CVG	Compressor Variable Geometry	MIC	Microphone
CVR	Cockpit Voice Recorder	MUH	Minimum Use Height
DA	Decision Altitude	MW	Master Warning
DAP	Digital Audio Panel	NAP	Non-Annunciated Procedures
DAU	Data Acquisition Unit	NAV	Navigation
DB	Database	OEI	One Engine Inoperative
DMA	Daily Meal Allowance	OVHD	Overhead
DU	Display Unit	PAX	Passenger
EAP	Emergency / Abnormal Procedures	PBE	Protective Breathing Equipment
EBC	Essential Bus Contactor	PBN	Performance Based Navigation
ECL	Emergency Checklist	PCU	Power Control Unit
EDL	Electrical Distribution Logic	PF	Pilot Flying
EDS	Electrical Distribution System	PFD	Primary Flight Display
EFIS	Electronic Flight Instrument System	PLI	Pitch Limit Indicator
EGPWS	Enhanced Ground Proximity Warning System	PM	Pilot Monitoring
EIC	Essential Interconnection Contactor	PMA	Permanent Magnet Alternator
EICAS	Engine Indication and Crew Alerting System	POB	Persons On Board
ELT	Emergency Locator Transmitter	PSU	Passenger Service Unit

QRH	Quick Reference Handbook
RA	Radio Altimeter
RA	Resolution Advisory
RAIM	Receiver Autonomous Integrity Monitor
RCT	Rain Echo Attenuation Compensation
RH	Righthand
RMU	Radio Management Unit
RNP	Required Navigation Performance
RSP	Right Seat Pilot
RTF	Radiotelephony
SBC	Shed Bus Contactor
SCV	Starter Control Valve
SOPM	Standard Operating Procedures Manual
SOV	Shut-Off Valve
SPC	Stall Protection Computer
SPD	Speed
SPS	Stall Protection System
SSFDR	Solid-State Flight Data Recorder
TA	Traffic Advisory
TBCH	Tuning Backup Control Head
TCAS	Traffic Collision Avoidance System
TCS	Touch Control Steering
TL	Thrust Lever
TOC	Table Of Contents
TUC	Time of Useful Consciousness
UFN	Until Further Notice
ULB	Underwater Locator Beacon
V/S	Vertical Speed
VTA	Vertical Track Alert
VV	Vertical Visibility
W/S	Windshear
WED	Water Equivalent Depth
WOW	Weight On Wheels
WPT	Waypoint
WX	Weather
XPDR	Transponder