OPERATIONS MANUAL
FLT CREW TRAINING

# PROJECT OPEN SKY
# ERJ-135/140/145 and Legacy


## TAXI, TAKEOFF, CLIMB, CRUISE, DESCENT & LANDING


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The procedures contained within are this author’s interpretation of generic flight operations. These procedures are not always accurate in all situations.

All diagrams have been recreated to mimic actual procedures or scenarios, however, are not taken from actual materials whatsoever. All diagrams are recreations of true documentation, modeled and re-edited to look as realistic as possible. Procedures are not always accurate.

This manual is not intended for real world flight.

**Project Open Sky aircraft are intended as a freeware add-on for Microsoft Flight Simulator 2004 and Flight Simulator X.**


**Project Open Sky**
**Embraer Regional Jet – ERJ/Legacy-Series**
**Version 2007.9.3**

**FSX and FS2004 Compatible**

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## PREFACE

This manual serves as a reference for operating procedures and training maneuvers. The flight profiles show the basic recommended configuration during flight.

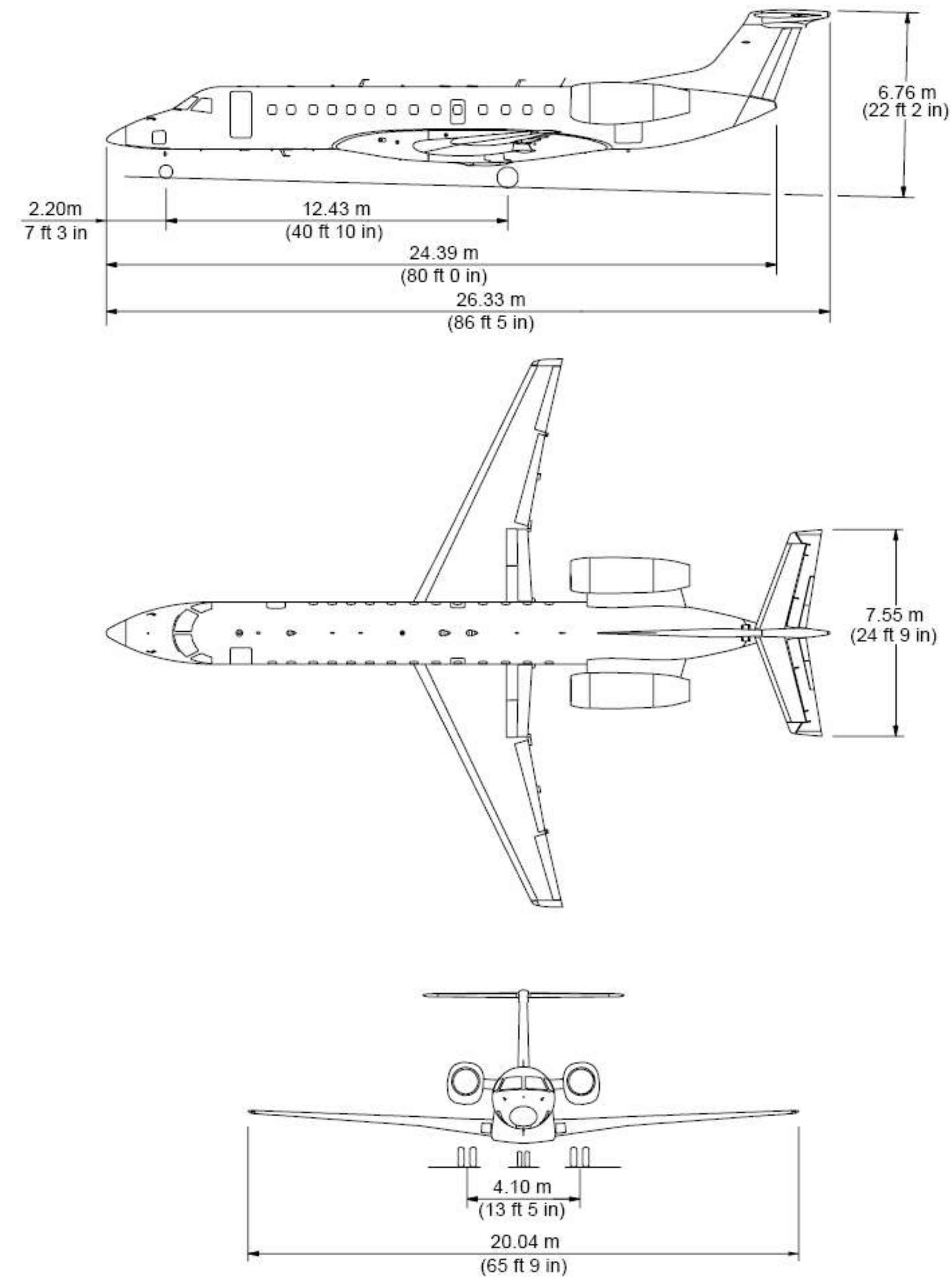
The maneuvers should normally be accomplished as illustrated. However, due to airport traffic, ATC distance separation requirements, and radar vectoring, modifications may be necessary.

Exercise good judgment.

## PRINCIPLE DIMENSION AND AREAS

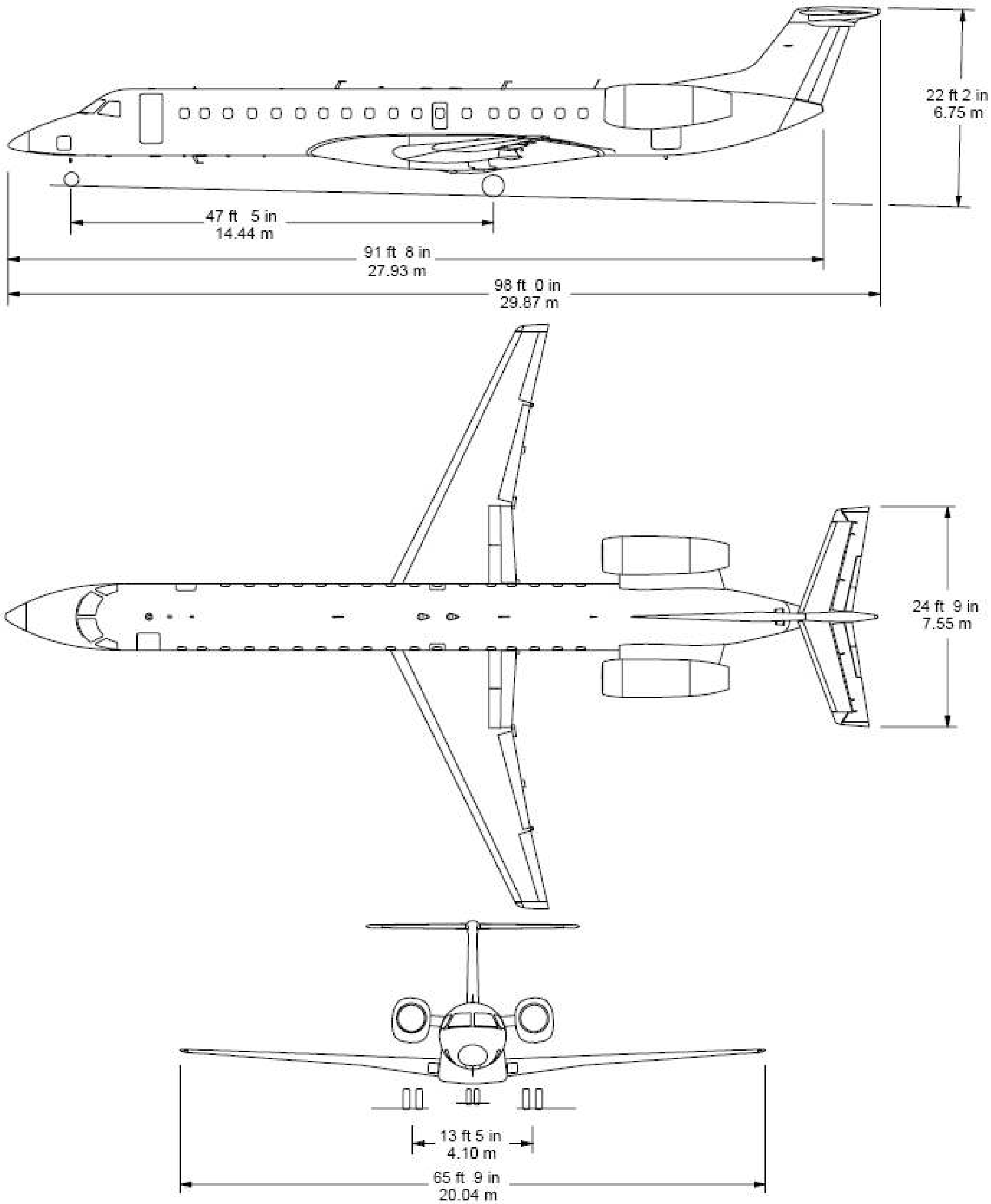
## Embraer ERJ-135/140/145 and Legacy – Aircraft Reference Manual

**ERJ-135 / 140**



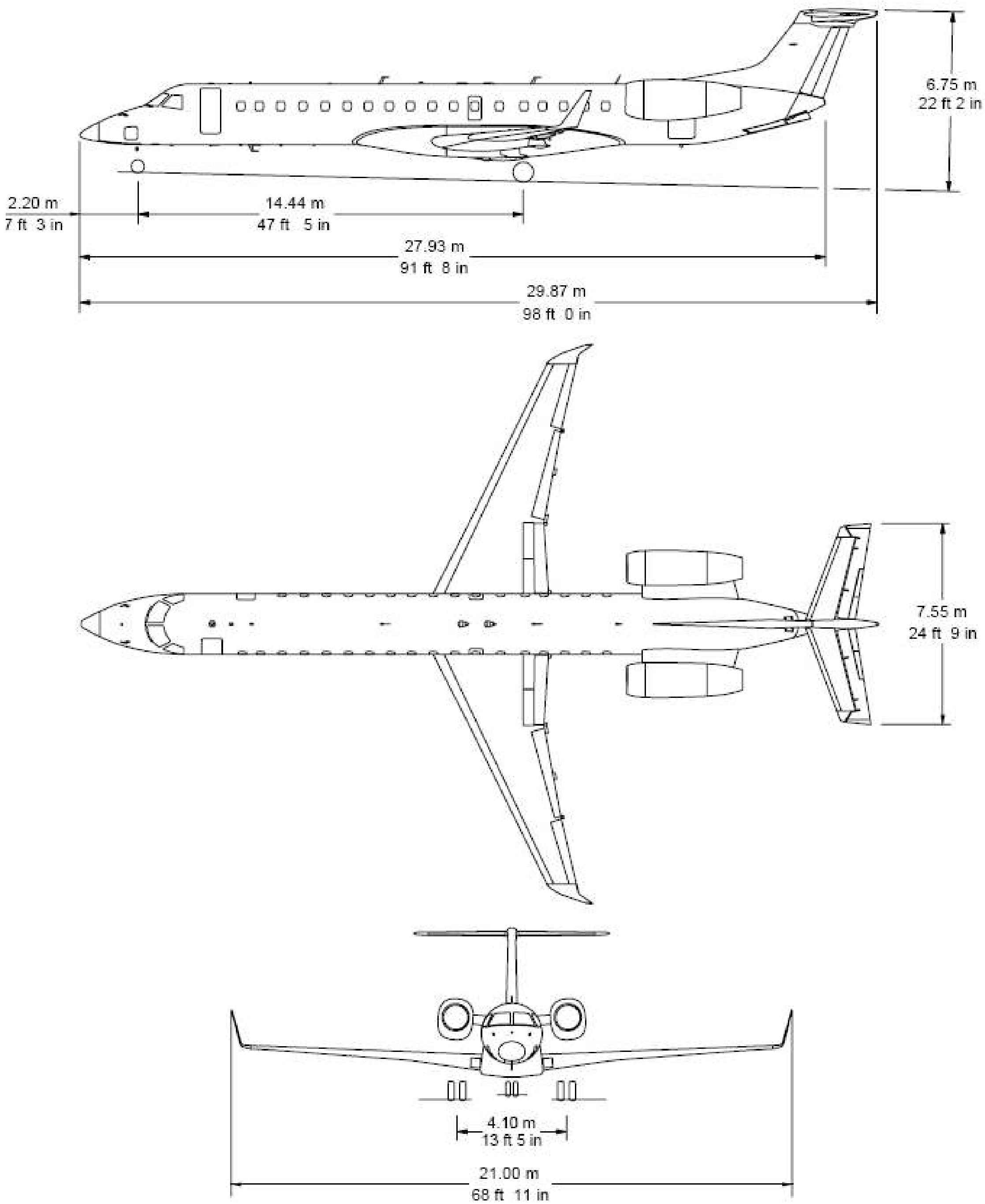

 

**ERJ-145 EP/ER/EU/MP/MK/LR/LU**



**ERJ-145 XR**




**Performance**
Typical Cruise Speed:
M.74 - Normal Cruise
M.80 - High Speed Cruise

## TAXI

1) Prior to departure, plan the trip with the takeoff and landing field required lengths. Airport takeoff or landing distances must be equal to or longer than the required lengths. An ERJ-145XR at elevation 1790 ft requires a takeoff runway of 7199 ft. Allowing for the proper takeoff distance gives the pilot the ability to stop the aircraft on the runway at or below V1, in the event of a rejected takeoff.

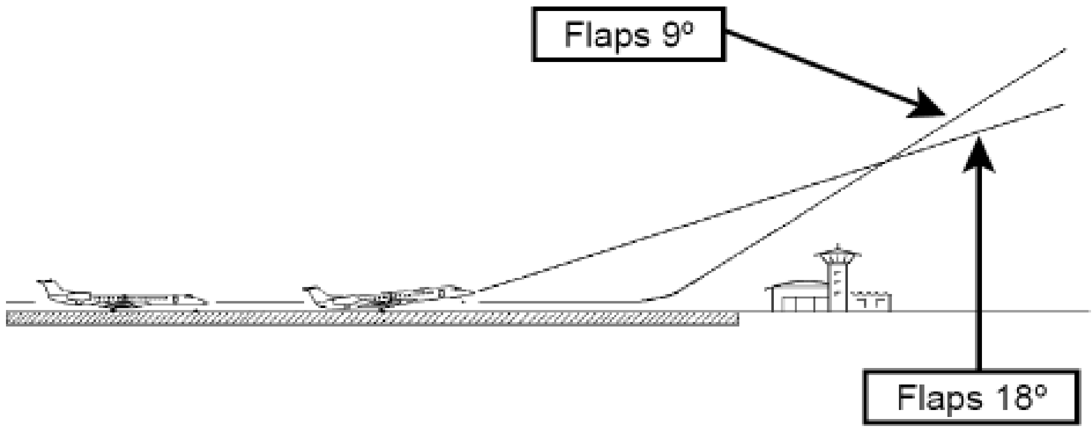
On landing, the required landing distances are as follows:

| Required Runway Length | |
|---|---|
| Landing - Flaps 22 | |
| Weight (in lbs) | Distance Required (at Sea Level) |
| 53000 | 7071 |
| 52000 | 6950 |
| 51000 | 6829 |
| 50000 | 6709 |
| 49000 | 6591 |
| 48000 | 6685 |
| 47000 | 6558 |
| 46000 | 6431 |

| | |
|---|---|
| 45000 | 6307 |
| 44000 | 6183 |
| 43000 | 6063 |
| 42000 | 5943 |
| 41000 | 5822 |
| 40000 | 5701 |
| 39000 | 5584 |
| 38000 | 5469 |
| 37000 | 5355 |
| 36000 | 5242 |
| 35000 | 5127 |
| 34000 | 5009 |
| 33000 | 4891 |

| Required Runway Length | |
|---|---|
| Landing - Flaps 45 | |
| Weight (in lbs) | Distance Required (at Sea Level) |
| 53000 | 5382 |
| 52000 | 5305 |
| 51000 | 5229 |
| 50000 | 5152 |
| 49000 | 5076 |
| 48000 | 5042 |
| 47000 | 4960 |
| 46000 | 4878 |
| 45000 | 4797 |
| 44000 | 4716 |
| 43000 | 4634 |
| 42000 | 4553 |
| 41000 | 4474 |
| 40000 | 4394 |
| 39000 | 4319 |
| 38000 | 4248 |
| 37000 | 4176 |
| 36000 | 4103 |
| 35000 | 4029 |
| 34000 | 3950 |
| 33000 | 3871 |

2) Consider the flap takeoff position prior to departure. Taking off at flaps 9 degrees allows for better climbout performance. However, takeoff at flaps position 18 degrees allows for lower V1 and V2 value and the airplane lifting off from the ground. However, climbout performance is lessened, causing obstacle clearance to become more difficult.




3) Set takeoff flaps for 9 or 18 degrees. Takeoff speeds are as follows:

| Flaps 9 | Takeoff Speeds | | |
|---|---|---|---|
| Weight | v1/vR/v2 | Tgt45 | vFS |
| 53131 | 142/142/145 | 146 | 179 |
| 53000 | 142/142/145 | 146 | 179 |
| 52000 | 140/140/144 | 144 | 178 |
| 51000 | 139/139/143 | 143 | 176 |
| 50000 | 138/138/141 | 142 | 174 |
| 49000 | 137/137/140 | 141 | 173 |
| 48000 | 135/135/139 | 140 | 171 |
| 47000 | 134/134/137 | 139 | 169 |
| 46000 | 132/132/136 | 138 | 168 |
| 45000 | 130/130/134 | 136 | 166 |
| 44000 | 129/129/134 | 135 | 164 |
| 43000 | 128/128/133 | 134 | 162 |
| 42000 | 126/126/132 | 133 | 161 |
| 41000 | 122/122/129 | 131 | 159 |
| 40000 | 120/120/127 | 130 | 157 |
| 39000 | 119/119/126 | 129 | 155 |
| 38000 | 117/117/124 | 127 | 153 |

| | | | |
|---|---|---|---|
| 37000 | 115/115/123 | 126 | 151 |
| 36000 | 113/113/121 | 124 | 149 |
| 35000 | 110/110/119 | 123 | 147 |
| 34000 | 108/108/118 | 121 | 145 |
| 33000 | 106/106/116 | 120 | 143 |
| 32000 | 104/104/114 | 118 | 141 |
| 31000 | 102/102/112 | 116 | 139 |
| 30000 | 100/100/110 | 114 | 137 |
| 29000 | 99/99/109 | 112 | 134 |
| 28000 | 97/97/107 | 111 | 132 |

| Flaps 18 | Takeoff Speeds | | |
|---|---|---|---|
| Weight | v1/vR/v2 | Tgt45 | vFS |
| 53131 | 136/136/138 | 146 | 179 |
| 53000 | 136/136/138 | 146 | 179 |
| 52000 | 135/135/137 | 144 | 178 |
| 51000 | 134/134/136 | 143 | 176 |
| 50000 | 132/132/135 | 142 | 174 |
| 49000 | 131/131/134 | 141 | 173 |
| 48000 | 129/129/132 | 140 | 171 |
| 47000 | 128/128/131 | 139 | 169 |
| 46000 | 126/126/130 | 138 | 168 |
| 45000 | 125/125/129 | 136 | 166 |
| 44000 | 123/123/127 | 135 | 164 |
| 43000 | 121/121/126 | 134 | 162 |
| 42000 | 120/120/125 | 133 | 161 |
| 41000 | 118/118/123 | 131 | 159 |
| 40000 | 116/116/122 | 130 | 157 |
| 39000 | 115/115//121 | 129 | 155 |
| 38000 | 113/113/119 | 127 | 153 |
| 37000 | 111/111/118 | 126 | 151 |
| 36000 | 109/109/116 | 124 | 149 |
| 35000 | 107/107/115 | 123 | 147 |
| 34000 | 105/105/113 | 121 | 145 |
| 33000 | 103/103/112 | 120 | 143 |
| 32000 | 101/101/110 | 118 | 141 |
| 31000 | 99/99/108 | 116 | 139 |
| 30000 | 99/99/108 | 114 | 137 |

| | | | |
|---|---|---|---|
| 29000 | 99/99/108 | 112 | 134 |
| 28000 | 100/100/109 | 111 | 132 |

4) The nose wheel steering and the engine thrust are used to taxi the airplane.

5) Make sure you have the necessary clearance when you go near a parked airplane or other structures.

6) When the APU in the taxi airplane or the parked airplane is on you must have a minimum clearance of 50 feet between the APU exhaust port and the adjacent airplane's wingtip (fuel vent).

7) The taxi speed must not be more than approximately 30 knots. Speeds more than 30 knots added to long taxi distances would cause heat to collect in the tires. Recommended speed is 20 knots. Beware of changing indicated air speed numbers due to tailwinds during taxi.

8) Before making a turn, decrease the speed of the airplane to a speed of approximately 8 to 12 knots. Make all turns at a slow taxi speed to prevent tire skids.

9) Do not try to turn the airplane until it has started to move.

10) Make sure you know the taxi turning radius.

11) Monitor the wingtips and the horizontal stabilizer carefully for clearance with buildings, equipment, and other airplanes.

12) When a left or right engine is used to help make a turn, use only the minimum power possible.

13) Do not let the airplane stop during a turn.

14) Do not use the brakes to help during a turn. When you use the brakes during a turn, they will cause the main and nose landing gear tires to wear.

15) When it is possible, complete the taxi in a straight-line roll for a minimum of 10 feet.
NOTE: This will remove the torsional stresses in the landing gear components, and in the tires.

16) Use the Inertial Reference System (IRS) in the ground speed (GS) mode to monitor the taxi speed.

17) If the airplane taxi speed is too fast (with the engines at idle), operate the brakes slowly and smoothly for a short time. NOTE: This will decrease the taxi speed.

18) If the taxi speed increases again, operate the brakes as you did in the step before.

19) Always use the largest radius possible when you turn the airplane. NOTE: This will decrease the side loads on the landing gear, and the tire wear will be decreased.

20) Extra care must be given to turn the aircraft due to the fuselage length and wingspan. A minimum distance from the edge of the pavement must be maintained to reverse the aircraft's direction.

21) Operate the brakes to stop the airplane.

22) Set the parking brake after the airplane has stopped.

23) To conserve fuel for long taxi periods, or ramp holding, one-engined taxi is recommended.

## TAKEOFF

1) Maximum demonstrated crosswind component for takeoff and landing is 30 knots.

2) Restart 2nd engine if on single-engine taxi.

3) Align aircraft with runway centerline.

4) Increase power to approximately 60% N1 for 5 – 10 seconds.

5) Watch EICAS indicator for engine problems or aircraft alarms.

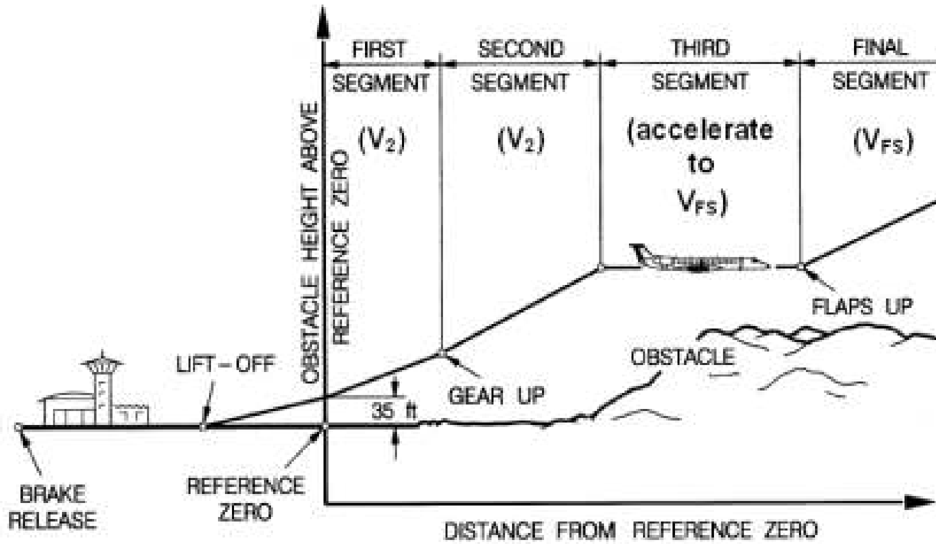
6) Increase power smoothly to pre-determined N1 speeds based on aircraft takeoff weight, (87% - 96% N1). This can either be done manually or using the autothrottle with the autopilot engaged.

7) At Vr, rotate aircraft 10 degrees upwards. (See Appendix A for speed reference cards.)

8) Hold nose at +10 degrees until positive rate of climb is confirmed, then raise landing gear after V2.

9) Set initial climbout target speed to Vfs (see target speed above in takeoff vspeed charts). Minimum climb speed is v2. Accelerate to Vfs:




10) Maintain +1800 fpm climb to 1500 FT. Accelerate through vFS with flap retraction..

11) Increase speed to 240 knots and in accordance with ATC instructions (max 250 KTS below 10,000 FT).

12) For full maneuverability beneath 10,000 FT, flaps must be fully retracted with aircraft at minimum safe airspeed.

## CLIMB

1) Once climb thrust or airspeed is set, the autopilot will compensate for environmental condition changes automatically during the climb.

2) Climb profile is 240 KIAS to 10,000 ft, then 270 KIAS (290 KIAS for 145XR / Legacy) to 14,000 ft. Maintain 270 (290) KIAS to 17,400 ft, and then .56M (.60M) above 17,400 ft to initial cruise level. At cruise level, then accelerate to long-range cruise .74M.

3) It is recommended that the aircraft be flown manually up to 15,000 FT, weather and ATC traffic conditions permitting. However, in high traffic conditions, to easy the workload of the pilot, the autopilot MCP altitude intervention may be engaged above a minimum altitude of 80 FT with the landing gear up.

4) Climb settings use a 10 – 20% derate of thrust up to 10,000 FT, then increases linearly to max thrust at 30,000 FT.

5) For **enroute climb**, climb at a rate of 1800 FPM, pursuant to ATC and traffic conditions. If there are no altitude or airspeed restrictions, accelerate to the recommended speed. The sooner the aircraft can be accelerated to the proper climb speed, the more fuel and time efficient the flight. Typical time to climb performance is as follows:

| Weight (lbs) | Fuel Required (lbs) | Distance (nm) | Time (min) |
|---|---|---|---|
| 54,000 | 1977 | 189 | 33 |
| 52,000 | 1786 | 167 | 29 |
| 50,000 | 1648 | 151 | 26 |
| 48,000 | 1515 | 138 | 24 |
| 46,000 | 1408 | 127 | 22 |
| 44,000 | 1314 | 118 | 21 |
| 42,000 | 1228 | 109 | 19 |
| 40,000 | 1150 | 102 | 18 |
| 38,000 | 1078 | 95 | 17 |
| 36,000 | 1011 | 89 | 15 |

6) As **engine and wing icing** may occur during the climb and descent, the engine anti-icing system should be in the AUTO or ON position whenever icing is possible. NOTE: Failure to do so may result in engine stall, overheating, or engine damage.

7) **For normal economy climb**, follow ATC speed restrictions of 250 KTS below 10,000 FT. If permitted by ATC and no speed restriction below 10,000 FT, increase speed to 270 KTS. Above 10,000 FT, climb at 270 KTS or .56 MACH. Climb speed table is as follows:

| ALTITUDE | SPEED |
|---|---|
| Sea Level to 10,000 FT | 250 KTS |
| Above 10,000 FT | 270 KTS/.56 MACH |

8) **Max climb speed** is 270 knots / ,56M until reaching initial cruise altitude, then switching to.74 MACH after reaching initial cruise altitude.

9) **For engine out climb**, speed and performance various with gross weight and altitude, however 250 knots at 1000 – 1500 FPM may be used.

10) Set **standard barometer** above airport transition level (depends on local airport geography).

## CRUISE


1) **Cruise** at .74 MACH.

2) **Hi-speed** cruise at .80 @ fuel burn penalty.

3) **Typical cruise altitude** 20,000s flight levels, up to a typical max altitude of 37,000 ft.

4) Long range cruise after crossover at cruise level is at .749M. General rule, with plane at cruise flight level, N1 should be 87.7% N1 to 89.7% N1, which will result in the proper cruise speed at or below .749M:

**At cruise at 37,000 ft, ISA + degrees C = 10, SAT degrees C = -47:**

| **Weight (lbs)** | **N1** | **F Flow** | **IAS** | **TAS** |
|---|---|---|---|---|
| 54,000 | 93.6 | 1246 | 241 | 438 |
| 52,000 | 93.5 | 1255 | 247 | 447 |
| 50,000 | 92.6 | 1176 | 239 | 434 |
| 48,000 | 91.1 | 1118 | 233 | 424 |
| 46,000 | 89.7 | 1060 | 227 | 415 |

**At cruise 31,000 ft, ISA + degrees C = 0, SAT degrees C = -46 (cruise .749M)**

| | | | | |
|---|---|---|---|---|
| 54,000 | 88.9 | 1435 | 275 | 436 |

| | | | | |
|---|---|---|---|---|
| 52,000 | 88.8 | 1438 | 277 | 442 |
| 50,000 | 88.8 | 1441 | 280 | 442 |
| 48,000 | 88.7 | 1444 | 282 | 445 |
| 46,000 | 88.7 | 1447 | 284 | 449 |

Note: 37,000 ft, at weight 46,000 lbs, both engines running:  N1/TAS/FF = 91/430/2175

Note: 37,000 ft, at weight 35,000 lbs, both engines running:  N1/TAS/FF = 86/389/1800


5) **Headwinds** will increase engine power, reduce cruise speed and decrease range.

6) **Tailwinds** will decrease engine power, increase cruise speed and increase range.

7) Follow previously entered FMC waypoints.

8) **Fuel Freeze --** Extended operation at cruise altitude will lower fuel temperature. Fuel cools at a rate of 3 degrees C per hour, with a max of 12 degrees C in extreme conditions. Fuel temperatures tend to follow TAT (total air temperature). To raise fuel temperature/TAT, a combination of factors can be employed:

- Descend into warmer air.
- Deviate to warmer air.
- Increase Mach speed.

An increase of 0.01 MACH will increase TAT by 0.5 – 0.7 degrees C.

9) **Increased fuel burn** can result from:
   - High ITT
   - Lower cruiser altitude than originally planned.
   - More than 2,000 FT above the optimum calculated altitude.
   - Speed faster or slower than .74 MACH cruise.
   - Strong headwind.
   - Unbalanced fuel.
   - Improper aircraft trim.

10) **Fuel penalties** are:

   - 2000 FT above optimum – 3 percent increase in fuel usage
   - 4000 FT below optimum – 5 percent increase in fuel usage
   - 8000 FT below optimum –12 percent increase in fuel usage
   - M.01 above M.74 – 3 percent increase in fuel usage
   - High speed cruise of M.80 – 19% increased fuel usage

11) In the case of **engine out cruise**, it may be necessary to descend.

12) Trim aircraft for proper elevator alignment.

13) In case of engine out cruise, trim rudder for directional alignment.

14) Deviate from flight plan for weather, turbulence, or traffic as necessary after receiving clearance from ATC.

15) Cruise pitch angle is approx 1 degree nose up.

## DESCENT


1) Descend at pre-determined TOD (Top of Decent)

2) Descend at 270 KT / .56M (290 KT / M.60 145XR/Legacy) above 10,000 FT.

3) Use speedbrakes or thrust to minimize vertical path error.

4) Proper descent planning is necessary to ensure proper speed and altitude at the arrival point. Distance required for descent is 3NM/1000FT. Descent rates are as follows:

| Intended Speed | Decent Rate | |
|---|---|---|
| | CLEAN | WITH SPEEDBRAKES |
| .56 MACH/270 KTS | 2300 FPM | 5500 FPM |
| 250 KTS | 1400 FPM | 3600 FPM |
| VREF 22 + 80 KTS | 1100 FPM | 2200 FPM |

5) Plan to descend so that aircraft is at approximately 10,000 FT above ground level, 250 KTS, 30 miles from airport.

6) Using speedbrakes will reduce the times and distances by half.

7) Arm speedbrakes on initial descent.

8) Set airport altimeter below transition level.

9) Avoid using the landing gear for drag above 180-200 KTS to avoid damage to doors or passenger discomfort.

10) **Recommended approach planning**, ATC and airport rules permitting:

- 210 KTS below 10,000 FT, 30 miles from airport.
- 180-190 KTS, 23 miles from airport.
- 170 KTS, 16 – 17 miles from airport.
- VREF, 5 – 7 miles from airport.

11) **In case of rapid descend due to depressurization**, bring aircraft down to a safe altitude as smoothly as possible. Using the autopilot is recommended. Check for structural damage. Avoid high load maneuvering.

12) **Stall recovery** can be accomplished by lowering the aircraft's nose and increasing power at once to gain airspeed. Beware of terrain. Accelerate to VREF 30 + 80 KTS. Do not retract gear until confirmed stall recovery and positive rate of climb. Keep nose at 5 degrees above the horizon or less.

13) If deployed, do not retract slats during the recovery, as it will result in altitude loss.

14) In the event of engine out approach, approach at VREF+5 @ flaps 22.

15) Under normal conditions **land at VREF @ flaps 45.** Landing speeds are as follows:

| Landing 22 | Landing Speeds | | |
|---|---|---|---|
| **Weight** | **vFS** | **Vref22** | **Target** |
| 53131 | 179 | 146 | 179 |
| 53000 | 179 | 146 | 179 |
| 52000 | 178 | 145 | 178 |
| 51000 | 176 | 144 | 176 |
| 50000 | 174 | 142 | 174 |
| 49000 | 173 | 141 | 173 |
| 48000 | 171 | 140 | 171 |
| 47000 | 169 | 138 | 169 |
| 46000 | 168 | 137 | 168 |
| 45000 | 166 | 135 | 166 |
| 44000 | 164 | 134 | 164 |
| 43000 | 163 | 133 | 162 |
| 42000 | 161 | 131 | 161 |

| | | | |
|---|---|---|---|
| 41000 | 159 | 130 | 159 |
| 40000 | 157 | 128 | 157 |
| 39000 | 155 | 127 | 155 |
| 38000 | 153 | 125 | 153 |
| 37000 | 151 | 123 | 151 |
| 36000 | 149 | 122 | 149 |
| 35000 | 147 | 120 | 147 |
| 34000 | 145 | 119 | 145 |
| 33000 | 143 | 117 | 143 |
| 32000 | 141 | 115 | 141 |
| 31000 | 139 | 113 | 139 |
| 30000 | 137 | 111 | 137 |
| 29000 | 134 | 109 | 134 |
| 28000 | 132 | 107 | 132 |

| Landing 45 | Landing Speeds | | |
|---|---|---|---|
| Weight | vFS | Vref45 | Target |
| 53131 | 179 | 141 | 179 |
| 53000 | 179 | 141 | 179 |
| 52000 | 178 | 139 | 178 |
| 51000 | 176 | 138 | 176 |
| 50000 | 174 | 137 | 174 |
| 49000 | 173 | 136 | 173 |
| 48000 | 171 | 135 | 171 |
| 47000 | 169 | 134 | 169 |
| 46000 | 168 | 133 | 168 |
| 45000 | 166 | 131 | 166 |
| 44000 | 164 | 130 | 164 |
| 43000 | 163 | 129 | 162 |
| 42000 | 161 | 128 | 161 |
| 41000 | 159 | 126 | 159 |
| 40000 | 157 | 125 | 157 |
| 39000 | 155 | 124 | 155 |
| 38000 | 153 | 122 | 153 |
| 37000 | 151 | 121 | 151 |
| 36000 | 149 | 119 | 149 |
| 35000 | 147 | 118 | 147 |
| 34000 | 145 | 116 | 145 |

| | | | |
|---|---|---|---|
| 33000 | 143 | 115 | 143 |
| 32000 | 141 | 113 | 141 |
| 31000 | 139 | 111 | 139 |
| 30000 | 137 | 109 | 137 |
| 29000 | 134 | 107 | 134 |
| 28000 | 132 | 106 | 132 |

16) The Project Open Sky ERJ is a CATII aircraft, meaning the aircraft is capable of landing on autopilot in conditions where ceiling is down to 50ft AGL.


17) **ILS Approach** - During initial maneuvering for the approach, extend flaps to 9 and slow to 180kts. When the localizer is alive, extend flaps to 18 when slowing through 170kts. At one dot below glideslope intercept, extend the landing gear and flaps to 22. Begin slowing to final approach speed. At the final approach fix, extend flaps to 45 and slow to Target vref speed. Be stabilized by 1000 feet above field level. This means, gear down, flaps 45 and engines spooled. Plan to cross the runway threshold at Vref.

18) **Visual Approach** - Similar to the ILS approach. The major difference is that aircraft must be stabilized by 500 feet above field level, as opposed to 1000 feet.

19) Land the aircraft. At average gross weights, at full flaps @ VREF, the ERJ will have a 1 degree nose up pitch. When landing the aircraft, flare as necessary.

20) Disengage reverse thrust at 80 knots.

21) The ERJ / Legacy series DOES NOT HAVE auto-braking. Smoothly operate the brakes manually.

22) Turn off onto high-speed taxiways at 30 knots or less.

23) Decelerate to 8 – 12 knots for 90 degree turns.

24) Taxi to gate.