EASA ATPL(A) · THEORY REVISION

The ATPL Cheat Sheet
032 Performance

The facts that actually get tested, stripped to the bone: definitions, key numbers, formulas, mnemonics and the classic exam traps for each subject. Built for the night before, the commute, and the last scroll before you walk into the exam hall.

032 Performance

54 memory items

One of 14 subjects; the full set is free at skystudyatpl.com/atpl-cheat-sheet

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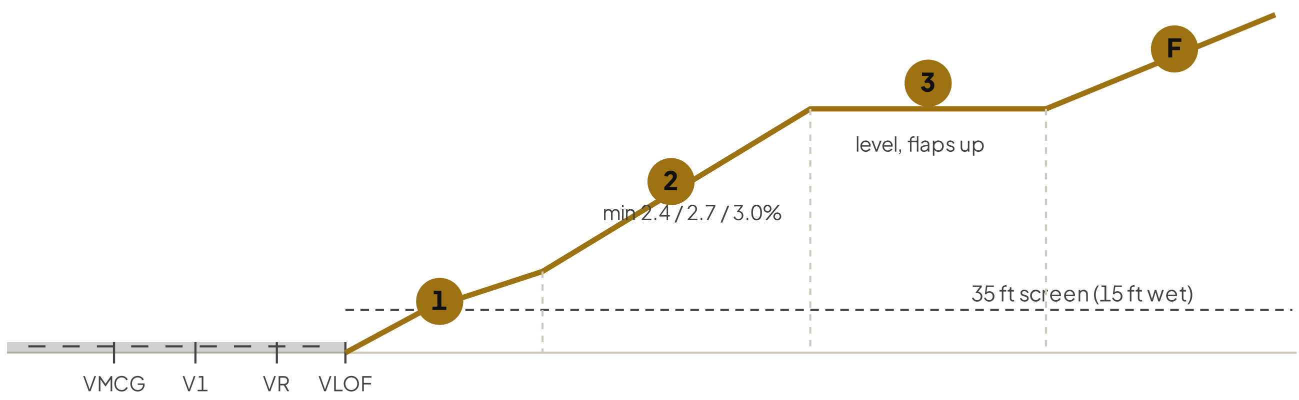
Performance

Performance classes, V-speeds, takeoff and landing, climb segments, WAT limits.

CLASS A TAKE-OFF CLIMB SEGMENTS (ONE ENGINE INOPERATIVE)



1 gear retracting, gradient positive. **2** steepest climb, gear up, to at least 400 ft (min 2.4% twin, 2.7% tri, 3.0% quad). **3** level acceleration, flaps retract. **F** en-route climb at MCT (min 1.2 / 1.5 / 1.7%). All one-engine-inoperative for Class A.

MUST-KNOW DEFINITIONS AND CONCEPTS

- **Class A**: multi-engine turbine, MTOM over 5700 kg or over 9 seats, or any turbojet; full engine-failure accountability at every stage.
- **Class B**: propeller aeroplanes, 9 seats or fewer and MTOM 5700 kg or less; simplified rules, no guaranteed OEI climb below the screen height.
- **Class C**: larger aeroplanes not meeting A or B (mostly older large piston types).
- **V1** (decision speed): stop by V1 to remain within ASDA; at or above V1, continue and reach V2 by the screen height after a recognised failure.
- **VR** (rotation): not less than V1, not less than 1.05 x VMCA, set so V2 is reached by the screen height.
- **V2** (takeoff safety speed): target by the screen height with one engine inoperative, giving the certified climb margin above stall and VMCA.
- **VMCG**: minimum ground speed to keep directional control after critical-engine failure using rudder alone.
- **VMCA**: minimum airborne speed to keep directional control with the critical engine out and a limited bank into the live engine.
- **VMU** minimum unstick, **VEF** assumed engine-failure speed, **VLOF** lift-off speed, **VMBE** max brake energy speed.
- **VS/VS0/VS1/VSR**: stall speeds and the reference stall speed used as the basis for V-speed margins.
- **Balanced field**: V1 chosen so the OEI accelerate-go distance equals the accelerate-stop distance, minimising required runway.
- **TORA/TODA/ASDA/LDA**: the four declared distances. **Clearway** extends TODA only; **stopway** extends ASDA only.
- Class A takeoff segments: 1st (gear retracting, one engine inoperative), 2nd (gear up, steepest, OEI), 3rd (level acceleration, flaps up), final (climb to safe en-route altitude, MCT, OEI).
- **Gross** flight path is demonstrated performance; **net** is gross reduced by a certification decrement and is what obstacle clearance is checked against.
- **WAT limit** (Weight, Altitude, Temperature): the maximum mass at which the required climb gradient is still met.
- **Drift-down**: the planned descent schedule flown after an engine failure in cruise when altitude cannot be held, checked against the net flight path.
- **PNR** is the last point a return is possible with required reserves; **ETP/PET** is where time to continue equals time to turn back.

KEY NUMBERS, LIMITS AND VALUES

- Takeoff screen height **35 ft dry**; a reduced **15 ft** is allowed on a wet runway under certain provisions VERIFY.
- VR not less than **1.05 x VMCA**; V2 not less than about **1.13 x VSR** for most turbojets VERIFY.
- VMCG lateral deviation limit about **30 ft** from centreline; VMCA demonstration bank angle limited to about **5 degrees** into the live engine VERIFY.
- **2nd segment** minimum climb gradient about **2.4%** twin, **2.7%** three-engine, **3.0%** four-engine VERIFY.
- **Final segment** minimum about **1.2%** twin, **1.5%** three-engine, **1.7%** four-engine VERIFY.
- **Approach climb** (OEI, go-around) about **2.1%** twin, **2.4%** three-engine, **2.7%** four-engine; **landing climb** (all engines) about **3.2%** VERIFY.
- 1st segment gradient must be **positive**; 3rd segment is a level acceleration with no gradient requirement, commonly around 400 ft AGL VERIFY.
- Dispatch landing factor, turbojet: about **x1.67 dry**, **x1.92 wet**. Turboprop: about **x1.43 dry**, **x1.64 wet** VERIFY.
- Landing distance is measured from a **50 ft** screen over the threshold to a full stop (distinct from the takeoff screen).
- ASDA = TORA + stopway; TODA = TORA + clearway.
- En-route OEI obstacle corridor commonly taught as about **5 NM** either side of track, with at least **1000 ft** net vertical clearance (more in mountainous areas) VERIFY.
- Wind rule of thumb: about **50% credit** for headwind, **150% penalty** for tailwind.

FORMULAS AND RELATIONSHIPS

- Climb gradient (%) is about (Rate of Climb / TAS) x 100, both in the same units (1 kt is about 101.3 ft/min).
- Specific air range is about TAS / fuel flow (distance per unit fuel).
- ETP distance from departure = (total distance x GS toward the point) / (GS out + GS back).
- As chosen V1 increases, accelerate-stop distance grows while accelerate-go shrinks; balanced V1 is where they cross.
- Required takeoff distance (Class A) is the greater of the OEI distance to the screen or a factored all-engine distance.
- V-speeds and stall speed rise with the **square root of weight**, so higher mass raises V1/VR/V2 and lengthens all distances.
- For fixed altitude and temperature, the WAT-limited mass is the mass at which the required gradient is exactly met.

MNEMONICS AND MEMORY ITEMS

- Ground-run order: **VMCG, V1, VR, VLOF, V2** = control, decide, rotate, lift, safety.
- Segment shape: **Up, Steep-Up, Level-Out, Up-Again** (1st climbs, 2nd steepest, 3rd level, final climbs).
- Gradient: **rate over speed, times a hundred**.
- Things that hurt performance, **HATS**: High density altitude, Aft/heavy mass, Tailwind, Slope (uphill takeoff, downhill landing).
- **Net** is what you may plan on, **gross** is what the aeroplane actually did; net is the conservative figure.
- **Clearway helps you go (TODA), stopway helps you stop (ASDA).**
- **Half the headwind helps, one and a half times the tailwind hurts.**

COMMON EXAM TRAPS

- Do not mix **V1** (decision, tied to distance) with **VR** (rotation, tied to reaching V2); V1 can never exceed VR.
- VMCG uses **rudder alone**, not nosewheel steering, which is why it floors V1.
- Obstacle clearance and WAT questions use the **net** flight path, never the gross.
- **Clearway** cannot be used for stopping (ASDA); **stopway** cannot be used for the continued takeoff (TODA).
- A factored **all-engine** takeoff distance can be the limiting case, not just the OEI cases.
- Do not apply the landing dispatch factors to the takeoff phase; they are for landing distance planning.
- Do not confuse the **35 ft** (15 ft wet) takeoff screen with the **50 ft** landing screen.
- Downhill slope shortens takeoff but hurts landing; uphill slope lengthens takeoff but helps landing braking.
- Drift-down is a defined procedure with its own speed schedule and net-flight-path obstacle check, not just an engine-out descent.
- Class B does not guarantee the same OEI climb-segment structure as Class A.
- VMCA is defined with a limited bank (about 5 degrees) into the live engine; wings-level gives an artificially high value.

Take-off V-speeds: the sequence

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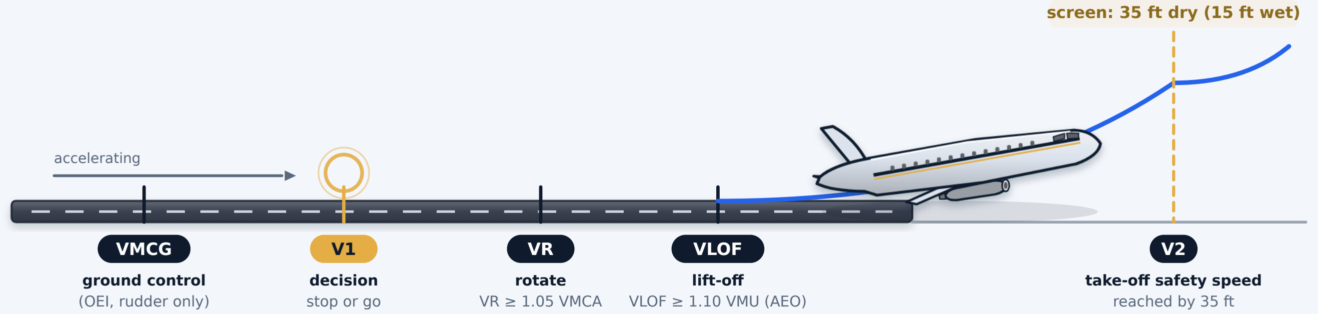
the order that must always hold

VMCG ≤ V1 ≤ VR < VLOF, then V2 by 35 ft



Failure recognised before V1: reject (RTO) and stop on what is left. At or after V1: continue, the speed set guarantees the screen.

1 V1, the decision speed

V1 is the decision speed: engine failure recognised at or above V1 means GO, and V1 can never sit below VMCG nor above VR or the brake-energy limit VMBE.

2 VR, rotation

VR is where the nose is raised; it must be at least 1.05 VMCA and at least V1, and high enough that V2 is reached at or before 35 ft with an engine out.

3 VLOF and VMU

VLOF is where the main wheels actually leave the ground: at least 1.10 VMU with all engines running, or 1.05 VMU with one engine inoperative (VMU is the minimum demonstrated unstick speed).

4 V2, the safety speed

V2 must be at least 1.13 VSR for two- and three-engine aeroplanes (1.08 VSR with four engines) and is the speed flown from the 35 ft screen through the second segment.

The take-off speed order always holds: VMCG ≤ V1 ≤ VR < VLOF, and V2 is reached by the 35 ft screen.

Balanced field: the V1 trade

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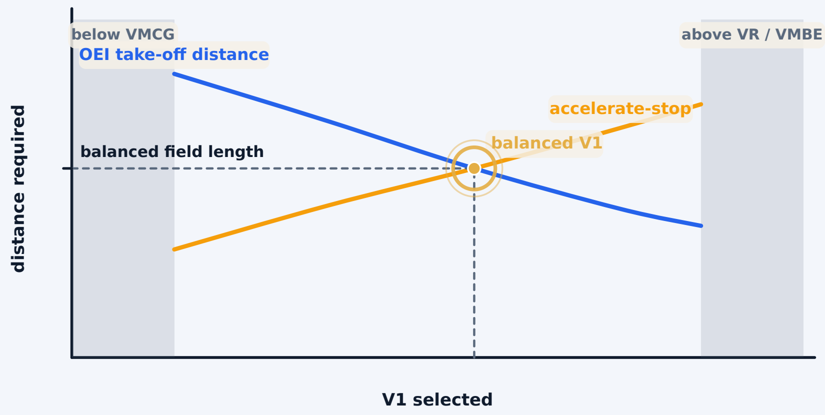

the V1 trade

raise V1: go shrinks, stop grows

lower V1: go grows, stop shrinks

V1 window:

VMCG ≤ V1 ≤ VR and V1 ≤ VMBE

On a longer runway both distances fit over a spread of speeds, so V1 becomes a range instead of a single value.

1 Raise V1

A higher V1 shortens the engine-out take-off distance (the failure is recognised at a higher speed, less is left to accelerate) but lengthens the accelerate-stop distance: more kinetic energy to destroy.

2 The balance

The field is balanced when the take-off distance required equals the accelerate-stop distance required: one V1 makes the go and the stop need exactly the same field length.

3 Balanced field length

The balanced field length is the shortest field that covers both decisions, which is why it is used for quick runway-adequacy checks.

4 Set V1 wrong

If the engine fails at a V1 set below the balanced value and the take-off is continued, the go distance grows; a V1 set too high risks the stop running off the end.

One V1 balances the field: the engine-out go distance falls and the accelerate-stop distance rises until they cross.

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