NEWSLETTER

Same Aircraft, Different Limits: How MTOW, MZFW & MLW Redraw the Performance Envelope

August 2026 | Shannon Ackert

Two aircraft can look identical on the ramp and still have different operating capability. Same airframe. Same engines. Same cabin. Different certified weight limits.

Those limits matter before a route is scheduled or a flight is dispatched. They determine how much fuel and payload the aircraft may carry, how heavy it may land, and whether the extra capability is worth its cost.

The 737-8 provides a good example. Boeing's published weight sets show the same basic aircraft with certified MTOWs 22,800 lb apart. More importantly, the first 20,400 lb of added takeoff weight comes with no increase in maximum zero-fuel weight or maximum landing weight.

More MTOW does not automatically mean more payload. Here, most of the added takeoff weight is available for fuel. The aircraft may depart heavier, but it cannot carry more structural payload unless MZFW rises, or land heavier unless MLW rises.

These are not day-to-day loading choices. They are certified limits selected for the aircraft and recorded in its approved flight manual and operating documentation. MTOW limits departure weight. MZFW limits zero-fuel weight and, for a given operating empty weight, the structural payload available for passengers, bags, and cargo. MLW limits landing weight.

Because each limit protects a different condition, the three do not have to move together. The certified limits define what is allowed; the aircraft's actual operating weight determines what is used on a given flight.

IN BRIEF

- Certified MTOW, MZFW, and MLW set the aircraft's approved weight limits before the airline plans or dispatches a flight.
- More MTOW does not automatically mean more payload. On the 737-8, the first 20,400 lb of added takeoff weight comes with no increase in MZFW or MLW.
- MZFW adds payload capability, not range by itself. MLW adds landing-weight margin and may bind on short sectors, tankering missions, or early returns.
- Some costs follow certified weight. EUROCONTROL uses the highest certified MTOW in the flight manual, not the actual takeoff weight of a specific flight.
- The right weight package should match the mission, not simply maximize every limit. Unused capability can still carry acquisition cost and recurring charges.
- Appraisers treat certified weights as part of the specification, not as automatic value. Higher limits add value only where operators and the market will pay for their utility.

How Manufacturers Package the Same Decision

Manufacturers package certified weight limits in different ways. Airbus generally uses defined Weight Variants. Boeing often publishes baseline and maximum operating weights, with additional selectable steps depending on the model and configuration. The terminology differs, but the underlying choice is the same.

An airline is not simply choosing the highest numbers available. It is choosing the limits its network can actually use. That matters because MTOW, MZFW, and MLW do not always move together.

Airbus's A320neo data shows this clearly. Weight Variants WV056 and WV103 sit at very different points within the certified weight range. WV056 has a 70.0-tonne MTOW, 62.8-tonne MZFW, and 66.3-tonne MLW. WV103 raises those limits to 79.0 tonnes, 65.3 tonnes, and 68.4 tonnes, respectively.

The difference is revealing. MTOW rises by 9.0 tonnes, while MZFW increases by only 2.5 tonnes and MLW by 2.1 tonnes. The higher variant therefore adds much more departure-weight capability than payload or landing-weight capability, as shown in **Table 1**.

The higher Weight Variant is not simply a larger number. It changes the mix of certified capability. More MTOW may support additional fuel, range, or operating flexibility. More MZFW raises the structural payload ceiling. More MLW raises the allowable landing weight. The value depends on which capability the operator can actually use.

Table 1. A320neo Weight Variants: Departure-Weight Capability Versus Payload and Landing Limits

A320neo Weight Variant	MTOW	MZFW	MLW	What changes
WV056	70.0 t	62.8 t	66.3 t	Lower certified departure-weight limit
WV103	79.0 t	65.3 t	68.4 t	Much higher MTOW with smaller increases in MZFW and MLW
Difference	+9.0 t	+2.5 t	+2.1 t	More departure-weight capability than payload or landing-weight capability

Source: Airbus, A320 Aircraft Characteristics - Airport and Maintenance Planning, July 2026, §2-1-1, pp. 3-5.

The 737-8 shows the same principle differently. Boeing's published data lists a baseline MTOW of 159,400 lb and a maximum of 182,200 lb, a 22,800-lb increase in certified departure weight.

Payload and landing limits move much less. MZFW rises from 142,900 lb to 145,400 lb, and MLW from 150,300 lb to 152,800 lb. Each increases by only 2,500 lb.

The maximum 737-8 weight option therefore adds far more departure-weight capability than payload or landing-weight capability. It may support more fuel, range, or operating flexibility where airport and route conditions allow, but it does not create an equivalent increase in payload.

Boeing's intermediate 737-8 weight set makes the point even clearer. MTOW rises from 159,400 lb to 179,800 lb, a 20,400-lb increase, while MZFW and MLW remain unchanged. That step adds departure-weight capability only; it does not raise the structural payload or landing-weight limits shown in **Table 2**.

Certified weight limits are not one combined setting. MTOW sets departure-weight capability. MZFW sets the zero-fuel limit and therefore structural payload for a given OEW. MLW sets the landing-weight limit. The right combination depends on the operator's missions, not on selecting the highest number in every column.

Table 2. 737-8 Published Operational Weight Limits: Baseline, Intermediate, and Maximum

737-8 weight limit	Baseline (lb)	Intermediate (lb)	Maximum (lb)	Baseline-to-Max Increase (lb)
MTOW	159,400	179,800	182,200	+22,800
MZFW	142,900	142,900	145,400	+2,500
MLW	150,300	150,300	152,800	+2,500

Source: Boeing, 737 MAX Airplane Characteristics for Airport Planning, D6-38A004, Revision K, July 2025, §2.1.2, p. 2-3. Boeing specifies that selected weight must be in 100-lb increments; certified limits are therefore selected from discrete steps rather than set at any value.

Why the Limits Do Not Move Together

MTOW, MZFW, and MLW do not move together because each protects a different part of the aircraft's operating envelope. MTOW limits takeoff weight. MZFW limits zero-fuel weight and therefore structural payload for a given OEW. MLW limits landing weight.

The important distinction is where the weight sits and when the aircraft sees the load. Payload is carried mainly in the fuselage, while much of the fuel sits in the wings. Wing fuel can reduce wing-root bending relative to the same weight carried in the fuselage, while fuselage payload generally increases it.

That is why MTOW can increase without an equal rise in MZFW. The added departure weight may be useful for fuel, but it does not automatically become more passengers or cargo.

Table 2 shows the pattern. The intermediate set adds 20,400 lb of MTOW with no change in MZFW or MLW. The maximum set adds 22,800 lb of MTOW but only 2,500 lb of MZFW and MLW. At maximum structural payload, the first 20,400 lb is essentially additional fuel capability, not additional payload.

MLW is different again. It is the certified structural landing-weight limit, reflecting the loads the landing gear and airframe must withstand at landing. The usable landing weight may be lower because of runway, weather, configuration, or landing-performance limits.

MTOW adds departure-weight capability. MZFW adds structural payload capability. MLW adds landing-weight margin. They are related, but they are not interchangeable.

Maximum Takeoff Weight (MTOW): The Departure-Weight Budget

MTOW is the aircraft's certified takeoff-weight limit. It defines how heavy the aircraft may be at the start of the takeoff roll. In simple terms, it is the maximum approved weight available for the aircraft, payload, and takeoff fuel at that point.

The Departure-Weight Budget

Actual TOW = Operating Empty Weight + Payload + Takeoff Fuel

Actual TOW ≤ Certified MTOW

Note: Takeoff fuel is the relevant term. Ramp fuel includes fuel expected to be burned during engine start and taxi before the aircraft begins the takeoff roll.

Once a selected MTOW is assigned to an aircraft and recorded in its approved operating documentation, it becomes a binding limit. The aircraft must remain within that payload-and-fuel ceiling unless its certified weight is formally changed.

A weight increase does not necessarily mean a different airframe. Within an OEM-approved weight range, the same basic aircraft may be certified at different operating limits. Depending on eligibility and configuration, a higher limit may be available through a Weight Variant change, service bulletin, AFM revision, or similar approved process. Some changes may require hardware; eligibility and pricing are aircraft-specific.

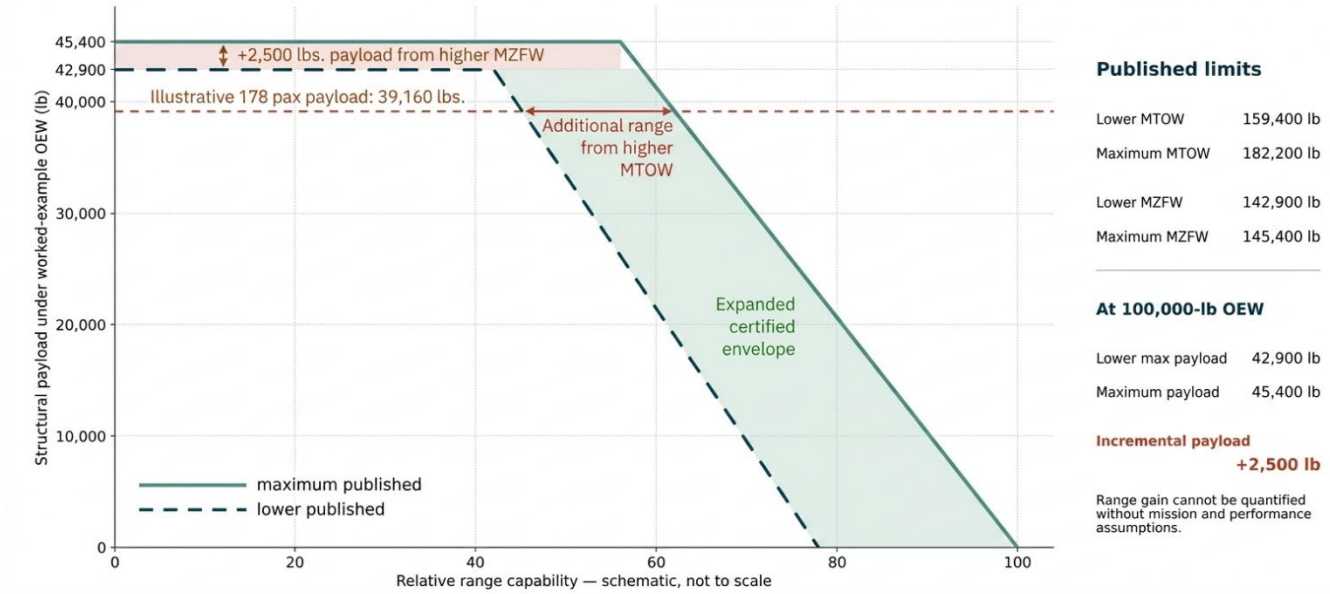
This means the certified weight setting can sometimes be changed later, not only at delivery. An operator may also be able to lower a certified limit and reduce charges where fees are based on certified MTOW. Any change requires approved documentation, required operator reporting, and compliance with the OEM's eligibility rules.

Higher certified MTOW allows more takeoff fuel, more payload, or some mix of both, but it does not guarantee either on every flight. The allowable takeoff weight is always the lowest applicable limit. Runway length, climb performance, obstacle clearance, brake energy, tire speed, temperature, wind, elevation, and other operating restrictions may reduce allowable TOW below the certified MTOW.

Higher MTOW therefore provides flexibility: it permits a wider set of payload-and-fuel combinations when conditions allow (**Figure 1**). It does not guarantee a specific increase in range, payload, or economic benefit on every mission.

The question is not whether the higher MTOW is better. It is whether the operator can use the added departure-weight capability often enough to justify its cost.

Figure 1. Two Different Limits Redraw the 737-8 Payload-Range Envelope



Source: Boeing, 737 MAX Airplane Characteristics for Airport Planning, D6-38A004, Revision K, July 2025, §2.1.2, p. 2-3. Curve geometry is illustrative and is not Boeing performance data.

Certified MTOW Sets the Limit; Actual TOW Drives the Performance Effect

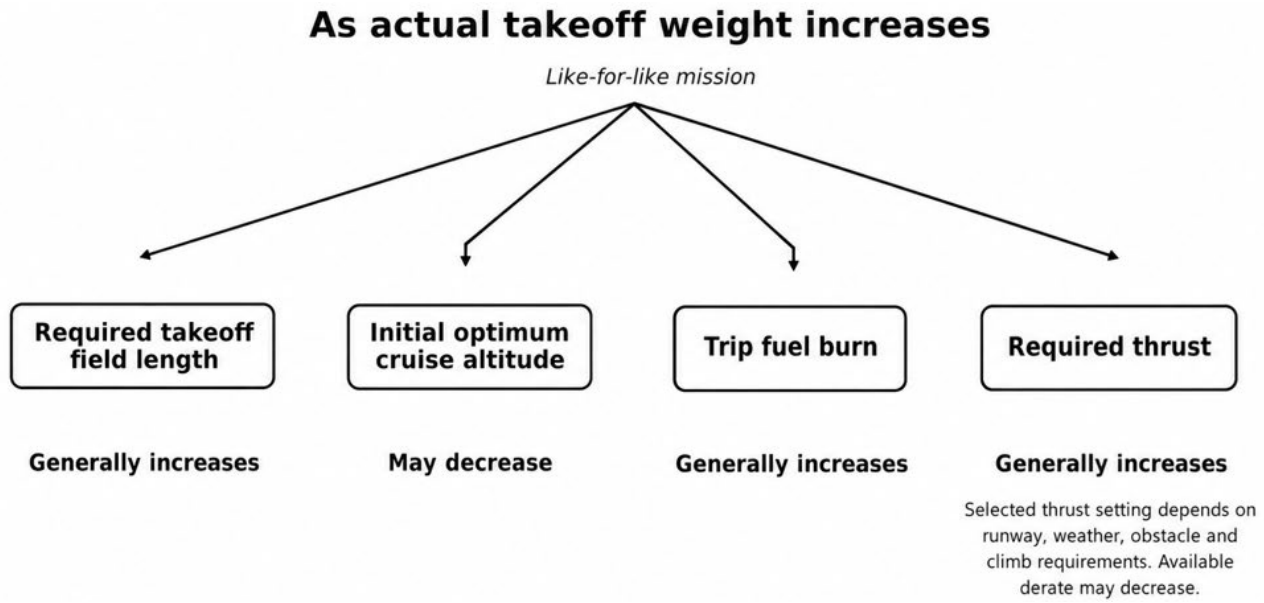
A common analytical mistake is to assume that a higher certified MTOW automatically creates the flight-performance penalty of a heavy departure. It does not.

A 737-8 certified at 182,200 lb but departing at 150,000 lb is evaluated, for that flight, at its actual 150,000-lb takeoff weight. The certified limit defines what is permitted; actual TOW drives the flight-performance calculation.

For a like-for-like mission, higher actual TOW generally increases required takeoff field length and fuel burn. It reduces climb margin and may lower the initial optimum cruise altitude. If the heavier departure requires less thrust derate or a higher takeoff thrust setting, engine maintenance exposure may also increase.

These relationships are directional. Actual values must be calculated for the specific aircraft, airport, weather, configuration, and mission (**Figure 2**). Certified MTOW tells you what the aircraft may do; actual TOW tells you what it is doing on that flight.

Figure 2. Actual TOW, Not Certified MTOW, Drives Flight Performance



Note: Directional relationships only; not to scale and not published 737-8 performance data. Actual magnitudes depend on the aircraft, airport, weather, configuration, and mission.

Certified Weight and Actual Weight Affect Different Costs

The distinction matters economically because not all costs are driven by the same weight (**Table 3**).

Some costs follow the certified limit. A higher certified MTOW may carry an OEM upweight charge and may affect route, terminal, airport, or landing charges where the formula uses certified MTOW. These costs can apply even when the aircraft departs below that limit.

EUROCONTROL is a clear example. Its en-route charge calculation uses a weight factor based on the highest certified MTOW shown in the aircraft's flight manual, not the actual takeoff weight of a specific flight.

The EUROCONTROL Weight Factor

EUROCONTROL Weight Factor = √(Certified MTOW in tonnes ÷ 50)

For the 737-8, 159,400 lb gives a weight factor of 1.20. The 179,800-lb option gives 1.28, and the 182,200-lb maximum gives 1.29. On the same route, those factors produce about 6.7% and 7.5% more weight-based service units, respectively, even if actual TOW is identical.

Higher certified capability is therefore not cost-free. To reduce the EUROCONTROL charge basis, an operator must formally lower the highest certified MTOW in the aircraft's flight manual and report the change. The real question is whether the value of keeping the higher MTOW exceeds its acquisition cost and any recurring charges.

A simple notional example shows the difference. Assume $100 per pound for certified MTOW or MZFW and $10 per pound for MLW. These are scenario inputs, not Boeing prices. The intermediate step adds 20,400 lb of MTOW with no change in MZFW or MLW, implying about $2.04 million. At maximum structural payload, that added margin can be used only for fuel. The maximum set then adds 2,400 lb of MTOW, 2,500 lb of MZFW, and 2,500 lb of MLW for another $515,000. Under these assumptions, about 80% of the $2.56 million total is spent before the aircraft gains any additional structural payload.

Under the same assumptions, MTOW and MZFW cost the same per pound, while MLW costs about one-tenth as much. An operator constrained by landing weight on short sectors would therefore obtain relief more cheaply

than one seeking additional departure-weight capability. Actual OEM pricing varies by sales campaign, model, and configuration.

Operating costs are different because they follow actual operating weight. On a like-for-like mission, higher actual TOW generally increases fuel burn. Engine maintenance exposure may also rise if the heavier departure requires less thrust derate or a higher takeoff thrust setting.

CO2 or emissions cost is conditional: it matters where emissions are priced. Noise cost is also conditional and depends on how the local charging scheme treats measured noise or certified noise categories.

Selected MTOW can create costs tied to the certified limit; actual TOW drives the flight-specific operating effect.

Table 3. Certified MTOW and Actual TOW Drive Different Cost Channels

Weight driver	Economic channel	Direction	Why it changes
Selected certified MTOW	Aircraft price / upweight charge	Higher ↑	Higher certified capability carries an OEM upgrade charge.
Selected certified MTOW	Route, terminal, airport, or landing charges	Higher ↑	Only where the applicable charging formula uses certified MTOW.
Actual operating TOW	Fuel burn/fuel cost	Higher ↑	For a like-for-like mission, higher weight generally increases fuel burn.
Actual TOW → thrust demand	Engine maintenance exposure	Higher ↑	If higher weight requires less derate or higher takeoff thrust.
Actual TOW → fuel burn	CO_2 / emissions cost	Conditional ↑	Only where CO_2 / emissions are priced.
Actual TOW → higher thrust	Noise charges/penalties	Conditional ↑	Only where the charging scheme prices measured or certified noise.

Source: Author analysis. Directional mapping only; not manufacturer or charging-authority data. Conditional channels apply only where the relevant charge is levied.

Maximum Zero-Fuel Weight (MZFW): The Structural Payload Ceiling

MZFW is the aircraft's certified zero-fuel weight limit. It defines how much the aircraft may weigh before usable fuel is added. For a given operating empty weight, MZFW sets the structural payload ceiling for passengers, baggage, and cargo.

The Structural Payload Ceiling

Maximum Structural Payload = MZFW − Operating Empty Weight

A higher MZFW raises the payload ceiling. It does not create range by itself; it simply allows more structural payload before the aircraft reaches its certified zero-fuel limit.

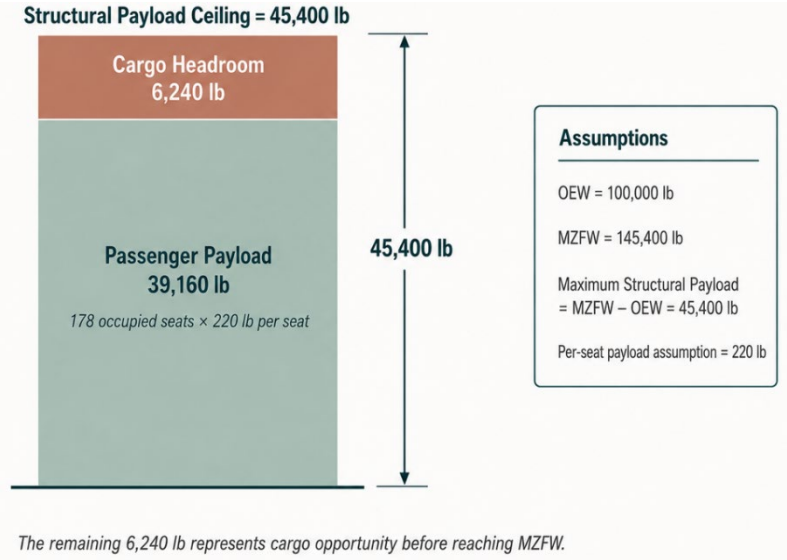
A lower MZFW does not create fuel capacity either. It lowers the permitted payload ceiling. On the maximum-payload portion of a payload-range curve, carrying less payload may leave more of a fixed MTOW available for fuel. The added range comes from carrying less payload, not from the lower MZFW itself.

The 737-8 provides a simple example. With an illustrative 100,000-lb operating empty weight, a 142,900-lb MZFW allows 42,900 lb of maximum structural payload. A 145,400-lb MZFW allows 45,400 lb. The higher limit therefore adds 2,500 lb of payload capacity. Whether an operator can turn that capacity into revenue depends on the route, passenger load, cargo demand, and available MTOW.

A passenger example makes this more concrete. At an illustrative 220 lb per occupied seat, 178 passengers represent 39,160 lb of passenger-related payload. Against a 45,400-lb structural payload ceiling, about 6,240 lb remains for cargo before reaching MZFW.

This is a weight-accounting example, not a Boeing mission-performance result. It simply shows how a higher MZFW can preserve cargo capacity after passenger payload is committed **(Figure 3**).

Figure 3. Higher MZFW Adds Cargo Capacity, Not Range



Note: Illustrative example at 220 lb per occupied seat and an assumed 100,000-lb OEW; not Boeing mission-performance data.

For lessors, financiers, and fleet planners, the question is whether the operator's traffic mix can use the added payload. Dense passenger missions and cargo-heavy routes may benefit from it. A low-density, long-range mission may not.

In short, MZFW adds payload capability, not range by itself.

Maximum Landing Weight (MLW): The Arrival-Weight Limit

MLW is the aircraft's certified landing-weight limit. It defines the maximum structural weight at which the aircraft may land.

Unlike MTOW and MZFW, MLW does not usually create a clean break in a conventional payload-range curve. Its effect appears through arrival weight. If the aircraft retains too much fuel at landing, or the sector is too short to burn enough fuel, MLW can become the binding limit on payload or dispatch weight.

The Arrival-Weight Limit

Planned Landing Weight = Actual TOW − Trip Fuel Burned

Allowable ZFW = lower of MZFW and (MLW - planned landing fuel)

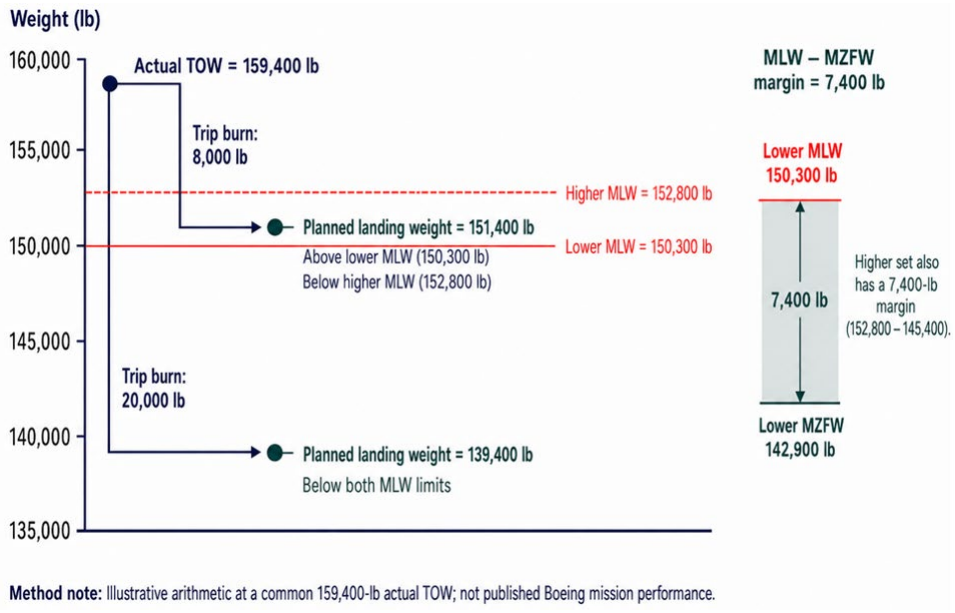
If planned landing fuel exceeds the margin between MLW and MZFW, then MLW, not MZFW, caps zero-fuel weight and therefore payload. This is most relevant on short sectors, fuel-tankering missions, multi-leg operations, diversions, and early returns. With enough trip fuel burn, MLW becomes nonbinding.

The 737-8 illustrates the relationship. In Boeing's published weight sets, the margin between MLW and MZFW is 7,400 lb in both the lower/intermediate and maximum columns. At maximum structural payload, each set therefore allows 7,400 lb of planned landing fuel before MLW begins to bind.

The maximum column raises both MZFW and MLW by 2,500 lb. It therefore raises both certified ceilings but does not increase the landing-fuel margin at the new maximum MZFW. The 7,400-lb relationship stays the same.

A simple example shows the arrival-side effect. Assume an actual TOW of 159,400 lb. With a 150,300-lb MLW, the aircraft must burn 9,100 lb before landing; with a 152,800-lb MLW, it must burn only 6,600 lb. After 8,000 lb of trip burn, planned landing weight is 151,400 lb - above the lower MLW but below the higher one. After 20,000 lb of trip burn, both MLW limits are nonbinding (**Figure 4**). This is illustrative arithmetic, not published Boeing mission performance.

Figure 4. On Short Sectors, MLW, Not MZFW, Caps Payload



Note: Illustrative arithmetic based on Boeing published weight sets; not Boeing mission-performance data.

Certified MLW is not always the landing weight available in operation. For a specific arrival, allowable landing weight is the lowest applicable limit, including structural MLW, climb-limited landing weight, and runway-length-limited landing weight. Runway condition, wind, temperature, elevation, landing configuration, and available distance can all reduce it below the published MLW.

Before dispatch, the operator may reduce payload or fuel. In flight, the crew may burn fuel, divert, or, on approved aircraft, jettison fuel. An overweight landing may also be conducted under approved procedures and can trigger a maintenance inspection. Higher MLW adds arrival flexibility, but it does not remove these constraints.

Choosing the Right Weight Package

MTOW, MZFW, and MLW should be chosen together to match the operator's missions, not simply set at three independent maximums (**Table 4**).

A long-range passenger operation may place the greatest value on MTOW because it needs departure-weight margin for fuel. Additional MZFW or MLW may be less useful if the operator is rarely payload- or landing-weight-limited.

A dense short- or medium-haul operation may see the opposite. It may place more value on MZFW and MLW because it carries more payload and burns less fuel before landing. On those missions, payload capacity and landing weight may matter more than additional MTOW.

Airport constraints still apply. Higher certified weights do not override runway length, climb performance, obstacle clearance, or landing-performance limits. The aircraft may be certified for a higher weight, but the airport, weather, or mission may prevent the operator from using it.

Table 4. Selecting the Weight Package: What Each Limit Governs, Where It Matters, and What to Watch

Limit	What it governs	Where it matters	What to watch
MTOW	How heavy the aircraft may depart	Fuel and payload margin where runway and climb performance permit	Certified MTOW may affect recurring charges; actual TOW drives flight-specific performance
MZFW	Maximum zero-fuel weight; for a given OEW, the payload ceiling	Dense passenger and cargo missions	Higher MZFW adds payload capability, not range by itself
MLW	How heavy the aircraft may land	Short sectors, fuel remaining at landing, multi-leg operations, and recovery flexibility	The usable landing limit may be lower than certified MLW.

For an aircraft owner, higher certified limits can broaden the aircraft's usable mission set and make it easier to place with another operator. But higher limits do not create value automatically. Capability that operators cannot use may still carry acquisition cost, recurring charges, or configuration complexity. The right choice depends on the missions the aircraft is expected to fly.

How Appraisers View the Weight Package

Aircraft appraisers generally consider certified operating weights as part of the aircraft's specification, but the value effect depends on the market. Higher MTOW, MZFW, or MLW is not automatically worth more. It matters when the added capability improves mission usefulness, future placement, or next-operator appeal enough for buyers and lessees to pay for it.

There is no universal ISTAT formula for that judgment. ISTAT appraisal standards do not prescribe a fixed value per ton of MTOW. In practice, an appraiser may consider marketability, mission usefulness, transferability, upgrade cost, and comparable transactions. The question is whether the weight package changes market value, lease value, residual value, or remarketing prospects.

For appraisers, the test is narrower: does the weight package change market value, lease value, residual value, or remarketing prospects? A higher-weight aircraft may command a premium where operators value the added capability. Where they cannot use it, or where it adds cost without useful mission benefit, the value effect may be limited or neutral.

It is essentially the airline's test one step removed. The operator asks whether it can use the capability. The appraiser asks whether the next operator will. A capability that passes both tests may be worth paying for; a capability that passes neither is simply a number in the flight manual with a charge attached.

What This Means Commercially

When an airline buys an aircraft, it is not simply buying metal, engines, and seats. It is buying a certified weight envelope and deciding how much of that capability it wants available.

MTOW, MZFW, and MLW define different boundaries. Together, they determine what the aircraft is allowed to do before the airline builds a schedule, sells a seat, or dispatches a flight.

1. MTOW tells you how heavy the aircraft may depart - and, in some charging regimes, sets part of the recurring fee basis.
2. MZFW tells you how much structural payload the aircraft can carry for a given operating empty weight. It adds payload capability, not range by itself.
3. MLW tells you how heavy the aircraft may land. It can become important on short sectors and flights that retain more fuel at arrival.

Selected limits define capability and may also create recurring cost. Actual operating weight and airport conditions then determine the flight-specific performance and economic effects.

That distinction matters to airlines, lessors, financiers, and investors. Higher certified limits can improve operational fit, placement flexibility, and transferability, but only when operators can use the added capability and are willing to pay for it.

Same aircraft. Different certified limits. Different commercial outcome.

Source and Method Notes

- Manufacturer data: Boeing, 737 MAX Airplane Characteristics for Airport Planning, D6-38A004, Rev. K, July 2025, §2.1.2; Airbus, A320 Aircraft Characteristics - Airport and Maintenance Planning, July 2026, §2-1-1, pp. 3-5.
- Weight and AFM framework: 14 CFR §§ 25.25 and 91.9; FAA AC 25.1581-1; FAA AC 120-27F. Structural-load framework: 14 CFR §§ 25.301, 25.321, and 25.343.
- U.S. landing-performance and structural framework: 14 CFR §§ 25.119, 25.121(d), 25.125, 25.473, 25.723, 121.195, and 121.197.
- EUROCONTROL route-charge framework: CRCO Customer Guide to Charges, April 2026, § A.1.2.2.
- Upweight pricing: purely notional scenario assumptions of $100 per pound of certified MTOW or MZFW and $10 per pound of certified MLW. These are not Boeing prices, OEM list prices, or market quotations. They are used only to illustrate relative economics; actual charges vary by sales campaign, model, and configuration.
- Unless identified as published data, payload-range curves, directional relationships, fuel burns, OEW, and passenger-weight examples are author illustrations, not manufacturer performance guarantees or flight-planning data.