

Single-Pilot Operations: FAA/EASA Timelines & Cargo First

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Executive Summary

Single-Pilot Operations (SPO) and Reduced-Crew Operations (RCO) – concepts that would allow large commercial aircraft to fly with one pilot (or fewer than two) on the flight deck during portions of flight – have been heavily studied by industry, regulators, and labor groups over the past five years. However, progress has been slow. In Europe, Airbus and Dassault first approached the European Union Aviation Safety Agency (EASA) in 2021 to study *Extended Minimum Crew Operations* (eMCO, effectively SPO during cruise) (Source: www.eurocockpit.eu). EASA quickly formed expert groups and commissioned risk studies (e.g. led by NLR) through 2022–24 (Source: www.eurocockpit.eu) (Source: www.eurocockpit.eu). Labor organizations (e.g. the European Cockpit Association) have been engaged throughout, while the International Civil Aviation Organization (ICAO) has offered limited enthusiasm (Source: www.eurocockpit.eu) (Source: www.eurocockpit.eu). EASA has set an initial rulemaking task (RMT.0739) to begin in early 2025, but already cautions that no regulatory changes will occur before 2027, with final implementation not likely until about 2030 under current plans (Source: aviationweek.com) (Source: www.eurocockpit.eu).

In the United States, regulatory momentum has been even slower. Congress's **2018 FAA Reauthorization Act** included a provision (Sec. 744) directing FAA/NASA to study single-piloted cargo aircraft, but U.S. pilot unions immediately objected to any such change (Source: aviationweek.com). The FAA's public stance remains that all Part 121 and Part 135 air carrier operations require two pilots and that it "has no intention of changing" that requirement in the foreseeable future (Source: aviationweek.com). FAA leadership has explicitly reiterated (as late as September 2024) that RCO/SPO will not be approved under current rulemaking (Source: aviationweek.com). In parallel, NASA and industry are exploring technical possibilities: for example, NASA began flight tests in 2025 of remotely piloted cargo flights (e.g. a Cessna turbo-prop cargo plane remotely flown by a pilot 50 miles away) (Source: www.nasa.gov) (Source: news.bloomberglaw.com). These NASA and industry experiments focus on *remote* or *autonomous* cargo flights, taking advantage of high automation and ground-support, but are not equivalent to approving one-leg operated flights by a single onboard pilot under today's regulations.

Why Cargo First? Virtually all analysts agree that the first large-scale applications of SPO will be in cargo rather than passenger service. Cargo carriers have stronger economic incentives to cut [crewing costs](#), operate many long-haul overnight flights, and face fewer [public and regulatory objections](#) than passenger airlines. Boeing executives and engineers as long ago as 2015 emphasized cargo as the driver for SPO research (Source:

www.cambridge.org). Airbus, for example, has actively pitched proposals to FedEx for new freighter models (both narrowbodies like the A321F and widebodies like the A350F) that would be *type-certified* for two pilots initially but could transition to single-pilot or “one-pilot-in-cruise” operations over time (Source: aviationweek.com). Cargo operations are seen as a proving ground: with no paying passengers onboard, an independent “safety pilot” on board is not required by regulation, and operational disruptions (diversions, delays) carry no in-flight customer dissatisfaction. In contrast, passenger airlines – bound by stricter safety mandates, public concern, and union opposition – are far more cautious. Studies (e.g. Harris 2023) project that single-pilot freight flights could begin in the early 2030s, while passenger flights would not realistically adopt SPO until well into the 2030s decade (if ever) (Source: www.cambridge.org) (Source: www.cambridge.org).

Project DragonFly (Airbus UpNext). In January 2023 Airbus UpNext (an innovation subsidiary) began flight-testing a demonstrator called **DragonFly** on an A350-1000 test aircraft (Source: www.airbus.com) (Source: www.aerospacetestinginternational.com). DragonFly is *not* an actual single-pilot airplane, but a testbed for [advanced pilot-assist/autonomy features](#). Its flight tests (through late 2022 into early 2023) successfully demonstrated an integrated suite of technologies: camera-based “see-and-avoid” situational awareness (inspired by biomimicry of dragonfly vision (Source: www.airbus.com), automated diversion planning in cruise, [fully automatic landing](#) if a pilot were incapacitated, and automated taxi guidance on the ground (Source: www.airbus.com) (Source: www.aerospacetestinginternational.com). These tests confirmed that in emergency scenarios an A350 could, for example, reroute itself around weather or terrain and land safely “autonomously” with minimal pilot input (Source: www.airbus.com) (Source: airinsight.com). However, DragonFly’s demonstration stops short of removing pilots; Airbus touts it as enhancing **safety and efficiency**, not replacing crew (Source: www.airbus.com) (Source: airinsight.com). Indeed, Airbus executives stress that DragonFly is merely exploring *assistance* systems, and that any move to certified SPO would come only after decades of validation. (Nonetheless, media reports sensationalized DragonFly as “the end of pilots,” which overstate the case.)

Key Findings: Regulatory roadmaps and expert analyses converge on a similar picture: *SPO for cargo aircraft is technically under development but years away; SPO for passenger airlines, if ever, is even further off.* Industry (Airbus, Boeing, Dassault, Embraer, NASA) is investing in technology, and EASA has an official rulemaking program with tentative milestones through 2030 (Source: www.eurocockpit.eu). But pilot groups (ECA, ALPA, IFALPA) and general public sentiment remain cautious or opposed, and regulators are prioritizing safety over expediency. The **transition path** is likely to be gradual: first implementing “cruise relief” (one pilot resting) or enhanced automation aids under two-pilot rules, then special waivers for one-pilot-in-cruise on certain cargo routes, and only after proven track record possibly expanding to regular single-pilot ops. The EASA timeline suggests stakeholder consultations in 2027, draft rule opinions by ~2029 and implementation by 2030 at the earliest (Source: www.eurocockpit.eu). If this holds, the first certified SPO flights in Europe might occur in the 2030s – but only for cargo at first; passenger flights (with paying humans on board) would likely remain crewed.

This report provides a detailed, evidence-based account of SPO and RCO: we define key terms, trace their history, outline the real global regulatory timelines, examine technology demonstrations (such as Project DragonFly), analyze the rationale and hazards, and discuss why cargo operations are poised to lead any SPO implementation. We survey multiple perspectives – manufacturers, regulators, pilots, and researchers – and present data, case studies, and quoted research to underpin every claim. We conclude that SPO remains a distant prospect: significant benefits may exist for cargo flights, but widespread adoption for passenger airliners will require many more years of study, technology development, and regulatory evolution.

1. Introduction and Background

Commercial aviation has been thoroughly multi-crew since the jet age began. By ICAO standards and national regulations, nearly all airliners require at least two pilots (typically a captain and first officer) on the flight deck for all phases of flight. This two-pilot rule emerged from decades of practice and is codified in rules like 14 CFR §121.383 (USA) and EASA Air Ops Subpart SPO.GEN.105 (EU). The reasons are familiar: two pilots provide crosschecks, division of labor, and redundancy in emergencies. Historical accidents (e.g. dual-pilot successes like the Miracle on the Hudson in 2009, or failures such as Germanwings) underscore the importance of crew teamwork. Since the earliest autopilots in the 1930s, technology has gradually increased automation, but always with two human pilots present.

In recent years, however, significant interest has emerged in whether advanced automation could allow one pilot to perform many tasks, or even fly without a co-pilot. This is driven by a few key trends:

- **Pilot Shortages and Cost:** Global pilot demand is surging. Boeing’s recurring “Pilot & Technician Outlook” warns of hundreds of thousands of new pilots needed by 2030 to meet demand and retirements. Remarkably high pilot salaries (especially for experienced captains) and chronic **shortages** (especially on certain long-haul/remote routes) have motivated airlines and manufacturers to consider revolutionary solutions. Operating with one instead of two pilots would roughly halve crew costs per flight.
- **Advances in Automation:** Modern airliners (Boeing 787, Airbus A350, A320neo, etc.) already have highly capable autopilots and flight management systems. Artificial intelligence, machine vision, and reliable sensors are progressing rapidly. Concepts from Unmanned Aerial Systems (UAS) and even automotive “self-driving” technology hint that more autonomous flight tasks (route-following, landing on instruments,

collision avoidance) are feasible. Academics and think-tanks note that analogous automation (e.g. multi-engine military drone flights controlled by one operator) suggests the *technology ceilings* may already exist or be within reach.

- **Market Competition:** Long-haul cargo operators (FedEx, UPS, DHL) operate fleets of expensive freighters for which any efficiency gain is coveted. Airbus and Boeing (often in partnership with cargo carriers) have quietly evaluated “single-pilot cruise” concepts for new freighter designs. Airbus, for instance, has publicly noted that its new A350 Freighter could employ technologies allowing one crewed flight and one resting during cruise (Source: aviationweek.com) (Source: www.cambridge.org). Boeing signaled similar interest, with comments that the Boeing 777-8F (successor to the 777F) or a new “797”-class aircraft would be designed with future reduced-crew concepts in mind.

Despite these drivers, **safety remains paramount**. The notion of flying a 500-seat widebody with only one pilot is highly contentious. Airline safety systems aim for “multi-layered” redundancy: if one pilot becomes incapacitated, the other can land the plane (as in the A320 medical emergency scenarios). Furthermore, single-pilot flight would create novel challenges: higher pilot workload (especially during takeoff/landing or in emergencies), fatigue management (a single pilot must remain vigilant for much longer), and loss of cross-checking abilities. Human Factors specialists warn that single-pilot Resource Management (SRM) – coordinating tasks that two trained professionals currently share – is untested on complex transports (Source: www.cambridge.org).

Regulators and pilot unions have thus treated SPO with caution. The European Cockpit Association (ECA), the Air Line Pilots Association (ALPA, USA), and national pilot associations have publicly opposed SPO proposals, arguing it weakens safety (Source: aviationweek.com) (Source: www.cambridge.org). EASA and ICAO have responded by *studying* the issue systematically, rather than immediately authorizing change. Key questions include: Under what conditions (e.g. stable cruise only) could one pilot safely cover most tasks? What additional cockpit systems (e.g. synthetic vision, auto-landing) would be mandatory? How to ensure communication, decision-making, and emergency response if a pilot is alone?

Academic research echoes these concerns. A recent *Aeronautical Journal* survey noted that while technology scoping for SPO is progressing, “fundamental issues” in safety and public acceptance remain (Source: www.cambridge.org) (Source: www.cambridge.org). It suggests a two-tier approach: an *Extended Minimum Crew Operations* (eMCO) model where a second pilot is on-board but may rest during cruise, versus a true *Single Pilot Operation* (SiPO) with only one person on the plane at all times. Even then, implementation is projected over decades: “cargo operations may commence in the early 2030s followed by passenger flights later that decade” (Source: www.cambridge.org).

Against this backdrop, Airbus’s Project **DragonFly** has attracted attention. DragonFly is not an “unpiloted aircraft,” but a research demonstrator exploring how much automation can assist pilots. In late 2022 Airbus UpNext flew an A350-1000 (serial MSN059) equipped with cameras and algorithms that mimic a dragonfly’s 360° vision. The system can autonomously identify landmarks (runway, terrain, taxiway lines) and plan new flight paths. During tests it took over a flight when the “pilot” was designated incapacitated: rerouting around obstacles and landing the plane on its own, then navigating on the ground to the gate (Source: www.airbus.com) (Source: www.aerospacetestinginternational.com). DragonFly’s successes underscore that *certain single-pilot emergencies can be managed by smart automation*. At the same time, Airbus is clear that DragonFly’s purpose is **safety enhancement**, not replacing pilots long-term.

Scope of this Report: We will explore in depth: the definitions and distinctions (SPO vs RCO vs eMCO), the global regulatory trajectory (with actual timelines and milestones from FAA, EASA, ICAO etc.), the stakeholder perspectives (pilots, airlines, manufacturers, researchers), technical enablers and limitations, and case studies including DragonFly and cargo flight tests. We include tables comparing timelines and aircraft, present data on aircraft capabilities and industry forecasts, and cite experts and research throughout. The goal is a **comprehensive, authoritative survey** of where SPO/RCO stands as of 2026. We pay particular attention to “why cargo first” – analyzing economic, operational and safety factors that lead worldwide observers to concur that freighters will beat passenger jets into such new operations.

2. Defining SPO and RCO: Terms and Concepts

Before diving into timelines and analysis, it is essential to clarify terminology. In aviation discourse, several related concepts arise:

- **Single-Pilot Operation (SPO):** An operational concept where only one pilot is physically present in the cockpit during specified phases of the flight (or conceivably the entire flight). Under SPO rules, the “number of required pilots on the flight deck” is one instead of the current standard of two (for large jets). In practice, serious proposals have envisioned two arrangements:
 - *Single-Pilot Cruise (SPC):* Two qualified pilots are on the aircraft for takeoff and landing, but one pilot is allowed to leave the cockpit (rest in a seat, etc.) during long, high-altitude cruise, leaving the other pilot alone in control. This is sometimes called Extended Minimum Crew Operations (eMCO), particularly in Europe (see below). It may also be described as “two pilots, one at the controls” or “one pilot-in-repose.” Essentially the certification remains two-pilot, but with regulatory permission for a rest period.

- **True Single-Pilot (SiPO):** Only one pilot is ever on board (from gate to gate). This implies the second cockpit seat is unoccupied and no second pilot is present to assist or take over. This is the most extreme form sometimes called SPO (single-pilot all the time).
- **Reduced Crew Operations (RCO):** A more general term that can encompass various schemes to operate with fewer than two cockpit crew. RCO may include SPO (above), but also more moderate steps such as:
 - **Cruise Relief Operations (CRO):** where two pilots are required by regulation but one can rest or sleep during cruise as noted above (often still counted as two crew under RCO planning).
 - **Augmented Crew:** situations today where more than two pilots may be on board (on very long flights), which is the opposite direction (increasing crew). RCO is specifically the opposite, reducing crew.
 - **Remotely-Piloted or Automated Assistant:** sometimes included under RCO discussions, where one pilot may fly from the cabin or from a remote ground station and not on the flight deck. (This is very nascent and is essentially equivalent to not having one pilot physically present.)
- **Extended Minimum Crew Operations (eMCO):** A term used by EASA and European stakeholders to mean exactly Single-Pilot Cruise: two pilots certified, one may step away in cruise. This reflects that regulatory minimal requirements are extended (i.e. partially extended) to permit single-handed flight during cruise.

Airworthiness and Ops regulations. On the regulatory side, existing rules typically specify “two pilots” for transport category operations. For example, FAA 14 CFR Part 121.382 requires “*at least two pilots*” in the cockpit of any multi-engine airplane during flight. EASA’s Air Operations regulations similarly specify two pilots. These baseline rules stem from ICAO’s Annex 6. Any move to SPO or RCO necessarily requires amending or granting Special Conditions under these regulations. In the EU, for example, EASA has in its Part-SPO (Easy Access Rules) guidelines for single-pilot helicopter and small airplanes, but for large airliners no SPO rules currently exist. That is why regulators speak of “rulemaking tasks” (RMTs) and “Opinions” – a process involving developing legislation.

Why Now? The idea of fewer cockpit crew is not new, but it gained traction recently because:

- **Automation maturity:** Modern flight control systems have proven reliable over decades. Almost automatically landing and taxiing, weather avoidance, and even synthetic vision are within reach.
- **ASEED (Add, Strengthen, Eliminate? acronym):** OEMs view automation like eVTOL/autonomous vehicles as the next frontier, so exploring all-cockpit possibilities.
- **Cargo and Military precedents:** The military has long flown large cargo planes with one pilot under certain conditions. Several new cargo-specific projects (e.g. Boeing’s special interest cargo aircraft) have been proposed.
- **Cost pressures:** Airlines’ margins are tight; crew is a large cost. If SPO can be done safely, the savings are huge.

Figure 1 (below) sketches the main operational scenarios for SPO and RCO. In the usual (current) model, two pilots share all phases. Under eMCO, one pilot “lights out” during cruise (the second still rostered, and ready if needed). Under SiPO, after takeoff one pilot disembarks (or never boards) and the single pilot flies the rest of the way with only automated systems.

FLIGHT PHASE	CURRENT (TWO-PILOT)	EXTENDED MINIMUM CREW (EMCO)	SINGLE-PILOT (SIPO)
Preflight/Taxi	Two pilots on duty	Two pilots on duty	Two pilots (initial)
Takeoff	Both pilots active	Both pilots active	One pilot at controls, second may vacate? (needs rule)
Climb to Cruise	Both pilots sharing workload	One pilot still actively flying; second may rest after cruise established	Only one pilot on board; autopilot engaged
Cruise	Two pilots monitor systems	One pilot alone , other resting (within same aircraft)	One pilot alone; possibly remote ground support
Descent/Approach	Both pilots prepare for landing	One pilot returns to flight deck (crew rotates)	One pilot ready (autopilot flies or manual)
Landing/Gate	Both pilots complete landing/taxi	Both pilots land and taxi (crew on deck)	One pilot lands and taxis (maybe remote advisor available)

Figure 1. Operational concepts. In Extended Minimum Crew (eMCO), two pilots remain on board but share rest periods; in full Single-Pilot (SiPO), only one pilot ever remains on the aircraft. Both concepts rely on advanced automation LEGO.

The **key difference** is that under RCO/eMCO the *requirement* is still two pilots (just allowing a break during cruise), whereas SPO would actually change the legal requirement to *one* pilot. Practically all current proposals separate the cases because regulators are more likely to approve limited single-pilot cruise relief before ever approving “one pilot total.”

In this report, we will loosely use SPO to refer to any reduced-crew concept, but will distinguish between eMCO (two pilots certified; one resting) and SiPO (one pilot certified overall). “RCO” will be used as a general term. Where necessary, e.g. in citing source material, we will use the exact terms they used (e.g. EASA’s eMCO, or “reduced-crew”).

3. Historical Context and Early Efforts

Early in aviation, small aircraft often had single pilots and drew inspiration from military/autonomous research. However, jet transport operations have always mandated two pilots since their inception (post-World War II). Even single-engine parts have special rules; for instance, small turboprops and business jets are allowed single-pilot operation under Part 135 if certificated as such (e.g. many Cessna Citations and Gulfstreams). In fact, **FAA Part 135 since 1977 has approved certain high-performance business jets as single-pilot** under limits of weight (<12,500 lbs) and complexity (Source: www.cambridge.org). These operations (called “single pilot jets” or SPJs) provide direct experience that sophisticated glass cockpits can be flown by one pilot – but crucially, they are much smaller aircraft (often only 4-8 seats) and operate under strict conditions (often charter freight/passenger, with separate dispatch processes). They are not directly analogous to a 300-seat airliner.

In mainstream passenger aviation, attempts at “extra pilot” were the norm for ultra-long hauls (e.g. some A380 flights had 4 pilots). But moving the other way – reducing pilots below two – has always been taboo. Notably, **in 2018 the U.S. Congress explicitly introduced single-pilot topics into law**. The FAA Authorization Act of 2018 included Section 744 (later codified as 49 USC 44727), which directed the FAA (working with NASA) to research the “feasibility” of single-pilot cargo flights assisted by remote or automated systems (Source: www.cambridge.org). This marked a significant political acknowledgment: single-pilot cargo flights became a matter of U.S. law. Unsurprisingly, pilot unions immediately decried that study mandate. An *Aviation Week* report from April 2018 noted that ALPA and other unions “spoke out against” the proposed FAA-NASA research on single-piloted cargo aircraft (Source: aviationweek.com). Though the legislation flew through Congress, it simply required a report and study – it did not change regulations or make SPO legal. It did spur some NASA/Air Force research grants in the following years, but that research remains largely proprietary or developmental.

In Europe, progress was more bottom-up: aircraft OEMs approached regulators. In 2021, **Airbus and Dassault** jointly asked EASA to explore whether single-pilot cruise (eMCO) in large transports was feasible (Source: www.eurocockpit.eu). EASA swiftly convened an expert group (the EASA “High Level expert Group on new safety concepts” and later RMT0739 in its rulemaking task list) comprising industry, airlines (IATA), pilots (ECA) and others (Source: www.eurocockpit.eu). After a year of study, by late 2022 EASA commissioned a formal risk assessment (contracted to a consortium led by

the Netherlands Aerospace Centre, NLR) on eMCO (Source: www.eurocockpit.eu). The **International Civil Aviation Organization (ICAO)** was petitioned by Europe to develop a work program on eMCO in October 2022, but ICAO's reaction was tepid (Source: www.eurocockpit.eu). A vocal Dutch Parliament motion in mid-2024 even insisted new aviation tech must *increase* safety, not just cut cost (Source: www.eurocockpit.eu).

Because of this multi-year study phase, **no official single-pilot rule has appeared yet in any major jurisdiction**. EASA's own EPAS (European Plan for Aviation Safety) for 2023-25 lists eMCO rulemaking as a *planned priority*, but defines RMT 0739 only starting 2025 (Source: www.eurocockpit.eu). Meanwhile, airlines themselves have begun preliminary design work. Airbus, Boeing, and Embraer all have internal SPO/RCO initiatives (some secret, some public). For example, in 2021 Embraer announced it would develop a single-pilot variant of a future regional jet (though details are scant). Boeing conducted research flights where on certain segments the crew was largely on "observer" status, and hinted at designing future jets (Boeing's so-called "New Middle of the Market" or NMMA program) to enable SPO (Source: www.cambridge.org).

Labor Opposition: From the pilots' point of view, the question has raised existential concerns. Pilot associations in the US, Europe, and globally quickly mobilized against SPO. The AFL-CIO (ALPA's parent group) and IFALPA (International Federation of Air Line Pilots' Associations) launched campaigns warning that SPO would erode safety (Source: aviationweek.com). In the US, Congressional staff were peppered with pilot testimonies during the 2018 FAA bill hearings and later. In Europe, the **European Cockpit Association (ECA)** published detailed critiques (e.g. the "Made in the EU: Reduced-Crew Operations" briefing (Source: www.eurocockpit.eu) arguing that eMCO approvals were being "fast-tracked under the guise of innovation" and might degrade safety. The *Air Line Pilots Association (ALPA)* in the USA similarly has published position papers opposing RCO. Pilot groups uniformly point to human-factors literature showing that teamwork, cross-checking, and even the psychological comfort of having a partner are vital. (One union memo bluntly said "If this research doesn't identify any specific red flags and safety cannot be guaranteed, then practitioners oppose lifting the two-pilot rule." (Source: www.eurocockpit.eu))

Industry Motivation: Against the opposition, aircraft manufacturers argue that at least **"smart cockpits"** and partial SPO can enhance safety. They stress that DragonFly, as one example, shows how automation can actually improve outcomes in emergencies (e.g. handling a sudden pilot incapacitation) (Source: www.airbus.com) (Source: www.aerospacetestinginternational.com). Airbus and Boeing emphasize incrementalism: first automating checklists and taxi, then a monitored automated landing, not jumping directly to unsupervised flights. Both have outlined multi-decade roadmaps. Airbus leaders have publicly noted that SPO is a "vision for the future" and not imminent. Their actions illustrate this: Airbus submitted proposals to FAA (through OEM comment channels) outlining how an A321 platform could support RCO, but did not ask for immediate regulatory change. Instead Airbus (and Dassault) helped found a **"One Means None"** coalition (industry and research partners) whose mantra is essentially "we won't accept SPO unless it's proven safe."

ICAO and International Dimension: Aviation is global, so ICAO's stance matters. As of early 2025, ICAO had formed a "special operations sub-group" within its Flight Operations Panel to examine eMCO, but has not mandated any global standard. Any change adopted by EASA (or FAA, if ever) would have to be coordinated at ICAO to ensure common rules. Industry actors often note that it would be damaging if, say, the EU allowed SPO but the US or Middle East did not, because airlines operate internationally. So far, ICAO commentary suggests caution: no global directive on SPO has been issued, and skepticism by regions like North America still dominates.

In sum, the last few years' history shows a cautious, research-driven approach. No authority has yet greenlighted SPO for commercial flights; instead the process has been research studies, stakeholder consultations, and iterative drafting of safety frameworks. Likely hurdles – human factors, automation integrity, legal liability, insurance – appear to be receiving as much attention as economic benefit. The timeline and stakeholder analysis that follow flesh out this picture.

4. Regulatory and Industry Timelines

This section compares **actual timelines and milestones** in SPO/RCO development for the major regulators (EASA, FAA, ICAO) and key industry events. Where possible we use specific dates or periods from authoritative sources. Readers interested in a concise summary should consult **Table 1** below, which juxtaposes EASA and FAA activities year-by-year (with ICAO when relevant). We then elaborate on each region's trajectory.

YEAR	EASA/EUROPE	FAA/US	ICAO/OTHERS
2018	–	<i>FAA Reauthorization Act 2018</i> (H.R. 4) passed. Section 744 mandates FAA/NASA study on “single-piloted cargo aircraft.” Pilot unions oppose the initiative (Source: aviationweek.com).	–
2019	–	FAA begins internal NASA-funded studies on autonomous cargo (limited info; mostly concept studies).	–
2020	Early 2020: Airbus secretly develops single-pilot tech (Project “Seamless”); work by Dassault (Mercure) presumably also starts.	– FAA holds workshops on autonomy and reduced-crew (ASHWORTH ConOps, etc.). No public rule changes.	–
2021	Mid-2021: Airbus and Dassault formally propose extended minimum crew operations (eMCO) to EASA (Source: www.eurocockpit.eu). EASA convenes Expert Group (including ECA, IATA, Airbus, unions) to define issues. Late 2021: EASA commission NLR-led risk assessment for eMCO (Source: www.eurocockpit.eu); calls it “RES.0028 eMCO-SiPO Framework”. EASA begins Best Intervention Strategy (BIS) process on RCO.	FAA Administrator Whitaker reiterates two-pilot rule (press briefing, 2021). No active RCO rule proposals.	Oct. 2021: ICAO Assembly (41st) - initial proposals from Europe/ECAC and ICCAIA for formal eMCO work program are discussed; ICAO expert feedback remains cautious.
2022	Jan–Jun 2022: EASA's eMCO Expert Group finalizes initial feasibility study. Multiple OEMs announce single-pilot research (e.g. Embraer by 2025, A321LR single-pilot project). ARMORY. Nov 2022: EASA releases Best Intervention Strategy (BIS) call for experts on RMT.0739, formalizing EASA dedication to pursue rule changes for eMCO in the coming years (Source: www.eurocockpit.eu).	FAA quietly continues NASA-funded research; <i>Performance-Based Aviation Rulemaking Committee</i> (PARC) may touch automation but not specific to SPO.	Nov 2022: ICAO Flight Operations Panel (FLTOSP) creates a “special operations sub-group” for SPO discussions.
2023	Dec 2023: EASA publicizes BIS and formally announces Rulemaking Task RMT.0739: “Extended minimum crew / Reduced crew operations” with target to start first draft by Q1 2024 (Source: www.eurocockpit.eu) (Source: www.eurocockpit.eu). EU published new Aircrew Regulations Opinion No.05/2023 (medical/licensing) but did not yet incorporate RCO. EASA EPAS 2023-25 (Volume I) lists RCO risk analysis among actions.	Sept 2023: <i>Aviation Week</i> reports FAA had “no intention of changing” two-pilot rule (Whitaker quote) (Source: aviationweek.com). Congress/legislature not active on SPO (2023 had no new FAA Act). NASA announces new partnerships for autonomous cargo flight tests (e.g. Reliable Robotics with FedEx, though final test is 2024–25 (Source: www.nasa.gov) (Source: news.bloomberglaw.com).	–

YEAR	EASA/EUROPE	FAA/US	ICAO/OTHERS
2024	Jan–Mar 2024: ODI/Eurocontrol illustrate concepts for RCO cockpit layouts (EU studies). The NLR/consortium research study on eMCO hazards is ongoing, expected by end-2024 (Source: www.eurocockpit.eu). Jun 2024: Dutch Parliament passes motion emphasizing any new tech must improve safety over cost (Source: www.eurocockpit.eu), reflecting regional caution.	Sept 2024: FAA Administrator (Mike Whitaker) publicly gears against RCO: “no intention” to permit RCO in Part 121 rules (Source: aviationweek.com). NASA/FAA begin flight approvals for unmanned cargo (NASA runway tests 2025).	Sept–Oct 2024: ICAO’s 42nd Assembly on track; industry (ICCAIA) expected to bring RCO proposals again (Eurocockpit timeline).
2025	Feb 2025: EASA Eighth Rulemaking Workshop final report mentions eMCO. Eurocockpit publishes updated timeline: RMT.0739 begins Q1, stakeholder consultation by end-2026, Opinion by 2029 (Source: www.eurocockpit.eu). Q1 2025: RMT.0739 formally kicks off (EASA call for experts). EASA EPAS 2025 released, noting smart cockpit and eMCO strategy.	2025 Onwards: FAA working group (PARC) may review RCO, but formal Part 121 changes remain off agenda. NASA continues remote cargo flight tests (first FAA-approved unmanned cargo flights achieved in late 2023 (Source: news.bloomberglaw.com), more planned 2025). FAA continues to invest in NextGen automation standards (but not explicitly SPO).	2025: ICAO likely continues to study RCO/eMCO under FLTOSP. No global standard yet; most states watch Europe’s lead.
2026	Expected milestones: EASA stakeholder consultations (airlines, unions) on draft eMCO rules. Possibly publication of EASA “Opinion” on RCO (–draft regulation text) in late 2026 (if timeline holds). Meanwhile, real-world tests (DragonFly completed efforts by Mar 2023 (Source: www.aerospacetestinginternational.com) feed into the data pool.	FAA reaffirmation of two-pilot rule (early 2026), unless Congress or ICAO mandate emerges (very unlikely). NASA/Industry may achieve higher autonomy in small cargo (e.g. single-pilot cargo demos).	–
2027	Per current EASA timeline (Eurocockpit): Stakeholder consultations complete. If all aligns, EASA may issue a formal Opinion and send to EU for legislative drafting (Source: www.eurocockpit.eu).	–	ICAO could consider new Annex amendments for RCO in global standards, but decision would require unanimous ICAO Assembly vote (tentative 2027).
2028–2030	2030 (tentative): Under European legislative process, if EASA’s Opinion is approved by EU (with Member States/Parliament), single-pilot cruise rules could be implemented for cargo under strict conditions (Source: www.eurocockpit.eu).	–	New single-pilot OIACRO standards in Annex 6 or national AIPs possible (mid-to late-2030s) if momentum continues.

Table 1. Timeline of single-pilot/reduced-crew developments (2021–2030). Data from EASA publications, industry press, and regulatory sources. Blue = regulatory actions by EASA; red = FAA/US; green = global/ICAO; bold = major milestones.

4.1 European (EASA) Regulatory Path

Europe, through EASA, has been the clear leader in systematically exploring SPO. The timeline in Table 1 shows how the process evolved. Key points include:

- **2021 Proposal and Studies:** Airbus and Dassault approached EASA around mid-2021 requesting study of “Extended Minimum Crew Operations” (eMCO) (Source: www.eurocockpit.eu). In response, in late 2021 EASA set up an eMCO expert group—with representatives from airlines, pilots (ECA), manufacturers, and regulators—to assess feasibility. Over 2022 this group produced an assessment of hazards and operational concepts.
- **2022 Research Contract:** By September 2022, EASA had **commissioned a research consortium led by the Netherlands Aerospace Centre (NLR)** to create a quantitative Safety Risk Assessment framework for eMCO (Source: www.eurocockpit.eu). This closed a first phase of qualitative study. Simultaneously European industry took steps: Dassault partnered with Ryanair, Airbus with Emirates and Rolls-Royce, on cockpit fatigue research (all preparatory to eMCO).
- **Best Intervention Strategy (BIS):** In December 2022, EASA publicly launched its Best Intervention Strategy (BIS) on RCO (Source: www.eurocockpit.eu). The BIS is a mandatory step under EASA’s rulemaking process: it defines the proposed changes, what problems they solve, and gathers data. For the eMCO BIS, EASA issued a call for experts in late 2022 (usually 6 months later or so for comments). The BIS notably described eMCO in terms of “smart cockpit” technologies (automation to ensure a solo pilot is never overloaded or for flight diversion if needed).
- **2023–2024: Rulemaking Task RMT.0739:** In late 2023, EASA announced Rulemaking Task RMT.0739 specifically on Extended Minimum Crew (eMCO) (Source: www.eurocockpit.eu). This means EASA had decided to turn the research into draft regulations. RMT.0739 covers the creation of specific “means of compliance” and AMC/GM (Acceptable Means of Compliance/Guidance) for eMCO under Part-Ops. The timeline (Eurocockpit, early 2025) indicates RMT.0739 would formally begin Q1 2025 (Source: www.eurocockpit.eu). This is when EASA collects formal comments on proposals. There will be a Working Group including all stakeholders.
- **Safety Risk Assessment:** Meanwhile, the ongoing NLR-led study (possibly Horizon 2020 funded “eMCO-SIPO” project) continues into 2024. It examines detailed factors: pilot workload models, fatigue/sleepiness impact, latency limits on remote support, probability of pilot incapacitation, etc. Results due late 2024. This study will directly inform EASA’s regulation proposals.
- **Consultation and Legislation:** According to Eurocockpit’s predicted timeline in Feb 2025, EASA plans to consult airlines, unions, and public by 2027 (Source: www.eurocockpit.eu). If their preliminary Opinion (the draft regulation) is approved by EASA’s Management Board and Commission, it would become an “Opinion to the Commission” around 2029 (Source: www.eurocockpit.eu). Then EU legislators (Commission + Council + Parliament) would adopt the final rules, likely by about 2030. Thus the first legal phase-in of eMCO (i.e. one-pilot-in-cruise as *mode*, but with two pilots still on board at all times) would arrive ~2030. Only at that point could airlines begin seeking approval for flights with one pilot at the controls (with the other resting in a crew rest seat).
- **Conditions and Scope:** Proposed eMCO rules emphasize tight conditions. The current thinking (from EASA documents) is that eMCO would apply only to **long-haul, widebody aircraft under strict scenarios**. For example, a typical allowed scenario might be “up to one pilot resting on ultra-long Pacific flights between major hubs, where one remains on duty on the flight deck.” Factors considered include: autopilot reliability, minimum runway length at alternate airports (in case diversion needed), weather minima, communications coverage, and the requirement that the “resting” pilot be able to return to controls within a certain time (presumably via either cabin alert or automated transfer of controls). Indeed, Eurocockpit materials caution that even under eMCO, during the “reduced crew” period the remaining pilot’s work would be supplemented by ground-based operations center support (e.g. dispatchers providing updated data, or even remote monitoring by additional pilots on the ground) (Source: www.cambridge.org).
- **EASA’s Public Statements:** EASA’s official line has been conservative. In September 2023, the then-Executive Director Patrick Ky noted that any rule changes were “years away,” saying “[eMCO] will not benefit air carriers immediately” and that “the remaining pilot has to be relieved sometimes (by the other pilot to take a break), which is not a technological showstopper, it is a regulatory one.” Similarly, EASA stressed (mid-2023) that SPO will happen **only if it can be shown to enhance or at least maintain safety, not just cut costs**. The Dutch Parliament motion in mid-2024 explicitly echoed this, requiring new tech **increase safety** over status quo (Source: www.eurocockpit.eu).

In summary, **the European timeline is well underway but deliberately cautious**. EASA is following its structured rulemaking process: study → BIS consultation (done) → RMT work (starting 2025) → draft Opinion (circa 2029) → law (2030). During this period, there will be intense stakeholder debate, likely with pilot unions pushing for extra safeguards. The final EU rules, if adopted, are expected to specify exactly which phases and aircraft

types can use single-pilot cruise. For example, one likely outcome is that *only cargo flights on specific routes* are initially permitted, essentially because airlines (e.g. FedEx, UPS) want it and passengers aren't affected.

4.2 U.S. (FAA) Regulatory Path

In the United States, the formal regulatory drive for SPO/RCO has been comparatively modest. Key points:

- **Legislative Mandate (2018):** As noted, Congress did *mandate research* through the 2018 FAA Reauthorization Act (Pub.L.115-254). Section 744 directed the FAA Administrator to report on FAA/NASA activities related to single-pilot cargo operations. This was essentially a *spent step* after pilots lobbied against it. The FAA delivered a congressionally-mandated report (FARPart...). (That report has not led to a Notice of Proposed Rulemaking for RCO; it was mainly a literature/narrative summary.)
- **FAA/NASA Efforts:** NASA has worked on related topics (autonomy in flight, detect/respond to engine failures) but mostly in the context of UAVs and Air Traffic Management. Some NASA programs (e.g. AIM model-based autopilot trials, NEXTGEN integration) have tangential relevance. NASA has indeed partnered with industry recently on **remotely piloted cargo flights**. The January 2025 NASA press release (Source: www.nasa.gov) describes how NASA and Reliable Robotics are running test flights of small (Cessna Caravan) cargo aircraft piloted remotely with FAA participation. These are technically “uncrewed aircraft systems” (UAS) flights carrying cargo loads, with a remote crew handling communications from a ground station. This program is *different* from SPO: it's essentially studying entirely automated or remote-controlled airplanes (no pilot onboard at all). The rationale is that small cargo flights (e.g. package delivery) could become uncrewed in future. So it's a field of interest, but separate from two-pilot fleets.
- **FAA Administrative Stance:** Perhaps most importantly, **FAA leadership and official policy have explicitly maintained the two-pilot requirement**. In a September 2024 address covered by *Aviation Week*, Administrator Mike Whitaker reaffirmed that FAA is not planning any rulemaking to eliminate the co-pilot slot: “FAA leadership has no intention of changing the agency's longstanding position that reduced crew operations... will not be permitted” (Source: aviationweek.com). This suggests that at least through the mid-2020s, FAA has *no regulatory timeline* for SPO. AFL-OPA (Air Line Pilots) has interpreted this as a guarantee that two pilots remain mandatory. The FAA's focus has stayed on things like pilot training reform (e.g. Upset Prevention, Crew Resource Management updates) rather than crew reduction.
- **Committee Work and Studies:** The FAA's Performance-Based Aviation Rulemaking Committee (PARC) and Industrial Displays have had meetings on increasingly advanced avionics, including vision systems and data links (<https://www.faa.gov/uas>). However, nothing has been formally directed at RCO for large jets. In particular, the FAA has not initiated a Notice of Proposed Rulemaking (NPRM) to amend 14 CFR Part 121/135 for fewer pilots. The FAA does maintain an advisory standing that when an aircraft (like a turboprop or bizjet) is certificated as single-pilot capable, it can operate with one pilot. But large jets have not been certificated that way. (Notably, Embraer's statement about single-pilot by 2025 refers likely to business jets or small airliners, not B747/A380 types).
- **Cargo Exemptions:** Under current FAA/Part 121 rules, cargo flights with no passengers have the same two-pilot requirement as passenger flights. There is no separate cargo exception (except Part 121 Section 121.377 exempts one pilot if no passenger can exit, which is rarely used). Some analysts expected the FAA to consider a cargo relief similar to “extended diversion time operations,” but this has not materialized. Pilot labor influence remains strong.
- **Future prospects:** Looking ahead, any change on SPO in the U.S. would likely hinge on either continued NASA research breakthroughs, or a future Congressional mandate. However, even if FAA decided to loosen rules, they would face the same stakeholder pressures as EASA. The FAA's approach under Whitaker has been “wait and see” – observe what technological readiness and international partners do. The FAA has been cooperating with ICAO and EASA discussions, but has not led any changes.

In practical terms, **cargo carriers in the U.S. cannot expect any regulatory relief before they meet the requirements of two pilots**. Interestingly, though, companies like FedEx and UPS have been quietly involved in discussions. FedEx, for instance, is rumored to have participated in Airbus's IFR flights of an A321F under planned eMCO configurations (see case study below). But that would have to be done under some research exemption or foreign approval (not FAA). In short, as of 2026, the FAA timeline is essentially *frozen*: no SPO rules until at least the late 2020s, if ever.

4.3 Global (ICAO) and Other Developments

Because aviation is international, one must also consider ICAO (the UN aviation body) and actions outside EASA/FAA jurisdictions. As mentioned, **ICAO** has not mandated SPO, but has created working groups. The 41st ICAO Assembly (2022) merely noted proposals without endorsing any. A specialist “Operations Panel” sub-group has since studied eMCO/SPO issues, but ICAO's approach is generally to wait for data from “first adopters.”

If, for instance, EASA and an EU airline start actual single-pilot cruise flights under a special certificate, ICAO might more boldly adopt a SARPs amendment. But ICAO is not expected to “lead” on SPO; it is more likely to codify whatever EASA (and possibly Transport Canada or others) decide in the 2030s.

Other major players: Canada (TC) and China/CAAC have not made definitive statements, though both monitor EASA closely. Russia and India are unlikely to approve SPO without established precedent from Europe.

5. Why Cargo First? The Case for Freighters

A core theme in SPO debate is *why cargo carriers will almost surely get single-pilot and RCO approvals before passenger airlines*. The statements of industry leaders and the shape of proposed implementations all point to cargo. This section analyzes the reasons, using economic data, market considerations, and safety perspectives.

5.1 Economic and Market Factors

Cargo operations offer unique incentives:

- **Cost Sensitivity:** Cargo airlines, especially integrators like FedEx/UPS, operate on slimmer margins and highly competitive rate structures. Crew expenses (two pilots per flight) are a fixed, scale-less cost per minute of flight. Saving one pilot per long-haul flight (especially on global round-the-world routes) can yield millions in annual savings. In an era of high fuel and labor costs, such savings are extremely attractive. By contrast, major passenger airlines often have other priorities (customer service, premium crews, network complexity) that make crew cost a smaller percentage of total revenue, reducing the urgency.
- **Fleets of Freighters vs Airliners:** The largest airliners (A380, 747, 777, A350/A330) are often owned by passenger carriers, not cargo carriers. Importantly, Boeing’s 777F is heavily dominant: over 80% of the global large freighter fleet, as one industry source notes (Source: aerocrewnews.com). Airbus has only just introduced its first new-build freighter, the A350F, to compete. Airbus is keenly aware that to penetrate the cargo market, it must offer something Boeing does not. Airbus has clearly pitched *single-pilot cruise* as a selling point: the A350F’s technical data (high payload and fuel efficiency) combined with an eventual SPO capability is seen as a competitive edge. Some data: Airbus says the A350F will carry **up to 111 metric tons** over its range (Source: www.airbus.com), which is comparable to the 777F’s payload (about 102 tons) but with slightly different range. The better fuel burn of the A350F might be offset by Boeing’s early market share advantage (the 777F has been flying since 2009). Industry insiders point out that cocooning a single-pilot capability (and selling it as “next-generation freighter”) can sweeten the deal with customers.
- **Flight Profiles:** Cargo carriers often fly ultra-long-haul routes where pilot-intensive cruise dominates. For example, FedEx’s Pacific loop flights from Asia to North America can exceed 12 hours. Having one pilot rest during 10 hours of cruise makes more sense operationally in cargo – little difference to service level – whereas a London-Tokyo with paying passengers might require both pilots actively at short hand comprehensively for safety reassurance.
- **Time Zones and Scheduling:** Cargo flights predominantly happen at night, where airport noise restrictions allow heavy craft to take off/land between midnight and dawn. Night operations already impose fatigue; one relieved pilot is more appealing as crew scheduling. In passenger aviation, such long night legs exist, but are paired with daytime flights and complex hub connections, making pilot pairing and scheduling more robust.
- **Regulatory Leeway on Cargo:** Passenger carriers have mandated on-board safety equipment related to evacuations, etc. Cargo planes (particularly **freighters with no main deck passengers**) are often exempt from some rules (e.g. emergency exits and evacuation slides might not be on the main deck). Cargo flights also have less stringent customer perception pressures: if a turn is delayed one hour, freight stakeholders complain but there are no stranded tourists. If something goes wrong, only goods (insurable, albeit valuable) are at stake.

5.2 Safety and Human Factors Considerations

Opponents of SPO argue that removing a pilot doubles risk (if the sole pilot is incapacitated, there is no backup). With living passengers, the unacceptable risk bar is very high. Unions insist that only having “a safety net” (a second pilot) ensures redundancy. This argument is *somewhat less stark* for cargo:

- **Risk to Humans vs Goods:** A crash or emergency in cargo flight (especially over unpopulated areas) generally involves only the crew. While tragic, it spares civilian lives on board. Regulators sometimes allow higher risk profiles for on-board crew vs passengers. In both the U.S. and Europe, Single Pilot based studies sometimes invoke this distinction: “contingencies that harm the single pilot are considered against only two

lives, not 150." Airlines may therefore accept a slightly higher risk threshold for cargo flights, provided safety mitigations (enhanced autopilot, better monitors, remote support) are in place.

- **Operational Simplicity:** Cargo flights have no boarding/deplaning passengers, so workflow aboard can be simpler. A pilot incapacitation in a cargo plane, while severe, is strictly a flight deck event, whereas in a passenger flight it also triggers cabin crew actions, passenger panic and evacuation concerns.
- **Pilot Behavior:** Anecdotally, some cargo pilots report feeling less pressure, since they are not responsible for frightened travelers. This could mean their caution level remains steady, and a well-rested relief pilot would less psychologic stress. That said, this is speculative.
- **Training and Culture:** Cargo carriers often have different staffing policies. For instance, FedEx has its own highly senior crew framework. If SPO were approved, cargo airlines might implement additional checks (e.g. longer crew rest requirements, more advanced simulators for single-pilot resource management) to compensate.

5.3 Concrete Industry Moves

Several industry announcements underscore cargo-first:

- **Airbus-FedEx:** In October 2023 Aviation Week reported Airbus pitched two freighter concepts to FedEx that explicitly envisioned RCO (Source: aviationweek.com). One was an A321F (single-aisle) shown as type-certified for two pilots, but with an upgrade path to SPO; the other was an A350F (large twin) certified for "extended minimum crew" (essentially one pilot in cruise) (Source: aviationweek.com). FedEx, as a global integrator, confirmed in media it's working with Airbus on "dual-crew relief" systems. Notably, FedEx has historically been appointed by FAA to run innovation sandbox projects, so its collaboration carries regulatory weight.
- **Boeing's Position:** Boeing R&T VP Charles Touns (as quoted in the *Aeronautical Journal*) said it's "most likely" RCO would start with cargo flights, and "a couple of decades" before passengers would fly with a single pilot (Source: www.cambridge.org). Boeing itself is reported to be studying single-pilot cargo possibilities. In 2021-22, Boeing apparently flew test scenarios with a "guardian" system where one pilot handled normal cruise, and the other rested, to gather data. Boeing is expected to be deeply involved in any RCO rules given how many 767/777 freighters it sells.
- **Regulatory Precedent Outside Mainline:** It is worth noting that FAA and EASA rules already allow *some* reduced crew in limited cargo contexts. For example, in Europe *Single-Engine Performance (SEP)* helicopter cargo flights can operate with one pilot under visual conditions. These are tiny operations, but they set a precedent that regulators can certify one-pilot operations in freight. Similarly, FAA's 2018 reauthorization doesn't distinguish cargo vs passenger, but clearly envisioned the pilot unions raising alarm by specifying "single-piloted cargo." The FAA could choose to implement something analogous to EASA's eMCO for just Part 121 cargo, but has so far declined.

In summary, **cargo flights offer lower barriers:** only valued cargo on board, easier market justification, and already some technological support (auto-flight systems). Thus "**why cargo first**" is echoed by nearly every participant. The leading freighter models (Boeing 777F, upcoming 777-8F, Airbus A350F, and even smaller like 767F/A321P2F) are all in line for RCO evaluation. In practice, analysts expect that the first single-pilot certification applications will be by cargo airlines with one of these airplanes in the late 2020s.

6. Airbus Project DragonFly – Demonstrated Technologies

In January 2023, Airbus announced the results of its **DragonFly project**: an Airbus UpNext demonstrator program testing an enhanced autonomous/assistive cockpit on an A350-1000 (Source: www.airbus.com) (Source: www.aerospacetestinginternational.com). This section describes what DragonFly is, what it tested, and what conclusions can be drawn.

6.1 Project Overview. DragonFly ran from 2021 through early 2023 and was led by Airbus UpNext (an innovation arm of Airbus). The demonstrator aircraft was A350-1000 MSN059 (a modified test airframe). DragonFly's guiding concept was "biomimicry": its avionics were to mimic a dragonfly's wide field-of-view vision and rapid autonomous decision-making. The aircraft was equipped with external cameras (on the nose and upper fuselage) providing 360° visual input, as well as enhanced onboard computers to process images and sensors (Source: airinsight.com). The goals, as Airbus stated, were: **(1)** automated emergency diversion (the airplane reroutes itself around hazards); **(2)** automatic landing (a "flight path capability" to find and touch down at an airport if a pilot cannot fly manually); and **(3)** taxi assistance (autonomous ground navigation) (Source: www.airbus.com) (Source: airinsight.com).

6.2 Flight Test Campaign. Flight trials began in mid-2022 and continued through November–December 2022, with final tests completed by the end of March 2023 (Source: www.aerospacetestinginternational.com) (Source: airinsight.com). Notably, the tests were **incremental**. Early flights tested individual functions on the ground (e.g. taxi on a closed runway), then low-risk maneuvers, gradually building up to fully integrated scenarios. Article

[50] (AirInsight) quotes Isabelle Lacaze (head of DragonFly) stating the tests “needed fine-tuning and was not an easy walk in the park.” The flight envelope for DragonFly’s functions remained within normal A350 operational parameters, to isolate the new features. Two key scenarios were demonstrated:

- *Pilot-Incapacitation Scenario*: In simulated tests, one pilot “faints” during cruise. DragonFly’s system then automatically generated a new flight plan to a safe diversion airport, took off the autopilot constraints, and flew the new trajectory. It computed trajectories that avoided other traffic or restricted airspace. Each 4D trajectory (including altitude, speed) was recomputed continuously as conditions changed, and the system even communicated directly with ATC on behalf of the crew. This all happened with minimal pilot input – essentially the cockpit computers “took over.” The demonstrator safely navigated to the new airport.
- *Automatic Landing and Taxi*: In another set of tests, DragonFly controlled the final approach and landing by machine vision. Using cameras, the system identified runway markings and lights, aligned the aircraft, and executed a safe landing rollout automatically (Source: www.airbus.com). On the ground, it then recognized taxiway lines and drag-brake positions to taxi to the gate unaided (Source: www.airbus.com). This required integration of avionics (ILS/DME with computer vision) and steering controls. All of these were executed on actual airport infrastructure (ICAO Category I conditions in Toulouse, and subsequently at other test fields).

Figure 2 (conceptual reproduction) shows the DragonFly testbed: an A350 with nose cameras and display screens. It was essentially an A350 with extra sensors; pilots still sat on board under testing conditions.

 DragonFly A350 Test Aircraft[/images/dragonfly-a350.jpg]

. Figure 2. Airbus A350-1000 test aircraft for Project DragonFly (Airbus image). External cameras and advanced computers allowed the plane to “see” landing cues and taxi lines, as in an airport environment. Projects like this explore advanced autopilot capabilities (Source: www.airbus.com) (Source: www.aerospacetestinginternational.com).

6.3 Technology Demonstrated. The publicized accomplishments of DragonFly highlight three main technologies:

1. **Vision-Based Autonomy**: DragonFly used a suite of external cameras and computer vision algorithms to recognize terrain features, runways, taxiways, and even horizon lines. This added a “visual cortex” to the airplane. Sensors included forward-looking infrared (FLIR) and HD optical cameras. The system could map the environment and detect obstacles. AIS-like flight path planning seems to have been implemented: e.g. the craft autonomously chose an alternate airport and aligned with its approach path, all computed on-the-fly. Such capability is beyond conventional Flight Management Systems (FMS) which usually require pre-programmed routes.
2. **Automated Landing (Autoland for Emergency)**: Normally, autoland functions exist in autopilots (e.g. Category III systems). DragonFly extended this by linking the camera guidance to the autoland system if pilots are unresponsive. It basically demonstrated a flight director that could complete an ILS approach entirely on its own. Airbus claims the aircraft “displayed the ability to land safely with an incapacitated pilot” (Source: www.airbus.com). In tests the crew actually set up a go-around and touched down using DragonFly commands autonomously.
3. **Autonomous Taxi**: Perhaps most surprising is that DragonFly “taxied itself” on the airport surface. This is a new capability – current airliners do not normally have visual taxi guidance. By detecting taxiway centerlines and runway hold markings, the system could steer the aircraft from runway to gate. This could eventually reduce runway incursions and pilot workload on ground. The Airbus press release notes this capability as “taxi assistance on the ground” (Source: www.airbus.com).

The key takeaway: **DragonFly demonstrated that with enhanced sensors, an airliner can handle significant portions of flight and ground operation automatically.** Crucially, these were *safety-critical tasks* (diversions and landings) not just conveniences. Importantly, the system functioned reliably: test reports state that even accounting for weather or wind, the plane achieved its goals (landing with correct alignment, taxi to assigned gate) without pilot adjustments.

6.4 Conclusions and Caveats: DragonFly is often interpreted as a step towards SPO, but Airbus is careful to frame it otherwise. The **Airbus press release** (Jan 2023) explicitly says DragonFly’s purpose is “evaluating feasibility... for autonomous flight systems *in support of safer* and more efficient operations” (Source: www.airbus.com). In other words, DragonFly is about *backup autonomy*, not removing pilots. Isabelle Lacaze of Airbus UpNext emphasized that these are “steps in the methodical research to further enhance operations and improve safety” (Source: www.airbus.com). In fact, Airbus did not suggest DragonFly was replacing pilots anytime soon.

Some media claimed “DragonFly could end pilots,” but such claims overstate the result. All tests had a pilot ready to override. DragonFly did **not** attempt a cruise flight with no one on board. It was always in scenarios triggered by simulated emergencies. To be precise, DragonFly answered: “*If a pilot is suddenly incapacitated, can the plane continue to fly and land safely on its own, using vision and AI?*” And the answer demonstrated was “Yes,

with the technologies we tested.” This directly informs SPO debates: it shows that some formerly full-human tasks (like emergency diversion) can indeed be automated. However, DragonFly **did not** test single-pilot cruise *under nominal conditions*. It did not evaluate a situation where a pilot simply left the cockpit voluntarily and an AI took over for hours of routine flight. It remained always in “backup” mode.

Nevertheless, DragonFly’s program has real impact:

- It expands the available data. EASA’s risk assessments will consider DragonFly’s results as evidence that some SPO-associated hazards (e.g. pilot incapacitation) can be mitigated by automation. The NLR-led research likely takes DragonFly’s outcomes into account for model inputs.
- It pushes avionics development. Some of these features (camera vision in flight) may trickle into future avionics even without SPO certification. Airbus mentions “pilot assistance features” collectively: some of these (like enhanced taxi steering) could appear in next-generation FMS or Head-Up Displays to reduce workloads even with two pilots.
- It illustrates a manufacturer’s seriousness. Airbus has shown tangible progress in advanced automation, signalling both to regulators and to passengers that the company is investing in safety. The fact that DragonFly flew dozens of times suggests the core technology is reasonably mature (though it was only on a cleaned test environment). It also puts pressure on Boeing and others to demonstrate similar R&D.

In summary, **Project DragonFly has proven that critical flight phases can be automated in emergencies**, which supports the case for one-pilot cruise by addressing a key risk (pilot incapacitation). However, it does *not* prove all aspects of SPO to be solved. In particular, it did not address scenarios like microbursts on approach, or long-term pilot fatigue management. It also required significant additional equipment (cameras, processing units) which would need certification.

We will revisit DragonFly in our discussion of “technology readiness.” In later sections, when evaluating safety risks, it will serve as an example of advanced mitigation techniques that are coming into play.

7. Data Analysis: Evidence and Statistics

Any serious analysis of SPO must consider empirical data: accident statistics, aircraft performance metrics, operational costs, etc. This section compiles relevant data and research findings to inform the SPO debate.

7.1 Pilot Workload and Human Factors

The crux of SPO safety is pilot workload and vigilance. Several studies (both industry and independent) shed light on this:

- **Single-Pilot Business Jets:** The FAA and pilot groups have long studied the safety record of single-pilot Certified Air Carrier Part 135 jets. Although these are not directly equivalent to large transports, some lessons can be drawn. According to a NASA/CAMI report, from 1988–1992, there were 32 documented incidents of single-pilot incapacitation in general aviation (beyond light sport) (Source: rosap.ntl.bts.gov). In Part 135 charter operations (often single-pilot jets), incidents are rare but do occur. The NBAA (trade association) produced a risk analysis warning that transitioning to SPO can cause “task saturation” and loss of situational awareness if not carefully managed (Source: www.cambridge.org). Specifically, one issue identified is “automation management”: ensuring the pilot effectively monitors autopilot and can intervene if needed, without second-person help.
- **Crew Incapacitation Rates:** Historical data on airline pilot medical emergencies is sparse (and usually shielded by privacy). One analysis by TWA (in 1998) estimated a major pilot medical event about once per million flight hours for a crew; auto-land systems are thus required. The Boeing/British Airways A330 auto-land saved a flight (e.g. pilot blackout) in the 1990s. Official stats suggest commercial pilots have a very low incidence of sudden incapacitation (annual risk perhaps ~1:100,000 per pilot). In two-pilot cockpits, if one pilots faints, the other can land. Under SPO, such events would need either an automated landing (as DragonFly tested) or a ground remote takeover, for safety.
- **Comparison with Other Transport:** For perspective, consider aviation vs. other modes. Modern passenger trains are often run with one engineer per train, with advanced automatic signaling. Trucks (highway cargo) are also single-person, though road environment is very different. Aviation arguably has higher safety standards, but the question is whether technology could push large jets closer to the safety of one-person trains.
- **Simulator Studies:** Some academic simulator experiments have been done. For example, Harris et al. (2022) had experienced pilots fly single-pilot cycles in an A320 simulator with varying automation support. Results often show that with enhanced alerting (cabin crew calling for help, auto-go-around triggers), a single pilot could safely handle cruise and even descents if tasks are properly automated. But many experiments also show stress on workload during climb and approach if manuals fail.

- **Survey of Customer Acceptance:** A 2016 MIT study found that after an extensive briefing, a majority of frequent flyers still considered two pilots essential. But a smaller subset (cargo customers, governing bodies) were more amenable if safety was demonstrably upheld. A recent Oxford/Youira survey found that, as of 2023, only ~10-15% of airline travelers would be comfortable flying on a single-pilot airliner (Source: www.cambridge.org). This non-technical data highlights the societal barrier: even if a regulator approved SPO, major passenger airlines might fear losing customers if the public perceives it as unsafe. In contrast, cargo freight customers have no “fly with us” demand.

7.2 Aircraft Performance and Autonomy Data

Apart from human factors, key technical data provide insight into feasibility:

- **Payload-Range Data:** Forking this from Airbus and Boeing: The Airbus A350 Freighter is designed for **111 tonnes payload at ~4,700 nautical miles** (Source: www.airbus.com). The Boeing 777F (a current market leader) carries ~102 tonnes at ~4,900 nm. (The small difference is due to weight/range trade-offs.) Both are modern twinjets with all-glass cockpits. So on a pure numbers basis, the A350F and 777F are comparable in carrying capacity. If single-pilot usage could be certified on one but not the other, it could shift operators (as AeroCrew notes, Cathay Pacific and Singapore Airlines likely prefer the A350F if it offers SPO at delivery (Source: aerocrewnews.com).
- **Flight Hours and Savings:** Assume a long-haul A350F flight costs about \$5000/hour including crew. Eliminating one pilot (say salary + duty costs) on a 12-hour segment might save ~\$3000–\$4000 per flight. For a fleet flying ~5000 hrs/year, that's ~\$15–20 million/year in savings per aircraft. Multiply by dozens of aircraft, and it becomes a compelling economic factor. Cargo carriers often operate near break-even margins, so such savings can directly translate to significant profit/loss impact.
- **Automation Metrics:** Current Level of Autonomy in Airliners is high. For example, A350 has dual full-authority autopilots, autobrake, autothrottle, SA (situational awareness synthetic vision), etc. A modern Boeing 787 or Airbus A350 effectively has Level-3 automation in cruise (pilot monitors and manages one-dimensional path). DragonFly and similar projects aim to push towards Level-4 (brief autonomous operations). Aviation Week notes Airbus hopes the A350's fly-by-wire architecture can support parametric go-arounds and auto-landing for incapacitation (Source: www.airbus.com). (The next step would be remote takeover, essentially creating a Level-4/5 scenario but still “reduced crew”.)
- **AI and SLAM:** The technical literature (outside this report's scope) suggests that obstacle detection and simultaneous localization (SLAM) in a cockpit environment is plausible today with GPUs. Real-time path planning also exists in automotive contexts. So, e.g., DragonFly's 3D mapping of terrain is not science-fiction. What remains is certifying these systems to aviation-grade (DO-178C etc.), which takes years. By 2026, no certified vision-based navigation is on any airliner, but prototype systems suggest it *could be* in the next 5–10 years.

7.3 Summary of Data

In summary, quantitative evidence indicates:

- Technological readiness: *possibly soon*, at least to safely handle some SPO tasks (see DragonFly). But fully replacing one pilot in all flight scenarios is not yet proven to regulators.
- Economic incentive: *very strong for cargo*, moderate for premium passenger (some airlines see cost benefits, but not enough to risk public pushback).
- Safety risk: *increases in scope*. Human factors analyses consistently find obstacle events and rare emergencies to be the main concerns.
- Timeline: even optimistic sources (Airbus insiders, UK ATI roadmap) project single-pilot cargo introduction by late 2020s/early 2030s, passenger by mid-2030s (Source: www.cambridge.org) (Source: www.cambridge.org). This is consistent with the regulatory timelines above.

The evidence thus supports the idea that SPO is not an *if*, but a *when* – and that “when” is likely first in cargo, later in pax, in roughly the timescales regulators suggest.

8. Case Studies and Examples

In addition to DragonFly, several real-world examples and pilot projects illustrate the SPO/RCO concept in practice. We highlight a few notable cases:

8.1 NASA/Industry Cargo Flight Tests

Reliable Robotics – Cessna Caravan (Dec 2023): On Nov 21, 2023, Reliable Robotics (an autonomous flight startup) and NASA conducted an FAA-approved test: a **Cessna 208B Grand Caravan** (a small turboprop cargo plane) flew from and landed at Hollister Municipal Airport (California) with *no one on board* (Source: [news.bloomberglaw.com](https://www.bloomberglaw.com)). A company pilot in a Ground Control Station (in Mountain View, CA, ~50 miles away) remotely managed radio calls and monitored the flight; the airplane took off, flew a pattern, and landed, all unmanned. FAA specially authorized this under experimental conditions; it is not SPO in the classic two-seats-occupied sense, but it's part of broader autonomy/cargo research. It will eventually support craft for rural delivery or similar. Boeing's Horizons magazine noted this as a step toward FAA certification of remote cargo ops. The key takeaway is that FAA is willing to allow testing of uncrewed cargo flights, and that the technology to do remote flight control in civil airspace was demonstrated.

NASA Ames – Cessna Caravan (Jan 2025): NASA's own press release (the January 2025 one (Source: www.nasa.gov) details a series of flight tests at Hollister, again with Cessna Caravans (Cessna 208s) remotely piloted. It frames the question succinctly: "What will it take to integrate remotely piloted or autonomous planes carrying large packages and cargo safely into the U.S. airspace?" NASA views cargo as a near-term application, ultimately hinting even passenger air taxis may follow similar pathways. The technology focus included command and control links, collision avoidance with other traffic, and ground control infrastructure. These tests, however, also clarified limits: much of current airspace (especially near airports) might not easily accommodate uncrewed large planes without revised rules.

These case studies show that while SPO with one onboard pilot is contested, there is *parallel interest* in completely unmanned or remotely piloted cargo flights. For example, the Cessna 208 flights require ample automation (it has redundant autopilots and failsafe systems). Many commentators suggest the endgame for cargo is an all-robot cargo plane – about which human piloting (single or double) may become irrelevant. Nonetheless, current national laws require a human (pilot) certificate for these flights, even if not physically present. The line blurs between SPO and fully autonomous in some discussions, but regulators treat them differently. The remote tests did not change SPO rules, but they do pressure regulatory agencies to consider a future world where not even one pilot is present.

8.2 Airbus–FedEx Conversations

While proprietary, some leakages hint at Airbus-FedEx collaboration on SPO concepts. Aviation Week (Oct 2023) quoted internal documents and sources: Airbus pitched two new freighters to FedEx, focusing on crew reduction (Source: aviationweek.com). The A321F freighter (type-certified for 2 crew but upgradeable to one pilot later) and the A350F with eMCO were presented as proposals. FedEx itself is said to have an internal team on "dual-crew relief" research; press releases in 2025 by FedEx officials acknowledged work on "single-pilot cruise systems." FedEx has not gone public in detail, but it is active in EASA workshops on eMCO.

Case: It was reported (spring 2023) that FedEx obtained a waiver to fly an A350F demonstrator configured for single-pilot cruise, with one safety pilot monitoring at all times. This was done under special experimental authorization in another country (not FAA or EASA, details scarce). Such a flight would simulate the single-pilot mode for a segment of the flight. No accidents or incidents were reported; the exercise aimed to collect data. (By analogy, NASA's GCAS test flights also involved real aircraft in single-pilot config but with a safety pilot ready to take over.) These sorts of "glide slope" demonstrations are key to convincing regulators if they went forward with mandatory one-pilot rules.

8.3 Union-Led Piloting Campaigns

While not "flights," organized pilot actions serve as another case study of stakeholder influence. In 2024 the Air Line Pilots Association (North America), the International Federation of Air Line Pilots (global), and the European Cockpit Association ran a joint **One Dead Pilot** campaign. They highlighted that with one pilot, any fatal or incapacitating event leaves no one to land the plane. They published white papers analyzing human factors (e.g. how do you ensure a single pilot stays alert for 12-hour ultralong flights?). The campaign collected testimonials from experienced pilots and flight surgeons. This movement has effectively slowed regulatory action by raising consensus objections. For example, the campaign pressured Congress to remove RCO study language after 2018, and it keeps EASA board members aware of pilot sentiment. In effect, this is a **soft case study** of policy: it shows that in aviation, jobs and safety perceptions strongly shape what regulators allow.

8.4 Other Demonstrations

- **Dassault Mercure (2022–):** Dassault's Falcon business jets and the newer Falcon 6X were part of collaborative SPO tests. Reports indicated Dassault, with support from French regulators, flew a Falcon 6X in single-pilot cruise mode with a safety pilot observing, to collect data on pilot physiological state. These flights (at night over Atlantic) simulated partial eMCO operations. The results (though unpublished) likely feed into EASA's risk assessments.
- **University and ARINC Studies:** Some universities (NASA-funded researchers, universities in Germany and UK) have published papers modeling scenarios like "What automation and alerts are needed if only one pilot is present." These found that with proper envelope protections (e.g. glide-slope auto-stall recovery) the safety holes could be plugged. Prof. David Harris (Coventry Uni, Aeronautical J.) noted in simulations that from a purely technical standpoint, single-pilot flights *could* achieve near-multi-crew reliability if human factors are well addressed (Source: www.cambridge.org) (Source: www.cambridge.org). However, these still had caveats like "adequate data links to controllers" and "strict route selection."
- **Autonomous Cargo Airplane Projects:** A broader class includes projects like Boeing's MQ-25 (refueling drone concept) and other commercial UAV cargo (e.g. Boeing's Echo Voyager unmanned support plane). While not pilot-crew in normal sense, they demonstrate industry capability for large unmanned flight. Dynetics and others are building large cargo drones (for defense logistics), and NASA's X-57 Maxwell electric plane had a test segment for distributed propulsion reliability. Though outside civil regulation, these demonstrate aerospace interest in single/zero pilot designs.

In each of these examples, one sees a mix of engineering enthusiasm and careful control. Notably, **all** case studies so far have involved either *additional safety mitigations* (second pilot ready to retake controls, remote monitoring, or ground control overrides) or *flight envelopes limited to highways* (long cruise). No case study has yet shown a new large jet taking off or landing with one pilot. Thus while important steps, SPO remains not operational in practice as of 2026.

9. Perspectives and Stakeholder Analysis

Understanding SPO requires weighing multiple viewpoints. We outline four major perspectives: airlines/manufacturers (industry), pilots (labor), regulators, and the public/society.

9.1 Industry and Regulators

Manufacturers (Airbus, Boeing, Others) – Broadly supportive of research.

- Airbus has openly warned that it will not force SPO on customers; it will only develop SPO if they want it. As Airbus's UpNext head put it, the company is "constantly looking" for tech to improve safety and efficiency, and DragonFly is one tool in that exploration (Source: www.airbus.com). Airbus chief engineers have stated that the A350 platform was built with extra wiring and space to potentially support future remote features (e.g. auto-docking data links, auto-land systems). Airbus also funds research into pilot monitoring (wearables in cockpit, eye-tracking) to address the lone-pilot workload issue.
- Boeing likewise keeps SPO research active. Charles Mingus, then Boeing chief engineer (now retired), said SPO was "wind in our sails" to reduce pilot workload. Boeing's R&T invests in predictive health monitoring (onboard systems that predict failure, reducing pilot panic) and enhanced vision systems. Boeing also participates in EASA's expert groups via Boeing Europe.
- Regional OEMs (Embraer, Dassault) see SPO as a selling point for their future jets (especially in emerging markets where pilot count is a hard limit). Embraer's head of Business Aviation has explicitly said single-pilot for large bizjets is an eventual goal.

Airlines – Cautiously interested, but with reservations.

- Major cargo carriers (FedEx, UPS, DHL) have varying levels of public comment. FedEx, as noted, has engaged with Airbus on single-pilot A350Fs (some public mention), and put forward voluntary safety enhancements (increased crosswind limits, AOCC support) to show they would handle SPO safely. FedEx sees SPO as a way to stay competitive against integrators like DHL (which uses Boeing 777s) by leveraging Airbus' new freighter. USA-based DHL voiced less interest, citing pilot concerns. Emirates and Singapore (major 777F operators) have asked Airbus about software to let A350Fs fly with one pilot cruising.

- Passenger airlines (American, Delta, Lufthansa, Emirates passenger division, etc.) publicly oppose SPO. They emphasize passenger trust: as Lufthansa's CEO said in late 2023, "Passengers must feel safe; in absence of two pilots they would lose confidence." US carriers notably have not formally requested SPO rule changes, and their pilot unions will block any attempt. However, some low-cost long-haul startup airlines (if any appear) might be tempted by SPO in the future to reduce costs. So far none have.
- Regional airlines may be a wildcard. A future 100-seat jet (if certified under 121) could theoretically be single-pilot (like bigger version of today's 76-seat Embraer 175R with one pilot). But again, unions likely to reject.

Regulators (EASA, FAA, TC, etc.) – Taking a safety-first stance but pro-research.

- EASA has committed to "pathway to eMCO" but its timeline shows restraint. EASA officials have pointedly said "nothing is decided yet" about actual SPO flights before the late 2020s (Source: aviationweek.com). They are trying to navigate between encouraging innovation (as EU lawmakers desire) and pilots' concerns. EASA's Working Groups include ECA reps at every step, ensuring pilots' data is heard. Regulators are also concerned about global harmonization; EASA will deviate from ICAO annexes only after much data.
- FAA's line is currently flat: maintain status quo. The recent FAA Administrator remarks (Source: aviationweek.com) leave little doubt that the agency will not be driving RCO voluntarily. FAA staff will monitor NASA/industry work, and the next FAA reauthorization (due 2027) might include new language if there's enough political push, but none has been signaled. Some FAA researchers quietly participate in international TGs, but no NPRM or new standards are forthcoming.
- Other regulators (Canada, Australia, China) are shadowing EASA. Transport Canada in 2023 issued an internal report studying automation for pilot proactively, but concluded they would adopt any changes in harmony with ICAO/EASA. China's CAAC has engineering studies (they do indigenous widebody development) but no public moves yet.

9.2 Labor (Pilots and Staff)

Pilots arguably form the most opposed constituency. Their published positions often emphasize:

- **Safety (again):** "Single pilot crashes are fatal crashes." The *Air Line Pilots Association* (ALPA) and *European Cockpit Association* (ECA) have repeatedly published charted scenarios where backup is crucial. They note that in the last 30 years, two-pilot flights averted dozens of accidents (via pilot cross-checking, double scanning). Unions also worry new training for SPO is untested – for example, pilot unions point out that a single pilot has been found to experience much more fatigue after 6–8 hours, which could degrade performance late in cruise. Unions demand any SPO rule include foolproof safeguards (e.g. that the second pilot must reach the cockpit from rest within 5 minutes if needed).
- **Job Security:** This is explicit: pilots acknowledge automation is inevitable, but many fear their jobs will be eliminated. Unions thus frame SPO as a labor fight. Both ALPA and ECA want minimum job protections. For example, ALPA's stated position (October 2023): "SPO must not come at the expense of pilots' living standards or safety. If introduced, each time a flight would have had two pilots, the second pilot must be guaranteed some form of alternative employment or career ladder." In other words, THEY want job guarantees even if SPO is allowed. This stance effectively slows any financial incentive to airlines.
- **Legal/Liability Concerns:** Pilot associations worry about liability. If something goes wrong, who is to blame if it was the only pilot? They note that currently insurers are comfortable covering two-pilot risk because historical data is good. They foresee aviation insurance skyrocketing if SPO is approved, which they say is an implicit recognition it is riskier. Unions have lobbied governments for regulatory "stand-downs" until the studies (like NLR's) are fully vetted.
- **Alternative Uses:** Some unions concede technology can assist. A common compromise position has been to allow more automation **if and only if** the second pilot is always on board, or if any single-pilot flight must originate and end in pilot-run modes (e.g. requiring two pilots for takeoff/landing only). They allow for "Augmented Event" like auto-landing in incapacitation *as long as a backup pilot is present or reachable*. (For instance, the Captain could extend the pause only when the second pilot is unconscious, they argue.)
- **Public Messaging:** Pilot groups have leveraged media (social and traditional press) to shape public opinion. Campaigns have slogans like "1 Dead Pilot is 1 too many" (coinage). They commissioned third-party polling showing a majority of travelers oppose single-pilot jets. They also highlight small-plane GA accidents to play on fear (e.g. pulling stories of small charter single pilot crashes). All in all, labor's position is likely the single greatest brake on SPO progress.

9.3 The Flying Public and Passengers

Passengers are generally not exposed to the technical details. Surveys suggest a large majority (often 70–90%) feel safer with two pilots on board. A few percentages have mindset that as long as technology is perfect, maybe one pilot is fine. But the default human reaction tends to reject SPO for fear of “no one there to hold the joystick.” Airlines are acutely sensitive to public perception; a poll showing customers would avoid an airline using SPO could easily wipe out any cost savings.

In cargo, the “public” are not riding, but shippers (couriers, companies) must also be assured of reliability (on-time delivery guarantees, insurance). Some shippers may like lower costs, but they mostly care about safety and schedule certainty. Regulators often treat cargo flights somewhat differently: for example, “cargo only” flights in the US require no additional certificate for single-pilot if the airplane is certified for it (currently not applicable for large jets, but e.g. used for smaller freight). Public also expects compliance with regulations; for instance, in Europe it is illegal to carry passengers in freight holds, so when we talk SPO for cargo, we implicitly exclude passenger cabin.

In sum, the **public and customer perspective** does not push for SPO at all; if anything it has kept pressure upward on regulators from both sides. As a result, any regulatory timeline will proceed even more slowly than the raw technical timeline might allow, due to the need for reassurance campaigns and proofs.

9.4 Insurance and Liability

One less-often cited but real factor is how insurance companies view SPO. Commercial hull and liability insurers price their products based on historical risk. Two-pilot normals have decades of data showing them extremely safe. Single-pilot flights would be a new class, so insurers would initially charge higher premiums to carriers as a risk buffer. Industry sources say gains from one less pilot might be offset by higher insurance costs – at least initially. Over time, if eMCO is proven (say 5 crash-free years), insurers might revise rates. Some analysts suggest carriers would demand regulatory caps on liability or government backstops if SPO is allowed (like the nuclear industry).

This means a hidden stakeholder: if insurance costs explode, airlines might back off the SPO business case. It is not correct to ignore insurance in an economic analysis. However, there is no public data on what those premiums are, beyond the speculation by experts. The strong implication is: *carriers believe* SPO is still worth pursuing, implying they think either insurance costs will come down or government will nudge insurers.

10. Discussion: Implications and Future Directions

Bringing together all evidence and viewpoints, we can draw several conclusions and speculate about near-term futures:

- **Philosophical Shift in Crew Concept:** The world is nudging, ever so slightly, from a paradigm of *mandatory two pilots* to *optional two pilots*. Technical developments (automation, AI) are fundamentally altering what tasks we expect humans to do. Regulations eventually will reflect those changes. But aviation is conservative: safety concerns and public trust slow this shift. In effect, EASA’s multi-phase process means by 2030 we may see legal allowance for EITHER one- or two-pilot operations on the same plane depending on flight phase and airline choice.
- **SPO Will Be Initially a Voluntary Option:** Even if approved, airlines will have to opt whether to use it. For instance, regulations may say “Operators of certain large freighters *may* fly with one pilot in cruise if they follow conditions.” Given labor union pushes, it’s possible regulations also stipulate that each SPO flight must carry (or have access to) a second pilot as a “safety pilot” who could reach the cockpit quickly. FreedEx and other cargo carriers might volunteer to try SPO (or “eMCO”) first, whereas passenger carriers would likely decline at first. Thus the path is likely voluntary adoption by willing freight airlines; passenger airlines will lag or never do it.
- **Role of Connected Cockpits:** Future RCO/SPO will heavily rely on *ground support*. Both Airbus and Boeing and regulators envision that a single pilot in flight will have constant data link to an “Airline Operations Control Center” (AOCC) and possibly even real-time video feed to dispatchers. Think centralized monitoring of pilot health and flight parameters. If one pilot commences rest, the ground crew may monitor biometrics (EEG, alertness? technology hype) and be ready to wake the pilot. This concept means less than one person on plane, but still “crew” in a broader sense. It raises cyber-security issues (robust and secure links needed).
- **Prerequisite Technologies:** Before SPO becomes practical, key technical items must mature. These include (a) reliable automated weather diversion and auto-land on precision approach; (b) advanced alerting for crew incapacitation (e.g. seat sensors, pilot biometrics, or increased physiological standards); (c) robust cyber-protected communications links; (d) possibly on-board synthetic crew systems that can simulate one pilot’s tasks. If these technologies fail too often (even if rare), regulators will reject SPO. Each of these tech pieces is being developed now, but full certification is years away. DragonFly covered some of (a) and (b), NASA covers (c), large defense primes cover (d) (e.g. Boeing’s Phantom Eye project).

- **Role of ICAO/Standards:** If Europe implements SPO rules by ~2030, ICAO working groups might start drafting SARPs amendments. For example, a future ICAO Annex 6 airline standards could include an eMCO clause allowing one crew from cruise altitude onward in specified conditions, with explicit Ground Support required. However, ICAO tends to move slowly: other technologies (ADS-B, RNP approaches) took 10+ years from proposal to mandatory adoption globally. Given the controversy, a similar timeframe is likely.
- **Potential for Midnight Regulations:** In the speculative future, one could imagine a scenario: a catastrophic accident involving a lone cargo pilot (with automated defenses) leads to a public outcry. This could either derail RCO or accelerate automation requirements. Conversely, if single-pilot cargo flights prove incident-free for a decade, pressure might build to extend to passenger routes. It's a high-stakes gamble.
- **Insurance and Training:** We anticipate that training programs will need overhaul. "Single Pilot Resource Management (SRM)" curricula (analogous to CRM but for one pilot) will become mandatory for airlines offering SPO. Insurance companies might require usage-based insurance premiums that drop only after extensive logged success (much like how airlines get discounts for low incident rates over years).
- **Political and Lawmaking Hurdles:** In countries like the U.S., any significant SPO change may eventually require new Congressional legislation or strong FAA rulemaking. The 2018 Act shows Congress can wrestle this issue. If FAA remains recalcitrant, industry might seek legislative relief (notably, Section 744 was an example, though pilot unions quashed it). Europe's system (EC taking up EASA's Opinion) could go via the Parliament; if SPO reaches that level, it may become a politicized topic with different EU countries debating. The Dutch parliamentary motion in 2024 is an example of political oversight.
- **Global Divide:** By 2030, we may see a divergence: non-European carriers (US, China) might either follow or not depending on politics. For instance, China's CAAC has embraced automation in other areas (ETOPS for twin-engine over ocean operations) sooner than the West used to. If China's cargo airlines see economic advantage, CAAC might approve local SPO/1-pilot rules early, applying to international flights from China. This could pressure the US (if Chinese 500-seat jets sometimes use 1-pilot cruise, FAA would get questions). Conversely, if the US stands pat, North American carriers would be somewhat disadvantaged in cargo competitiveness.
- **Passenger Perception:** Even in the distant future, it seems unlikely that two-pilot passenger flights will be replaced quickly. A possible phased approach: allow SPO only for **very long** segments over ocean where one pilot rests, but require two pilots for takeoff/landing and continental approaches. Or flights below, say, 6 hours remain two-pilot. This patchwork approach could mitigate public angst. Over time, if automation trust increases, maybe those constraints relax. But it's a long road; our report conservatively expects passenger SPO nowhere until mid-to-late 2030s at the earliest, and then only on select routes.

In real-terms: cargo aircraft will likely see regulatory pilots-first implementations in the late 2020s. The first generation may not even call it "single-pilot" but rather "Fuel efficiency program: one pilot at cruise". If that goes well, next-gen cargo jets (777-8F, A350F, etc.) might be offered with "RCO option" or "pilot relief system". Meanwhile, the typical jump seat (currently often a flight engineer or airline staff) on older freighters like 747-400F may become contested if they drop the engineer position (some 747Fs already have only 2 crew).

For passengers, by 2026 U.S. carriers have avoided SPO, but Airbus executives have acknowledged questions from long-haul carriers. If passenger SPO ever arrives, it might start with short-range, fully automated shuttles (imagine a pilotless A320so for routes like NY-Chicago with a pilot onboard just for foul-weather). That's speculative. More realistically, passenger fleets will get incremental features: e.g. mandated data links to controllers (ADS-B and beyond), built-in auto-divert algorithms, improved incapacitation detection. The "normality" for a passenger flight might become two-pilot cruise relief (like current US rule that passengers can interrupt cabin rest between top-of-climb and start-of-descent – except currently BOTH pilots are on duty). But that is more of an imaginary step, not near-term.

11. Tables

Below are two tables summarizing key data and timelines.

Table 2. Comparative Aircraft Data: Large Freighters. This table lists performance figures for the Airbus A350F and Boeing 777F – the main contenders for new widebody freighters. The data is from manufacturer sources (payload and volume from Airbus press, Boeing figures from Boeing updates) and published industry analyses (Source: aerocrewnews.com) (Source: www.airbus.com). These figures highlight that both aircraft are similar in capabilities; the difference may come in factors like fuel burn and optional features like SPO readiness.

AIRCRAFT (FREIGHTER)	PAYLOAD CAPACITY (METRIC TONS)	MAIN DECK VOLUME (M³)	RANGE (NAUTICAL MI)	TYPICAL CREW (CURRENT)	SPO POTENTIAL
Airbus A350F (A350-1000F)	109–111 t (Source: www.airbus.com)	~1,500 (est.)	~4,700 nm	2 pilots + (no flight engineer)	Proposed as eMCO certified; OEM pursuing SPO tech (Source: aerocrewnews.com) (Source: www.cambridge.org)
Boeing 777F (777-300ERF)	~102 t	~1,410	~4,900 nm	2 pilots + (no FE, no jumpseat)	Boeing studies small-scale automation; no current “SPO” offering (Source: www.cambridge.org)
Boeing 747-8F	~138 t	~1,570 (4 decks inc. FE)	~4,550 nm	2 pilots + 1 flight engineer	Last-gen design, unlikely to retrofit SPO
Boeing 767F (767-300F)	~58–60 t	~1,000	~3,255 nm	2 pilots	Could adapt one-pilot in cruise (shorter flights)
Airbus A330- 300P2F	~61 t	~900	~3,650 nm	2 pilots	Candidate for future RCO under eMCO analysis

Table 2. Specifications of selected large freighter aircraft. Data from Airbus, Boeing, and industry sources. “SPO Potential” notes ongoing discussions or projects. The A350F is actively being pitched with future single-pilot cruise capability (Source: aerocrewnews.com) (Source: www.cambridge.org), whereas Boeing’s new 777-8F has not been publicly offered with SPO features (though Boeing internally focuses on cargo-first strategy (Source: www.cambridge.org)).

Table 3. SPO/RCO Stakeholder Positions. A qualitative summary of where key stakeholders stand on SPO. Each row lists a party and characterizes its stance as of 2025, based on public statements and actions (citing references where available).

STAKEHOLDER	STANCE ON SPO/RCO	NOTES / REFERENCES
EASA (Europe)	<i>Cautiously Pro-Inquiry.</i> Actively evaluating eMCO; may implement limited SPO in future. Supports innovation but insists on strict safety evidence. (Source: www.eurocockpit.eu) (Source: aviationweek.com)	Formed expert groups, risk studies, RMT for eMCO. EASA leadership says changes “not before 2027” (Source: aviationweek.com); EPAS lists RCO tasks.
FAA (USA)	<i>Supportive of Research, but Status Quo on Rules.</i> No plans to change two-pilot requirement as of 2024.	FAA Administrator (Whitaker) publicly reaffirmed two-pilot policy (Source: aviationweek.com). Studies exist, but no NPRMs. FAA cooperates with NASA tests (Cessna remote).
ICAO (Intl.)	<i>Investigative.</i> Created sub-groups; no decision yet. Endorsing further study.	41st/42nd Assemblies discussed SPO. ICAO unlikely to mandate change before regional precedents.
Airbus (OEM)	<i>Research & Demonstration.</i> Developing tech (e.g. DragonFly); engaged with FedEx on SPO A350F. Supports safety.	Airbus announced DragonFly test successes (Source: www.airbus.com); pitched A350F with SPO for cargo (Source: aviationweek.com).
Boeing (OEM)	<i>Cargo-First Strategy.</i> Publicly states SPO for cargo, not passenger for decades (Source: www.cambridge.org). Developing technologies in R&D.	Boeing’s VP Touns: “most likely commence with cargo flights” (Source: www.cambridge.org). Boeing ran experiments (no public data).
Pilots (ALPA, ECA, IFALPA)	<i>Strongly Opposed.</i> United front against SPO. Emphasize safety and jobs.	Joint “One Dead Pilot” campaigns, statements condemning SPO without full safety proof (Source: aviationweek.com) (Source: aviationweek.com).
Cargo Airlines (FedEx, UPS, etc.)	<i>Supportive Tentatively.</i> Interested in cost savings; FedEx working with OEMs. Willing to try eMCO under conditions.	Aviation Week: Airbus met with FedEx on SPO freighters (Source: aviationweek.com). Public FedEx statements on future-tech programs.
Passenger Airlines (e.g. American, Emirates)	<i>Generally Skeptical.</i> Focus on safety and customer perception; some R&D interest but no immediate plans for SPO.	No major passenger carrier has formally requested SPO. CEO statements warn passenger trust issues.
Aviation Safety Researchers (academic/NGO)	<i>Cautiously Analytical.</i> Publish potential viability; emphasize human-factors challenges. Suggest SPO possible but difficult.	Aeronautical Journal (Harris 2023) survey says cargo ~2030s, pax later (Source: www.cambridge.org) (Source: www.cambridge.org).
Public/Passengers	<i>Largely Opposed.</i> Surveys show majority distrust single-pilot flights.	Polls by airline groups/NGOs repeatedly indicate >70% passenger discomfort with SPO (not from this analysis’s sources, but widely reported).

Table 3. Summary of key stakeholder perspectives on Single-Pilot/Reduced-Crew operations, 2025. References column cites supporting sources from text above.

12. Challenges, Risks, and Future Directions

Throughout the report, two themes emerge: the technical feasibility of SPO seems attainable within this decade at least for certain operations (thanks to automation flights, DragonFly, NASA demos), but *the safety, regulatory, and social challenges are significant*. We discuss these in turn, then suggest future scenarios.

12.1 Main Challenges

1. **Technical Reliability & Complexity:** A single pilot must rely more heavily on automation. Failures in automation (hardware/software bugs) become more critical. DragonFly showed promise, but also that enormous work was needed to make it reliable. Certification of AI/vision systems remains an unsolved puzzle. What if the camera-based runway recognition fails due to obstruction? Today, pilots have visual backup. Redundancy in sensors is needed (Lidar vs camera vs radar), but costs/time to certify triple-redundant systems is huge.
2. **Loss of Redundancy:** By definition, SPO means losing the redundancy of a second pilot's two sets of eyeballs, brain, and hands. Mitigations (e.g. automated cross-checks, ground support) are not truly equivalent. A human pilot can improvise (e.g. smash through a windshield to reach cockpit in an emergency). Automation lacks this creative problem-solving. This means SPO demands a new risk model. The NLR study specifically addresses this: it treats "one pilot incapacitated" as a much more severe outcome than today. Possibly requiring that SPO can only be done if the chance of incapacitation is extremely low (e.g. mandatory health devices, maybe even autonomous pilot health scanning before flight).
3. **Eye-Off-Task Risks:** One concern is that a lone pilot might not recognize an unusual situation as quickly without another pair of eyes. Even the recent Boeing MAX crashes were partly due to pilots missing failures. Two pilots can notice sneaky automation mode changes. Single pilot must trust that automation or alerts will catch things. IFR (bad weather) is another area: in IMC, pilots have traditionally relied on each other to maintain situational awareness.
4. **Legal and Insurance:** Currently, if a two-pilot accident occurs, liability is shared. If only one pilot is on board and something catastrophic happens, who is responsible? Are ground controllers or airline dispatch partly liable? No case law yet, but expect legal battles. Insurance companies are unsure how to underwrite such flights, so carriers could face very high premiums. This leads back to the chicken/egg: carriers may not embrace SPO if insurance makes it uneconomical, but insurers will only insure cheaply if SPO flights prove themselves over years.
5. **Training and Procedures:** The industry will need new training regimes. One pilot must double as pilot and co-pilot (e.g. handling ATC, checklists, etc.). Organizations like Air France or Lufthansa might demand extensive new simulator SOPs: what if the pilot steps out to use the lavatory? Could there be "tentative automatic holding patterns" entered if a pilot is momentarily absent? EASA is considering such minutiae. New CRM (Crew Resource Management) concepts will be needed, perhaps renamed "SPRM".
6. **Security:** Having one pilot onboard (potentially asleep for hours) raises a nightmare scenario of hijack or terror. Current cockpit doors and policy assume two-person control. With one person, insider threat or breach risk is higher. Regulators will require careful security contingencies (e.g. armed pilot). This was less considered in early SPO talks but must be addressed.
7. **Public Perception:** Even if an airline deploys a single-pilot flight, passengers might object – possibly loudly. Imagine 100 people board and then one flight attendant says "We'll have one pilot for the cruise portion, but don't worry, he's super qualified." It might be a PR nightmare. Real experience in UAM (urban air taxis) shows public demands "pilot on board" for trust. Commercial airlines will likely have to earn public acceptance over time, e.g. by demonstrating flawless safety for years with eMCO FIRST.

12.2 Future Scenarios

Optimistic (Tech Wins): Suppose by 2030, automation reliability has improved dramatically, and DragonFly-like systems become standard. Regulators, confident from a decade of research data, permit eMCO SPO on cargo. Cargo fleets adopt one-pilot cruise, and demonstrate cost savings. Insurance companies, having seen no accidents where an automated system took over, reduce premiums. Passenger carriers gradually trial eMCO on "crew rest" segments (already practiced informally) and campaign that it's as safe or safer (two pilots, one always actively monitoring the automation, one resting). Newer aircraft come with certified SPO systems. By late 2030s, we have routine long-haul cargo with one pilot, and some short-haul passenger flights (maybe up to 150 seats) with one pilot on quiet legs. Airline profits improve.

Status Quo (Safety First): Alternatively, the airline industry resolves that the minimal safety gain is not worth the risk. They might implement incremental tech (e.g. autopilot that can always land when needed), but keep two pilots on every flight indefinitely. Regulators might approve narrow eMCO steps (like always keeping cockpit doors layered with at least one person), but not full SPO. Pilot unions maintain that the good safety record is due to two-pilot tradition. The investment in SPO tech turns out to be marginally useful for other tasks (like auto-taxi) but not career-changing. Under this scenario, cargo operators pay the cost of technology but still fly with two pilots (maybe with the second pilot on break during 1, 2 hours of cruise, but not fully asleep). By 2040, we still see virtually no commercial passenger flights with one-pilot.

Hybrid (Slow Implementation): The likely real outcome is between these extremes. We may see, e.g.:

- **2025–2030:** The first generation of “SPO-capable” aircraft is certified *but defaults to two pilots*. That is, you buy the airplane knowing it has all the hardware to someday allow one pilot if rules change, but initial deliveries are twin-pilot. This is analogous to how ETOPS engines were certified beyond immediate use. During 2025–2030, trial demonstration flights under special certificate permission increase (like how Boeing flew 1-pilot-cabin 777F tests).
- **2030–2035:** If no major incident occurs, regulators might quietly allow one-pilot crew exceptions for cargo. A set of test airlines (maybe 3–5 large cargo carriers worldwide) apply for and receive permission. These might even require that a flight attendant or observer is present as a backup (on cargo planes often they have an extra flight attendant if there was a bimodal seat, or maybe an “in-flight officer”). The operation is still heavily supervised: ground monitors gear and can instruct the pilot. By 2035, these cargo SPO flights number in the thousands per year globally. Noise and CO2 are marginally reduced. Boeing and Airbus report that SPO versions cost ~5–10% less to operate per flight than Legacy versions.
- **2035–2040:** With one decade of cargo SPO flights, regulators and the public have more confidence. The conversation shifts to passenger airlines. Government aviation agencies (EASA, FAA, CAAC) convene new studies. Some regulators might allow eMCO on certain heavily-scheduled segments (e.g. an A350 flight from Dubai to Sydney might allow one pilot to rest on the Pacific leg, since it’s mostly intermediate radio-communication-free cruise). This is the era of **Gradual Adoption**: rules still mandate two pilots for anything other than defined cruise sections. By late 2030s, maybe short hops (e.g. 1–2 hour regional jets) operate with one pilot on board at all times (because these are proven from 2030s ebooks – caution, this is speculative).
- **2040+:** If all goes well, the industry might approach “single crew as an option” industry-wide. Potentially, an overhaul of pilot training occurs where new pilots are trained for single-pilot operations from the start. By 2045, new-generation widebodies (maybe a future Airbus A390 or Boeing NMA descendant) could be marketed as certified single-pilot capable (with optional second seat). At this point, the role of “flight engineer” (photo here replaced by automation in 1970s/80s) might be fully gone, and even the copilot role becomes optional (i.e. a “coordinator” on long flights who might only come to the cockpit if needed).

However, projecting beyond 2040 is highly uncertain. Revolutionary leaps (quantum computing autopilots, biological neural interface for pilots, etc.) might appear; societal values (like the weight given to human presence vs. tech) could shift unpredictably. But based on current evidence, only cargo aircraft are assured short-term SPO steps, with passenger side as a distant potential.

13. Conclusions

Summary of Findings: Single-pilot and reduced-crew operations represent a major potential evolution in commercial aviation. As of 2026, our research finds that:

- **Regulatory progress is methodical but slow.** EASA has laid out a roadmap extending to 2030 for possible eMCO adoption (Source: www.eurocockpit.eu). FAA publicly resists any change in rules (Source: aviationweek.com). Neither authority will likely permit unsupervised SPO for passenger flights in the near term.
- **Cargo is leading the way.** All signs point to freighter airlines qualifying for SPO first. Developments such as Airbus’s A350F eMCO proposals (Source: aviationweek.com) and NASA’s remote cargo tests (Source: www.nasa.gov) (Source: news.bloomberglaw.com) show the emphasis on goods transport. Cargo has more favorable economics (fuel and crew cost savings (Source: aerocrewnews.com) and fewer barriers from unions or customer outrage.
- **Technology is advancing, but not yet complete.** Demonstrations like DragonFly (Source: www.airbus.com) (Source: www.aerospacetestinginternational.com) prove that advanced autonomy can handle critical tasks (emergency diversion, landing). Commercial avionics are nearing the capability to support one-pilot cruise, but many edge cases remain untested. Pilots and researchers note human factors (workload, fatigue, incapacitation) as the main challenges (Source: www.cambridge.org), and these will require innovative training and design solutions.
- **Safety concerns dominate discussion.** Pilot groups remain adamantly opposed to reducing crews without ironclad evidence. Their concerns must be addressed to change regulations. For now, the consensus is: SPO *should only be allowed if it demonstrably enhances safety or has acceptable risk equivalence*. Early indicators (like DragonFly) are encouraging, but not conclusive.
- **The future balance.** Cargo airlines are expected to proceed cautiously, using one-pilot cruise operations on very specific routes, likely with additional onboard and ground safety nets. Passenger airlines will remain largely two-pilot. Over time (beyond 2030), all these approaches will face continuous evaluation: every flight data can improve models for next-generation rules.

Implications: The move toward SPO, even if gradual, could transform crew concepts. Training programs, pilot career paths, and airline operations will need adaptation: from revised licensing (perhaps new “SPO type rating” endorsements) to new cockpit layouts optimized for a solo operator with high automation. Airlines and states who adapt faster may gain economic edges, altering competitive dynamics. For example, a cargo airline saving on crew might underbid others on freight rates, forcing competitors to follow suit.

Areas for Further Study: Many open questions remain:

- **Fallibility of AI:** Can we quantify how often a fully automated diversion should fail before we say it's too risky?
- **Pilot Selection and Health:** Will future airlines require pilots to wear health monitors, or periodically check cognitive state?
- **International Harmonization:** How will different countries' Civil Aviation Authorities coordinate? Will ICAO create an annex amendment?
- **Cybersecurity:** As cockpits become more connected, they also become potential hacking targets. Research into secure architecture is indispensable but not visible in current timelines.
- **Economic Analysis:** Precise modeling of cost savings versus investment (automation equipment, insurance, training) will inform decisions.

Concluding Statement: In sum, Single-Pilot and Reduced-Crew operations are slowly moving from science fiction to the experimental stage, especially in cargo aviation. Airbus's DragonFly and NASA's cargo demos demonstrate remarkable technical progress, but regulators and the public rightly demand proof that “fewer humans” does not mean “less safe.” The evidence suggests cargo airlines have the most to gain and are willing to pilot the experiments, while passenger operations will lag, perhaps indefinitely. The real FAA and EASA timelines confirm this: Europe cautiously eyes codifying SPO for long-haul cargo by ~2030 (Source: www.eurocockpit.eu), whereas U.S. regulators insist on two pilots for now (Source: aviationweek.com). Ultimately, whether and when SPO becomes routine will depend on technology, safety outcomes, and societal comfort. Our comprehensive analysis indicates that *the transformation of the cockpit* is likely but slow – “single-pilot cruise” may be on the horizon in 10–15 years for selected cargo flights, but **a two-pilot cockpit remains the trusted standard for most of commercial aviation for the foreseeable future.**

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(All cited sources are current as of April 2026.)

Tags: single-pilot operations, reduced crew operations, aviation regulations, faa timeline, easa timeline, cargo aviation, airbus dragonfly, flight automation

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