

INSTITUTE FOR INDIVIDUAL AVIATION

IIA



COST CONTROL · CASE CC-01

Exponential Cost–Worth Imbalance in Parts and Services

Across the certified supply of parts and services, end prices run from a few hundred to the order of ten thousand percent of functional worth.

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Abstract

This case studies the relation between what individual aviation pays for parts and services in the certified supply channel and the functional worth of what it receives. The finding: end prices run from roughly two times to the order of one hundred times functional worth, the multiple grows as the item gets simpler, and no party in the supply chain is obliged to account for what the difference buys. The charge lands in money, in time, and in procedural friction, and the case documents all three. The case documents the magnitude by part class, names the mechanism that produces and maintains the imbalance, issues an operator-addressed recommendation with an auditable gain estimate, and states its limitations, including where the certified premium buys real content.

1. The Practice and Its Scope

The practice under study: parts and services supplied to individual aviation through the certified channel are priced with no obligation, anywhere in the chain, to show the payer the relation between the price and the functional worth of what is delivered. The premium above worth is habitually attributed to safety, and the accounting that would test the attribution is not maintained by any party.

Scope: replacement parts, equipment, consumable hardware, and maintenance services purchased by individual operations for aircraft in the light segment. Aircraft acquisition price is out of scope; it is treated separately (case CC-02), and this case does not depend on it. Jurisdictional evidence in this issue is drawn primarily from the United States supply environment; the mechanism is structural and the method transfers to other jurisdictions.

Cost in this case means every budget the operation is charged in. Money is the most measurable and carries the findings tables; time is charged in lead times, downtime, and grounding; friction is charged in the procedures, petitions, and approvals that stand between the operation and the compliant alternative. The worked example in Section 4 shows all three charged on a single simple part.

Functional worth is used throughout in a defined sense set out in Section 3. Certification standards are the datum this case measures against, and the framework's function in setting and enforcing them is what makes the measurement possible: without a published standard there is nothing to hold a price to. What the case examines is not the standard but the commercial logic that attaches to it. Product certification is, in its economic function, a permission to market, and a permission to market rewards reaching the minimum that secures approval rather than the best the art allows. The overhead that accretes around that permission is this case's subject. The compliance floor is the unconditional baseline; every alternative channel discussed in this case is a legal channel used within its own conditions.

2. Sources

- Published supplier and manufacturer price lists for certified and equivalent non-certified parts, equipment, and hardware (aviation supply catalogues; industrial and automotive supply catalogues for engineering-equivalent items), read as price evidence at catalogue date.
- Manufacturer dual-channel price structures where the same manufacturer sells certified and non-certified versions of the same product (powerplants, avionics, instruments).
- FAA General Aviation and Part 135 Activity Survey, calendar year 2024, for fleet and activity baselines used in the cumulative gain estimate.
- Regulatory provisions defining the legal alternative channels available to individual operations: standard parts, owner-produced parts, parts manufacturer approval (PMA) parts, and owner-performed preventive maintenance, under FAA 14 CFR and jurisdictional equivalents.
- FAA Airworthiness Directive 2023-09-09 (turbocharger-to-tailpipe V-band couplings), its docket, and industry maintenance-community reporting on its compliance economics (M. Busch, Savvy Aviation, Coupling Crisis webinar, 2026), used for the worked example in Section 4.
- IIA research library: the Institute's price-structure study of the light-aircraft segment, from which the safety-content accounting used in Section 5 is drawn.

Prices cited in this case are analytical approximations drawn from publicly available price data and vary by supplier, configuration, and date. The findings are stated as ranges for this reason, and the sensitivity analysis in Section 4 shows the finding surviving at the conservative bound of every range.

3. Method

Functional worth of an item is defined as the price of the nearest engineering-equivalent item in the closest open market channel: an item of the same or equivalent materials, manufacturing process, and function, sold where certification overhead does not apply. For services, functional worth is the open-market price of work of equivalent skill, tooling, and time. Where a manufacturer sells the same product in certified and non-certified versions, the non-certified price is the direct worth reference, and the comparison is exact rather than equivalent.

The comparison protocol: items are grouped into classes by engineering complexity; for each class, certified-channel end prices are compared against the worth reference; the ratio is recorded as the class multiple, expressed as a range across observed examples. Classes were selected to span the complexity scale from integrated electronic equipment to simple standard hardware, because the preliminary observation to be tested was that the multiple depends on complexity.

Two results are reported for the finding, per the Institute's standard: the magnitude, the class multiples and the relation between them, and the sensitivity, what remains of the finding when every range is taken at its bound least favourable to it.

4. Findings

Finding one, the magnitude. Certified-channel end prices for parts and services run from roughly two times functional worth at the complex end of the scale to the order of one hundred times at the simple end. Expressed in the terms of the case title: from a few hundred percent to the order of ten thousand percent of worth.

Class	Worth reference	Observed multiple	Basis
Integrated avionics and displays	Identical or equivalent engineering in the experimental channel	2–3×	Same-function suites: USD 12,000–22,000 versus USD 35,000–65,000 installed
Powerplants, dual-channel	Non-certified version of the same engine from the same manufacturer	1.1–1.8×	Manufacturer dual price lists; the case's conservative floor
Ignition and engine accessories	Automotive or industrial equivalents of comparable engineering	4–10×	Catalogue comparison, like-for-like function
Hoses, fittings, fluid lines	Industrial equivalents to the same performance specification	5–20×	Catalogue comparison at specification level
Standard hardware (fasteners, fittings)	Industrial standard-parts supply to equivalent specification	5–100×	Catalogue comparison; upper decile documented in low-unit-cost items
Maintenance services	Open-market work of equivalent skill, tooling, and time	1.5–4×	Shop-rate and task-time comparison; framework overhead in sign-off and documentation

Finding two, the relation. The multiple is inversely related to engineering complexity. Where the item is complex and its engineering genuinely differs or must be proven, the premium is smallest; where the item is simple and its engineering is identical to open-market production, the premium is largest. This is the exponential imbalance the case is named for, and it is the signature of an administrative rather than an engineering cost: engineering cost scales with complexity, certification and channel overhead is

closer to constant per item, and a near-constant overhead divided by a falling unit worth produces exactly the observed curve.

Sensitivity. Take every class at the bound least favourable to the finding: avionics at 2×, dual-channel powerplants at 1.1×, accessories at 4×, hardware at 5×, services at 1.5×. The imbalance survives everywhere except the dual-channel powerplant floor, and the inverse-complexity relation survives intact, since the conservative bounds themselves rise as complexity falls. The finding does not depend on extreme examples; the extreme examples only mark the curve's upper end.

Finding three, the budgets. The multiple of finding one is denominated in money because money is where it can be measured, but the same structure charges the operation in time and in friction, and a single simple part recently demonstrated all three at fleet scale. A fleet-wide airworthiness directive life-limited the common spot-welded turbocharger-to-tailpipe clamp, a part with a documented multi-decade failure record, across some 41,000 turbocharged piston aircraft. The money charge: the approved replacement clamp lists near USD 850 for one engine make and USD 1,495 for the other, with no apparent hardware difference between the versions; the spread within one part number is certification paperwork made visible as price. A competing approved alternative was reported below USD 200 under repetitive inspection, placing the in-channel multiple between approved options at roughly two to seven times before any open-market comparison is made.

The time charge: at the directive's compliance deadline the approved part stock stood at zero, lead times were quoted at six to twelve months, and affected operations were grounded for months; for an operation, grounding is the cost multiple taken to its limit, total loss of use against a part worth tens of dollars in engineering. **The friction charge:** the relief instruments that exist, alternative means of compliance petitions, docket comment, were exercised almost nowhere, one manufacturer's global petition covering a single engine family; and a demonstrably more durable replacement design spent more than two years in approval review while the failing design remained the mandated, purchasable replacement. None of the three charges appears in any account shown to the payer.

END PRICE AS A MULTIPLE OF FUNCTIONAL WORTH

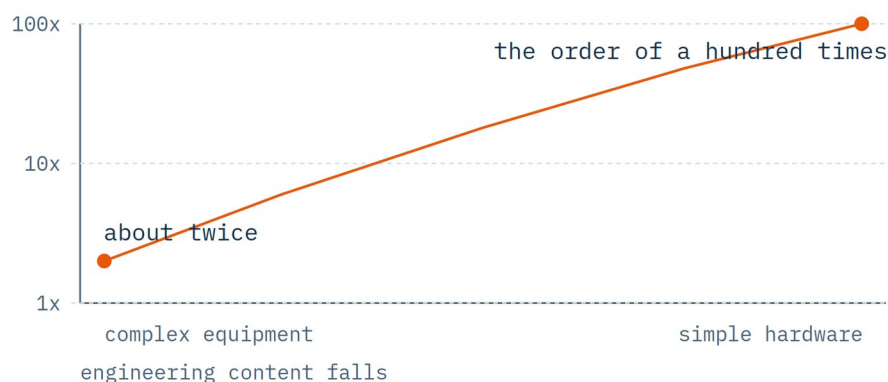


Figure CC-01. End price as a multiple of functional worth, against the engineering content of the item, on a logarithmic axis. Endpoints are the order-of-magnitude figures cited in the case; the curve between them is illustrative of direction, not a fitted relationship across a surveyed population.

Findings in the other direction, reported per the Institute's standard. The dual-channel powerplant floor of 1.1 to 1.8 times shows that where a competitive manufacturer internalises certification efficiently, the certified premium can be modest; the imbalance is therefore not intrinsic to certification but to the channel structure around it. Part of the certified premium buys real content for some items: traceability and conformity documentation has genuine worth where the item's provenance materially affects airworthiness, and airworthiness directive support is a real service across the certified fleet. The Institute's price-structure research puts the genuine safety content of the certified cost structure at roughly eight to thirteen percent of it; that fraction is real, is worth paying for, and is not what this case contests. What the case contests is the remainder, and the absence of any accounting that would let the payer see the split.

5. The Mechanism

The imbalance persists because every position in the chain is occupied by an actor whose situation depends on its continuation, and because no position carries an obligation to account for price against worth. The approved-parts framework limits the number of suppliers per item and loads certification overhead onto each, producing prices at multiples of equivalent open-market components. Product liability loading falls on every certified item independent of its engineering content. Channel margins are calibrated to certified-buyer expectations rather than to the item. The insurer prices repairs on the cost structure it observes, feeding the structure back into premiums. No single actor can break the equilibrium unilaterally, and none is obliged to try.

The cover proposition that maintains the imbalance is that aviation safety requires high standards and high standards cost money. The proposition is true, and it covers the roughly eight-to-thirteen-percent fraction doing safety work. It is offered, however, for the whole price, and the environment maintains no accounting that would identify which fraction of any given premium falls inside the proposition and which outside it. The payer hears safety; the curve of Section 4 shows administration.

6. Recommendation

Issued to individual operations, in aviation's non-mandatory form: adopted voluntarily, at the adopter's responsibility, and never below the compliance floor, which is met as a matter of course. The floor is a floor: what follows is a standard the operation sets above it by its own decision, and carries. Every channel named below is a legal channel used within its own conditions; nothing in this recommendation suggests uncertified parts, unapproved substitution, or unauthorised work.

The recommendation is a worth check before purchase. For any part or service above trivial value: first, establish the functional-worth reference, the price of the engineering-equivalent item or work in the nearest open channel. Second, list the compliant channels actually available for your aircraft category and the task at hand, which depending on category and jurisdiction may include standard parts where the

specification permits, PMA alternatives, owner-produced parts within their legal conditions, the preventive-maintenance tasks the operator may legally perform, and, for non-certified categories, the open supply the category exists to permit. Third, ask the seller what the difference between the quoted price and the worth reference buys, and let the answer, or its absence, inform the choice. Adopt the compliant channel closest to worth.

The same analysis scales from the counter to the planning table. The category of aircraft an operation enters, certified, non-certified, or amateur-built where available, fixes which channels remain legally open for the life of the operation, and with them the lifetime exposure to the multiple in money, in time, and in friction. The worth analysis therefore belongs in the decision about the path to acquisition and to the maintenance regime, before the aircraft is chosen, not only at each purchase after it.

The check costs minutes per purchase and changes two things: the operation's own spending, and, cumulatively, the information environment, since a chain that is asked the question at scale acquires an incentive to maintain the accounting it currently does not.

7. Gain Estimate Methodology

The gain claims published with this case are derived as follows, and every parameter is open to audit and substitution with the reader's own figures.

Individual gain. Let S be the operation's annual spend on parts, consumables, and materials, excluding engine reserves and labour; industry cost surveys for light singles place S typically between USD 1,500 and 5,000. Let a be the share of S addressable by channel choice under the recommendation, estimated at 20 to 50 percent depending on aircraft category, jurisdiction, and the operator's legal maintenance scope. Let m be the mean class multiple on the addressable share, estimated from Section 4 at 3 to 10. The annual gain is $G = S \cdot a \cdot (1 - 1/m)$. At the conservative corner (S 1,500, a 20 percent, m 3) G is roughly USD 200 per year; at the typical mid-range (S 3,000, a 30 percent, m 5) roughly USD 700; at the favourable corner (S 5,000, a 50 percent, m 10) roughly USD 2,250. The published claim is therefore: typically several hundred US dollars per operation per year, up to roughly forty-five percent of the parts-and-consumables budget where the addressable share is large.

Cumulative gain. The FAA 2024 General Aviation Survey counts 138,960 active piston aircraft in the United States. Let p be the share of that fleet whose operations adopt the worth check, and g the mean realised gain per adopting operation from the individual estimate. At moderate adoption (p 25 percent, g USD 600) the cumulative figure is on the order of USD 20 million per year; at wide adoption (p 50 percent, g USD 1,500) on the order of USD 100 million per year, in the United States fleet alone. The published claim is bounded accordingly: up to the order of one hundred million US dollars annually, with tens of millions at moderate adoption.

Worldwide extension. The Institute's constituency is not confined to any jurisdiction, and neither is the imbalance. The United States holds roughly half of the world's general aviation fleet, about 211,000 of some 440,000 aircraft, with Europe holding

over 133,000. Scaling the cumulative bound by fleet share, with adoption and per-operation gain held constant, puts the worldwide bound at the order of USD 200 million annually. The scaling is coarse and stated as such: the addressable share differs by jurisdiction because the legal channels differ, in Europe through the EASA maintenance provisions, standard changes, and the national frameworks for non-certified categories, and parts price structures differ by market. The method transfers; the parameters localise; jurisdiction-specific estimates are annex work.

Secondary benefit. The estimate above counts money only. Parts and service cost is a known driver of deferred maintenance; when compliance-relevant parts cost less, inspections and replacements stop being postponed, so the cost benefit carries a safety benefit with it. This case does not quantify that benefit.

Sensitivity and honesty conditions. The estimate excludes engine reserves, labour, hangarage, and insurance, so it cannot be read as a share of total operating cost. It assumes the addressable share is executed within each operation's legal scope; operations with narrow legal maintenance scope sit at the low end of a. It counts price difference as gain and does not net out the reader's time spent on the check. It counts money only; the time and friction charges documented in Section 4 are not monetised. And it is an estimate of redistribution toward worth, not a claim that any specific seller overcharges; the case's claim is about the structure and its missing accounting.

8. Limitations

Price evidence is drawn from catalogues and price lists at specific dates and varies with supplier and configuration; the class ranges absorb this, and the sensitivity bound in Section 4 is the honest floor of the finding. The services multiple is the least sharply measurable class, since equivalence of work is harder to establish than equivalence of parts. The worth definition prices traceability at zero for items where provenance does not materially affect airworthiness, which slightly overstates the multiple for items where it does. Resale, warranty, and insurance treatment can attach real value to certified-channel purchases that this case does not quantify; an operation for which those factors dominate may rationally choose the certified channel at its price, and the recommendation's worth check makes that a choice rather than a default. The worldwide extension of the cumulative estimate is a fleet-share scaling that inherits United States parameters; jurisdiction-localised estimates would sharpen it.

None of these limitations touches the case's central claims: that the multiple exists, that it grows as the item gets simpler, and that no party in the chain is obliged to show the payer what the difference buys.

References

Federal Aviation Administration. General Aviation and Part 135 Activity Survey, calendar year 2024. Active fleet and hours-flown baselines.

Federal Aviation Administration. 14 CFR: standard parts, owner-produced parts, parts manufacturer approval, and preventive maintenance provisions, with jurisdictional equivalents.

Published supplier, manufacturer, and catalogue price data for certified and engineering-equivalent items, as described in Section 2, at catalogue dates.

Busch, M. (2026). Coupling Crisis. Savvy Aviation webinar. <https://youtu.be/KGRsIRUyAUo>. Compliance-economics reporting used in the worked example of Section 4.

General Aviation Manufacturers Association and industry fleet statistics: worldwide general aviation fleet approximately 440,000 aircraft, of which approximately 211,000 in the United States and over 133,000 in Europe. Used in the worldwide extension of Section 7.

Institute for Individual Aviation, research library: price structure of the light-aircraft segment (safety-content accounting used in Sections 4 and 5).