

THOUGHTFOCUS



Strategic IV&V for a Safety-Critical Fuel Quantity Gauging System

A 11-Year Partnership in Avionics Certification

Executive Summary

The client partnered with ThoughtFocus to secure FAA certification for its Fuel Quantity Gauging System (FQGS) on a high-performance turboprop aircraft. The project faced significant challenges, including verifying a legacy-derived system under DO-178C guidelines and overcoming severe memory constraints on the embedded hardware.

As a strategic certification partner, ThoughtFocus led the independent verification and validation (IV&V) effort, enabling a successful SOI-3 audit with zero major findings. The team also developed a debugger-based automation framework that cut manual testing effort by more than 30%, accelerating the certification process and improving test coverage.

Client Profile

Client A Global Tier-1 Aerospace Supplier.

Industry Aerospace & Defense.

Application Safety-Critical Avionics (Fuel Systems).



The Challenge

Modern Compliance on Legacy Foundations

From 2019 to 2025, the program focused on achieving independent verification and validation to meet DO-178C Level B and C compliance. Certification efforts were complicated by three major challenges.



The "Legacy" Trap & Traceability Gaps

The system included substantial legacy components from an earlier software baseline. Integrating legacy components with new requirements created traceability gaps.

The Risk: The System Requirements (SRD) and Software Design (SDD) documents had ambiguities, and the code lacked complete bidirectional traceability. This posed a high risk of non-compliance during certification audits.

Technical Debt: Ensuring that new updates did not break existing functionality while retroactively establishing traceability for legacy code was a major concern.



Hardware Memory Constraints

The target hardware for the FQGS lacked sufficient memory to support standard testing instrumentation.

The Roadblock: The processor could not accommodate the full suite of test procedures alongside the actual flight software. This forced the team into slow, manual testing cycles, as they could not run automated scripts directly on the target.



Audit Pressure (SOI-3)

The program was driving toward the critical Stage of Involvement (SOI-3) verification audit. Any major findings during this audit would derail the certification timeline and incur significant remediation costs.



The Solution

A DO-178C Driven Engineering Framework

ThoughtFocus implemented a structured IV&V methodology that integrated deeply with the client's R&D workflow to "shift left" and catch defects early.



Requirements-Based Verification & Traceability Reconstruction

ThoughtFocus conducted a forensic review of the requirements and design data.



Gap Analysis: The team identified ambiguities and inconsistencies in the SRD and SDD reviews before testing began.



Traceability Logic: They rebuilt 100 percent bidirectional traceability across the SRD, SDD, code, and test artifacts, ensuring no undocumented variables or unverified logic remained.

Comprehensive "Shift-Left" Defect Removal



Static Analysis: Line-by-line code reviews were performed to ensure adherence to coding standards (MISRA) and DO-178C guidelines.



Dynamic Analysis: High-Level (HLV) and Low-Level (LLV) verification validated arithmetic functions, edge-case logic, and data handling.

The Innovation: Debugger-Driven Automated Testing

To solve the memory limitation aimed at the hardware, ThoughtFocus engineered a **debugger-based automation framework**.



How it worked

Instead of loading resource-intensive test scripts onto the flight computer, the team executed tests externally through the debugger interface, enabling breakpoints, value injection, and output capture without consuming target memory.



Impact

This enabled bulk overnight test execution, allowing regression suites to run automatically without engineer intervention.

Tools & Environment

Although proprietary specifics vary, engagements of this nature typically employ:



Requirements Management: DOORS



Static Analysis: RTRT



High-Level Testing: SCADE



Low-Level Testing: RTRT



Traceability: REQIFY



Debugger Interfaces:
JTAG/SWD-based automation



Target Hardware: FQGS embedded
processing unit



Key Business & Technical Outcomes

Certification Success:

Zero

Major Findings

In aerospace certification, audit outcomes are a critical measure of success. ThoughtFocus supported the successful completion of the SOI-3 audit with no major findings, validating the airworthiness of the software process and protecting the client's delivery schedule.

30–40%

Reduction in Testing Effort

By utilizing the debugger-based automation strategy, the team eliminated the need for manual, human-driven testing on the target hardware.

This significantly reduced the regression testing cycle, enabling tests that previously took weeks to be completed.

100%

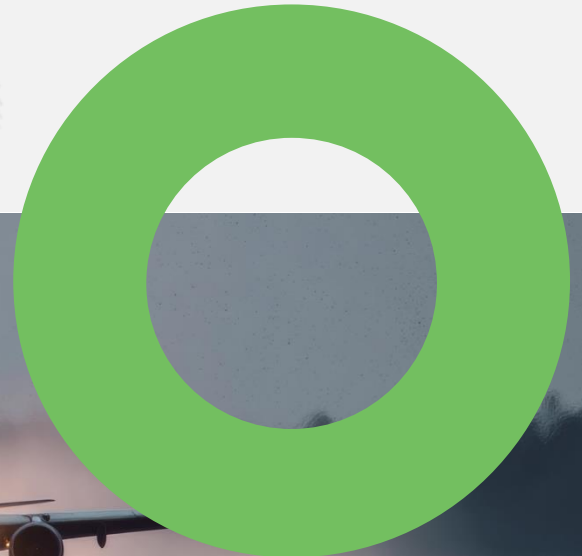
Traceability & Risk Reduction

- Achieved 100% bidirectional traceability from requirements to code and tests
- Identified and mitigated 15–20% of design risks early in the lifecycle
- Resolved ~85% of code reliability issues during early review cycles, preventing costly downstream rework

99%

Target Execution

Despite severe memory constraints on the embedded processor, the team successfully executed 99 percent of HLV and LLV procedures directly on the target environment through the automation framework.





Reduce certification risk across safety-critical programs

ThoughtFocus partners with aerospace OEMs and Tier-1 suppliers to deliver Independent Verification & Validation for safety-critical systems. From DO-178C compliance to audit readiness, we help teams achieve predictable certification outcomes with confidence.

Learn how ThoughtFocus can support your certification programs.

✉ info@thoughtfocus.com

🌐 www.thoughtfocus.com

