Intelligent Documentation Support for Rail Engineering

Why an off-the-shelf, commodity RAG doesn't solve the documentation problem in a safety-critical environment — and what Tritem Smart offers instead

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01

The problem that costs the most time where there is the least time to spare

An engineer developing control software for a rail vehicle, and the validation engineer verifying its compliance, both work inside an environment of hundreds — often thousands — of documents: interface specifications (ICDs), system requirements, standards (EN 50128, EN 50126, EN 50129, IEC 62279), subcontractor documentation, and prior validation reports. Answering a seemingly simple question — "which documents define this interface, and does requirement X have full coverage in specification Y" — requires manually searching through many files, some of which differ from one another in ways a text search engine won't notice, but that matter enormously for safety.

In a safety-critical environment, the cost of a mistake is not symbolic. A missed interface in a certification body of evidence, a reference to an outdated specification version, or an incomplete set of requirements covered by a test is not a minor inconvenience — it's a gap in the evidence chain that later has to be explained to a certification body. So the engineer's and the validation engineer's time drains away not into work that creates value, but into the task of confirming that nothing was missed.

That is the specific problem — not "document search" in the generic sense — that a documentation support system in this industry actually needs to solve.

02

Can you just buy this off the shelf? Yes — and that's exactly the trap

The answer to "can a ready-made RAG (retrieval-augmented generation) system be obtained today from other sources" is: yes, easily. Semantic, LLM-based search is now available as a feature of enterprise office tools, as a "RAG-as-a-service" cloud offering, as a built-in component in many engineering document-management platforms, and even as something a team can assemble from off-the-shelf components in a few weeks. On that count, the market is already saturated.

The problem is that all of these solutions — call them "commodity RAG" — are designed for the same average use case: searching generic corporate text, where a "good enough" answer on the first attempt is an acceptable outcome. Rail engineering documentation breaks that assumption in several places that matter most:

Documents look like each other.	Hundreds of interface descriptions within a single project share nearly identical linguistic structure — what distinguishes them is technical detail, not style or vocabulary. A standard semantic search engine, trained on general text, systematically confuses such documents, because it "sees" similarity exactly where the difference is what counts.
Completeness, not just relevance, is a safety condition.	A "chatbot over documents" tool is optimized to return the single most likely answer. In a certification context, the question is rarely "what is the most likely answer" — it's "do we have all related sources." That is a fundamentally different design goal, one that commodity RAG simply isn't built to meet.
No distinction between document classes.	A system requirement, an interface description, and a reference document each require a different retrieval logic — "the correct result" means something different for each. General-purpose tools treat the whole corpus as if it were uniform.
No evidentiary trail.	An answer without a precise pointer to source, version, and location within the document isn't usable as part of an evidence package for an auditor or a notified body — and that is exactly where the validation engineer's and the software engineer's work ultimately ends up.

Zero industry knowledge.	A generic model doesn't know how "test" differs from "validation" in the sense used by rail standards, or which clauses require particular interpretive caution. It answers fluently — and sometimes it is fluently wrong.

In short: it's easy to "have a RAG." It is not something you can simply buy off the shelf and have it understand that, in this industry, a retrieval error is a safety error.

03

Tritem Smart: built from the ground up for rail documentation, not bolted onto it

Our system is not a general search tool with a "rail layer" added on top. It is designed from first principles for safety-critical rail vehicle documentation, drawing on Tritem's 22 years of experience validating control systems — the same engineering discipline behind our technology for testing production firmware on the real controller.

For the client, this translates into three concrete advantages:

ADVANTAGE 01

Precision exactly where generic tools fail.

The system distinguishes between near-identical interface descriptions instead of confusing them — precisely where commodity RAG fails most severely.

ADVANTAGE 02

Completeness as the design goal, not a side effect.

The system is designed to return a complete, verified set of related sources rather than the single most probable answer — matching what an engineer preparing a compliance evidence package actually needs, not what a user looking for a quick suggestion wants.

ADVANTAGE 03

Accountability and auditability built into the design.

Every answer is grounded in a specific source that can be pointed to, cited, and justified — without that, no AI-generated answer has evidentiary value in a regulated environment.

The system is continuously developed under the same measurement discipline known from our validation work: no change goes live without a measured, confirmed improvement — exactly as no HIL test result reaches a report without repeatable verification. We do not disclose internal mechanisms here — that is Tritem know-how — but it is precisely this discipline that guarantees the system's quality improves in a controlled way, not by chance.

04

Working with agents: from a single query to autonomous verification

The simplest way to use the system is to ask a question and receive an answer with cited sources — already this cuts the time needed to locate the right piece of documentation from a quarter of an hour to seconds.

The system's full potential, however, shows up when it operates in agentic mode — when an engineer or validation engineer assigns not a single question, but a task to be carried out:

> **Preparing a complete documentation package ahead of a test session**
>
> The agent independently gathers all documents related to a given control function, compiles them, and produces a structured, source-linked summary, instead of leaving that work to the engineer.

> **Verifying requirements coverage**
>
> The agent checks whether a given function has a full, documented traceability path from requirement through interface specification to test evidence, and explicitly flags gaps or contradictions instead of waiting for someone to miss them.

> **Integration into the tools the team already uses**
>
> The agent answers inside the engineer's actual workplace (test management system, requirements repository, team chat), so documentation stops being a separate stop in the daily workflow.

In this mode, the system stops being "a search engine with a better answer" and becomes an active participant in preparation and verification — one that asks its own follow-up questions, checks completeness on its own, and flags risk before it ever reaches a report.

05

How much time this actually saves

The baseline is the work done manually today: locating the right documents, confirming they are current, cross-referencing requirements against interfaces, and preparing material ready to use in a test, a code review, or a certification report. In practice, a single instance of this task can consume anywhere from tens of minutes to several hours — depending on the complexity of the function and the number of related documents — and it recurs many times over in the working week of every validation engineer and control software engineer.

Targeted retrieval with a completeness guarantee cuts this task down to a few minutes, and agentic mode — which prepares a ready, verified package outright — can remove it from the engineer's day almost entirely. On a weekly basis, this means real hours of team time recovered, hours that can be redirected to what actually requires engineering judgment: designing test cases, analyzing results, and working on the software itself — not hunting for the right paragraph in the hundredth PDF.

We recommend measuring this effect on the client's own team through a short pilot on a selected module — this yields a figure specific to the given project and documentation structure, rather than relying solely on an averaged estimate.

06

Summary

A ready-made RAG can be bought anywhere today — but what you buy that way is optimized for the average office document, not for safety-critical rail vehicle documentation. The difference shows up exactly where it matters most: in the precision of distinguishing near-identical documents, in a guarantee of completeness rather than a best guess, and in the ability to point to a source that a certification argument can actually be built on.

Tritem Smart is built from the ground up for exactly this problem — and to the same standard of measurement rigor we have applied for 22 years to validating rail vehicle control systems. The result for the client is time handed back to engineers: fewer hours spent searching, more spent engineering.