Safety Performance Indicators for EASA Part 21 Organizations

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Contents

Introduction

Implementing a Safety Management System (SMS) within the EASA Part 21 environment requires a shift from mere regulatory compliance to a proactive, data-driven approach to safety management.

The primary rationale for utilizing Safety Performance Indicators (SPIs) is to provide measurable tools that verify if safety objectives are being consistently achieved.

The use of SPIs in Design (Part 21J) and Production (Part 21G) environments serves several critical functions:

- Quantifying Performance: SPIs translate broad safety policies into measurable metrics, allowing organizations to track their safety performance over time.
- Validating Risk Controls: Indicators are essential for assessing whether the safety controls implemented during the design or production process remain effective in real-world operations.
- Identifying Emerging Hazards: Continuous monitoring through SPIs helps detect hazards that may not have been apparent during initial design stages, especially as products are deployed in varied environments.
- Supporting Continuous Improvement: By analyzing SPI trends, organizations can identify areas needing improvement and capture lessons learned to evolve their management system.

Leading vs. Lagging Indicators

Effective safety management requires a balance between two types of metrics:

- Lagging Indicators: These measure safety events that have already occurred. They provide a retrospective view of failures, such as the number of design-related findings during audits or the frequency of safety incidents during testing.
- Leading Indicators: These measure safety activities and processes intended to prevent future events. They identify latent hazards and systemic weaknesses, such as the timeliness of hazard identification or the results of safety training competency assessments.

Integration and Scalability

The selection of SPIs must be commensurate with the size, nature, and complexity of the organization.

- Part 21J (Design) focuses on metrics related to design error rates, safety-driven design changes, and the effectiveness of compliance verifications.
- Part 21G (Production) emphasizes indicators related to manufacturing deviations, non-conforming parts, and the coordination between design and production to ensure products conform to approved safety standards.

Ultimately, SPIs foster a "Just Culture" and a proactive safety environment by encouraging open reporting and providing a transparent way to demonstrate that safety is prioritized alongside cost and innovation.

The implementation of a Safety Management System (SMS) within EASA Part 21J (Design)

SPIs are generally categorized into two types:

The following tables outline specific SPIs tailored to the unique environments of Design (Part 21J) and Production (Part 21G) organizations, based on regulatory guidance and industry best practices.

Safety Performance Indicators for Part 21J (Design) Organizations

Design organizations focus on the integrity of the design process and the continued airworthiness of products, parts, and appliances. SPIs in this environment track the effectiveness of design assurance and the ability to identify hazards early in the development lifecycle.

Indicator Type	Performance Metric (SPI)	Objective/Description
Lagging	Design-Related Certification Findings	Number of non-conformities identified by authorities during certification audits.

Indicator Type	Performance Metric (SPI)	Objective/Description
Lagging	Safety-Driven Design Changes	Rate of adjustments made to approved designs specifically stemming from identified safety issues.
Lagging	Operational Incidents linked to Design	Number of safety occurrences in the field traced back to design defects or deficiencies.
Leading	Hazard Identification Timeliness	Tracking the promptness of identifying and mitigating potential hazards during early design stages.
Leading	Design Review Issue Frequency	Metrics tracking the types and frequency of safety issues caught during internal design reviews.
Leading	Safety Case Updates	Frequency of reviews and updates to the organization's Safety Case to reflect design evolution.

Safety Performance Indicators for Part 21G (Production) Organizations

Production organizations focus on ensuring that products and parts conform to the approved design and are in a condition for safe operation. SPIs here emphasize the coordination between design and production to manage deviations and manufacturing quality.

Indicator Type	Performance Metric (SPI)	Objective/Description
Lagging	Reported Production Deviations	Number of non-conforming parts or manufacturing deviations that required safety impact assessments.
Lagging	Mandatory Occurrence Reports (MORs)	Frequency of significant safety issues reported to authorities within established 72-hour timelines.
Lagging	In-service Failures (Production Related)	Number of system failures or technical malfunctions in service traced to manufacturing quality.
Leading	Internal Safety Audit Completion	Percentage of internal safety audits and site "walkabouts" completed by leadership as scheduled.
Leading	"Speak Up" / Voluntary Reports	Volume of safety concerns proactively reported by staff without fear of reprisal.
Leading	Safety Training Competency Scores	Results of trainee comprehension assessments following SMS and Human Factors training.

Indicator Type	Performance Metric (SPI)	Objective/Description

Effective SPI management requires a balanced approach, using Lagging Indicators to understand historical weaknesses and Leading Indicators to drive proactive improvements. By continuously monitoring these metrics, Part 21 organizations can foster a positive safety culture and ensure that safety remains a core business value.

Case Study - For an airline operating with a Part 21J Design Organisation Approval (DOA) specifically focusing on cabin interior modifications and repairs

The Safety Management System (SMS) must ensure that every design change maintains or enhances airworthiness and operational safety.

Rationale for Cabin-Specific SMS Indicators

Cabin modifications involve complex interactions between structures, electronics (IFE, galleys), and human factors (emergency egress, crew workload). SPIs in this environment move the focus from simple regulatory compliance to managing the "product risk" lifecycle.

- **Proactive Risk Mitigation**: Cabin designs must account for emerging risks like new material flammability or cabin air quality before they become operational issues.
- **Design-Production Interface**: Indicators track the coordination between the DOA and the Production Organisation (POA), ensuring that what is designed is accurately manufactured for safety-critical parts like seat tracks or oxygen systems.
- **Operational Validation**: SPIs monitor how designs perform under real-world stress, such as seat durability or emergency lighting reliability, feeding feedback back into future design iterations.

Safety Performance Indicators for Cabin Design (Part 21J)

Indicator Type	Performance Metric (SPI)	Description & Purpose
Lagging	Minor/Major Change Non-Conformities	Number of cabin modification packages rejected or returned by EASA due to technical safety flaws.
Lagging	Post-Installation In-Service Defects	Number of reported technical failures in modified cabin components (e.g., IFE bus overloads, loose cabinetry) within the first 100 flight cycles.
Lagging	Emergency Equipment Reliability	Number of instances where emergency path marking or oxygen drop-out systems failed operational tests after cabin reconfiguration.
Leading	Hazard Identification during Concept Phase	Ratio of potential hazards identified and mitigated during initial design reviews versus those caught later in flight testing.
Leading	Compliance Verification Engineer (CVE) Quality	Tracking the thoroughness of CVE checks, measured by the internal audit detection of missed certification specifications (CS-25).
Leading	SMS Competency in Design Engineering	Percentage of design staff achieving high proficiency scores in cabin-specific Human Factors and flammability training.

Key Focus: Human Performance & Safety Culture

In cabin design, human error during design calculations or compliance documentation can result in "latent defects" that only appear during emergencies.

1. **"Safety by Design"**: The SMS should prioritize embedding safety early to avoid retroactive, expensive modifications.
2. **"Speak Up" Culture**: Encouraging designers to report if they feel a client-requested modification (e.g., higher-density seating) pushes safety margins too thin without fear of reprisal.

3. **Continuous Monitoring**: Utilizing automated tools to track trends in design errors ensures the DOA remains proactive rather than waiting for an incident.

Based on the integrated approach required for an EASA Part 21J Design Organization, here is a sample Management of Change (MoC) checklist specifically tailored for a major cabin reconfiguration project. This checklist ensures that safety risks related to organizational, procedural, or technical shifts are proactively managed.

Management of Change (MoC) Checklist: Major Cabin Reconfiguration

Phase	Item / Requirement	Verification
Planning	**Risk Identification:** Have potential new hazards related to the cabin layout (e.g., egress path changes, oxygen coverage) been documented?	[ ]
	Resource Allocation: Are personnel, technology, and budget adequately assigned to manage this specific modification project?	[ ]
	Integrated Approvals: Does the change process align safety across multiple certifications if the airline also holds a Part 145 or Part 21G?	[ ]
Design	**Safety by Design:** Have safety engineers been involved from the concept stage to prevent retroactive modifications?	[ ]
	Human Factors Analysis: Has an assessment of cognitive demands on crew (e.g., new galley layout) or usability for passengers been conducted?	[ ]
	Redundancy & Fail-Safe: Do critical elements like emergency lighting or seat track attachments include layers of safety redundancy?	[ ]
Impact	**Transition Risk:** Has a risk assessment been conducted for the "transition period" between the legacy layout and the new design?	[ ]

Phase	Item / Requirement	Verification
	Future Exposure: Have potential failure modes (e.g., structural fatigue of new monuments) that could affect operators or maintainers been evaluated?	[ ]
	Change Accountability: Is the Head of Design Organisation (HDO) or relevant manager signed off on the decisions regarding safety risk tolerability?	[ ]
Training	**Competency Assessment:** Have all designers and CVEs involved in the project received initial or recurrent training on the specific SMS principles for this change?	[ ]
	Procedure Updates: Have Standard Operating Procedures (SOPs) or checklists been updated to reflect the new technical design environment?	[ ]
Monitoring	**SPI Alignment:** Have the Safety Performance Indicators been adjusted to track specific risks associated with the new cabin materials or systems?	[ ]
	Internal Audit Schedule: Is a project-specific safety audit scheduled to verify the effectiveness of the new risk controls?	[ ]

Critical Considerations for Cabin Reconfigurations

- **Just Culture:** Ensure that designers feel safe to "Speak Up" if project timelines threaten to compromise the thoroughness of the safety case or testing protocols.
- **Continuous Monitoring:** Following implementation, hazard logs must remain "living documents" to track any unforeseen technical issues reported by the crew or maintenance.
- **Digital Integration:** Use digital tracking or dashboards to monitor the status of risk mitigations in real-time throughout the project lifecycle.

Developing effective Safety Performance Indicators (SPIs) in a "low product design/repair" environment

Consider the example of an airline-linked Part 21J focusing on minor modifications or cabin repairs and how they present a unique set of challenges. Unlike high-volume manufacturing (Part 21G), these environments often suffer from "data poverty" and subjective risk assessments.

Based on the principles of EASA Part 21 SMS, here are the primary challenges:

The "Small N" Problem (Statistical Significance)

In a low-volume design or repair area, the sample size () of projects is often too small to generate statistically meaningful trends.

- **The Challenge:** If a DOA only performs five major cabin reconfigurations a year, a single "Lagging Indicator" event (like a certification finding) represents a 20% failure rate. This creates "noisy" data that can lead to overreactions or, conversely, a false sense of security if no events occur.
- **Impact:** Traditional lagging indicators (e.g., "In-service failures per 1,000 flight hours") become nearly useless because the exposure time is too low to catch rare defects.

Subjectivity in Leading Indicators

Because low-volume shops rely heavily on individual expertise rather than automated assembly lines, SPIs often become qualitative rather than quantitative.

- **The Challenge:** Metrics like "Hazard Identification Timeliness" or "Design Review Issue Frequency" depend entirely on the rigor of the individuals involved. In a small team, there may be a "social cost" to reporting issues, which can skew the "Speak Up" volume.
- **Impact:** If the "Safety Case Updates" metric is high, is it because the team is proactive, or because the initial designs were poor? Distinguishing between "activity" and "effectiveness" is difficult.

The "Latent Defect" Time Lag

In cabin interiors and repairs, a design error (e.g., a structural attachment flaw or a flammability non-compliance) may not manifest until an emergency occurs or during a heavy maintenance check years later.

- **The Challenge:** The feedback loop for "Operational Incidents linked to Design" is extremely long. By the time a lagging indicator flags a problem, the original design team might have moved on, or the modification might be fleet-wide.
- **Impact:** This makes "Validating Risk Controls" in real-time nearly impossible, forcing the organization to rely almost exclusively on "Safety by Design" (Leading Indicators), which are harder to measure.

Defining "Normal" in Custom Repairs

Part 21J organizations dealing with repairs often face unique, one-off scenarios.

- **The Challenge:** SPIs work best when there is a standardized "baseline" to measure against. In a repair environment, every "product" is slightly different.
- **Impact:** It is difficult to set "Alert Levels" or "Target Levels" (as required by SMS) when the nature of the work changes from a seat track repair one week to an IFE integration the next.

The Design-Production-Maintenance Interface

As noted in your text, the interface between the DOA (Design) and the airline's Part 145 (Maintenance) or Part 21G (Production) is a critical risk area.

- **The Challenge:** A design might be "safe" on paper but impossible to install correctly in a cramped cabin.
- **Impact:** If a part is installed incorrectly, is that a **Production Deviation (Lagging)** or a **Human Factors Design Error (Leading)**? Assigning "ownership" of the SPI can lead to departmental friction rather than safety improvements.

Summary of Challenges

Challenge	Impact on Part 21J/Repair Area
Low Data Volume	Metrics are volatile and lack statistical "power."
Normalization of Deviance	In small teams, "the way we've always done it" becomes the baseline, hiding systemic risks.
Verification Gaps	CVE (Compliance Verification Engineer) quality is hard to measure without "over-auditing" the auditors.

Challenge	Impact on Part 21J/Repair Area
Feedback Delays	Safety flaws in cabin mods may stay hidden for years (e.g., hidden corrosion or wear).

For low-volume Part 21J (Design) and repair environments, traditional "count-based" metrics (like the number of incidents per year) are often misleading. If you only have two projects a year, one error is a 50% failure rate; zero errors might just mean you were lucky.

To overcome this, you should shift toward Process-Based SPIs and Barrier-Efficiency Metrics. These focus on the quality of the work being done rather than waiting for something to break.

Design Maturity & "Right First Time" (RFT)

Instead of counting total errors, measure how much "rework" is required before a design is finalized. This highlights systemic weaknesses in the initial design phase.

- **SPI: Technical Query (TQ) Density per Modification.**
    - **What it measures:** The number of clarifications or corrections requested by the Production (Part 21G) or Maintenance (Part 145) teams during the embodiment of a design.
    - **Why it works:** High TQ density suggests the design instructions were unclear or impractical, which is a leading indicator of a future human-factor error during installation.
- **SPI: CVE "Return to Desk" Rate.**
    - **What it measures:** The percentage of compliance documents (e.g., Flammability Reports, Stress Analysis) sent back by the Compliance Verification Engineer (CVE) for technical corrections.
    - **Why it works:** It measures the technical competency and "self-check" rigor of the design engineers before the "last line of defense."

Barrier Effectiveness (The "Swiss Cheese" Model)

In a low-volume area, you want to know if your safety "layers" are actually working.

- **SPI: "Shadow" Audit Detection Rate.**
    - **What it measures:** During a random spot-check of a finished repair/design package, how many minor C.S. (Certification Specification) non-compliances are found that were *missed* by the standard process?
    - **Why it works:** It tests the "thickness" of your organizational barriers.
- **SPI: Safety Case "Living Document" Activity.**
    - **What it measures:** The number of times a Hazard Log or Functional Hazard Assessment (FHA) is updated *after* the initial kickoff but *before* final release.
    - **Why it works:** Zero updates often mean the team is "pencil-whipping" the safety assessment. Frequent updates show active risk management as the design evolves.

Human Performance & Competency

Since a small Part 21J relies heavily on a few key individuals, their "readiness" is your best leading indicator.

- **SPI: SMS "Safety Lab" Participation.**
    - **What it measures:** Instead of just "training completed," measure the percentage of staff who participate in voluntary "what-if" tabletop exercises or "safety coffee talks" regarding recent industry ADs (Airworthiness Directives).
    - **Why it works:** It measures the **Safety Culture** and the proactive mindset of the team, which is the best defense against "latent defects."
- **SPI: Percentage of "Minor" Issues Self-Reported.**
    - **What it measures:** The ratio of internal "oops" moments caught by the team versus those caught by an external auditor or the customer.
    - **Why it works:** A high ratio indicates a healthy "Just Culture" where people aren't afraid to admit a calculation error early.

Operational Feedback (The Long Loop)

Even with low volume, you can track the "health" of the designs you've already released.

- **SPI: Repair "Repeat Visit" Rate.**
  - **What it measures:** For a specific repair scheme (e.g., a cabin floorboard repair), how many times does the same tail number return for the *same* repair within 12 months?
  - **Why it works:** It identifies if the design was a "band-aid" rather than a robust engineering solution.

Summary Table: Process vs. Event SPIs

Metric Category	Traditional (High Volume)	Alternate (Low Volume/Repair)
Design Quality	Number of Major Non-Conformities	**CVE Rework Rate** (Internal Quality)
Safety Reporting	Total Number of MORs	**"Internal Catch" vs. "External Finding" Ratio**
Production	Rate of Scrap Parts	**Technical Queries per Design Package**
Human Factors	Training Pass Rates	**Safety Tabletop Exercise Engagement**

Management Review & Oversight

A Management Review meeting for a Part 21J Design Organization (DOA) with low volume needs to focus on Process Integrity rather than just "counts." A dashboard for this environment should highlight where the "safety margins" are thinning, even if no accidents have occurred.

Part 21J Safety Performance Dashboard (Quarterly)

The "Safety Health" Heatmap (Leading Indicators) – Example

This section tracks how well the organization is performing its *internal* safety functions.

Metric	Target	Current	Status	Trend
CVE "Return to Desk" Rate	< 15%	**22%**	⚠	📈 Increasing (Needs Review)
TQ (Technical Query) Density	< 2 per Mod	**1.2**	☑	📉 Improving
Hazard Log "Maturity"	> 3 updates/proj	**4.1**	☑	↔ Stable
Internal vs. External Catch	5:1 Ratio	**3:1**	⚠	📉 Decreasing

Analytic Note: The high *CVE Return Rate* combined with a low *TQ Density* suggests that while our designs are "installable," the technical documentation is struggling to meet certification standards before reaching the CVE.

Barrier Efficiency: The "Internal Catch" Ratio

For low-volume shops, this is the most critical chart. It compares **Internal Safety Reports** (caught by your team) against **External Findings** (caught by EASA, the customer, or the Part 145 shop).

- **Goal:** You want a high volume of internal catches. A "Zero Internal Reports" month is actually a **Red Flag** in a low-volume environment—it suggests the "Speak Up" culture is dormant.

Repair & Mod "Longevity" (Lagging Indicators)

Since you don't have thousands of flight hours to measure, you measure "Premature Returns."

- **Metric: "Infant Mortality" of Repairs.**
  - *Definition:* Any repair or modification that requires a "re-fix" or engineering clarification within the first 50 flight cycles.
  - *Current Status:* **1 occurrence** (Project: Galley Flooring Mod).

- *Root Cause:* Sealant specification was incompatible with cleaning agents used by the operator.

Management of Change (MoC) Status

A snapshot of active organizational changes (e.g., new software, new subcontractor, or remote working shift).

- **Current Change:** Transition to 3D Scanning for Cabin Surveys.
- **Risk Level:** Medium (Potential for "Data Gap" if lighting is poor during survey).
- **Mitigation:** Dual-check with manual measurements for the first 3 projects.

Why this works for you:

1. **Contextualizes Low Data:** One "Infant Mortality" event is treated as a deep-dive learning opportunity rather than a statistical anomaly.
2. **Focuses on the CVE:** In a small Part 21J, the CVE is your primary safety barrier. Measuring their "Return to Desk" rate protects them from burnout and protects the company from poor submissions.
3. **Visualizes the "Speak Up" Culture:** By tracking the *Internal Catch Ratio*, management can see if the team is actually looking for hazards or just waiting to be audited.

Next Steps

Sofema Aviation Services www.sassofia.com and Sofema Online www.sofemaonline.com provide classroom, webinar and online training for Part 21 J, Part 21 G and CS 25 – please see the websites or email team@sassofia.com