

Organizational-Level SMS Safety Performance Indicators for Automated Vehicle Developers

This guide was developed collaboratively with industry partners and serves as a resource for considering metrics that may be helpful in establishing and measuring organizational safety in the automated driving system context.

ORGANIZATION-LEVEL SMS SAFETY PERFORMANCE INDICATORS FOR AUTOMATED VEHICLE DEVELOPERS

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Safety performance indicators, or SPIs, are metrics that help identify safety trends and concerns within an organization. This resource guide focuses on indicators at the organizational level and not on automated driving system (ADS) or subsystem safety indicators—though these are also important when designing a safety management system (SMS).

Eleven categories of organizational-level SMS SPIs are outlined below. Note that the first six categories include a “starter set” of SPIs, which may be appropriate and feasible for organizations early in the lifecycle of

implementing an SMS program. Keep in mind that this resource guide is likely incomplete; the types of measures available to a company may change and evolve over time.

Who are the users of the SPIs?

SPIs are intended to be periodically viewed by the CEO, the Accountable Executive for Safety, and Safety Managers. A subset will be shared with the organization’s Safety Review Board (SRB). The SPIs are intended to inform decisions and actions that continuously improve safety across an organization.

Organizational Safety Performance Indicators				
Safety Objective	Common Traps and Pitfalls	Level of Maturity	Sample SPIs	Possible Data Source
Category 1: KEY SAFETY PERSONNEL				
The organization establishes clear accountability for safety issues, has continuity of key safety roles, and has a stable safety program.	Being over-prescriptive of safety roles: <i>Instead, it is recommended that an organization establish an early, pragmatic approach where the Process Owners are set based on the existing, known safety issues that have occurred within the organization.</i>	Starter Set	<ul style="list-style-type: none"> Role continuity ratio of Accountable Executive Role continuity ratio of Safety Managers Role continuity ratio of Process Owners 	Human Resources (HR) system or
	Too many key safety personnel: <i>Instead, it is recommended that an organization employ a simple approach with a handful of Process Owners (possibly ten or fewer) when establishing an early SRB.</i>	Intermediate	<ul style="list-style-type: none"> Number of cases where the reasons for the departure of key personnel have been analyzed 	Safety Department internal tracking

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Category 2: VOLUNTARY SAFETY REPORTING				
<p>Everyone feels empowered to raise safety concerns.</p> <p>Leaders understand trends in identified safety issues over time.</p>	<p>Over-engineered Voluntary Safety Reporting Program (VSRP) process: Safety reporting must have minimal friction. A common pitfall is to over-engineer the reporting process. Any extra steps, logins, fields, or clicks will drastically reduce program success. Organizations should carefully balance between ease of use and useful data fields.</p>	Starter Set	<ul style="list-style-type: none"> ▪ Number of VSRP reports received per month/quarter/year and trend ▪ Time to disposition for safety reports ▪ % of reports for which feedback to reporter was provided within 10 working days 	Spreadsheet or Reporting System
		Intermediate	<ul style="list-style-type: none"> ▪ Occurrence of repeat or similar safety issues over time ▪ Known risk of reported concerns (e.g., Aviation Risk Management Solutions [ARMS] Event Risk Classification [ERC], referenced in APPENDIX B – Related Resources; or items that needed immediate escalation) ▪ Type of disposition <ul style="list-style-type: none"> – Environment, Health, and Safety (EHS)/Operations/Engineering/Staff – Logged for statistics/Monitoring Plan/Mitigation Plan 	Reporting System

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Category 3: SAFETY ISSUE RESOLUTION				
Timely identification and resolution of safety issues.	Incorrect focus: <i>Inadvertent or unintended focus on volume of reports (quantity) vs. meaningful action (quality/outcomes)</i>	Starter Set Intermediate	<ul style="list-style-type: none"> ▪ Time to dispensation of Corrective Action Plan ▪ Action deadline extension history ▪ Number of issues by assurance function ▪ Rate of repeat issues ▪ Number of common root causes per month/quarter/year ▪ Number of common corrective actions per month/quarter/year ▪ Number of common hazards identified ▪ Time spent in each step of Issue Progression (e.g., if using 8D, time from containment to identification, to root cause, to action, etc., per month/quarter/year. For more information on 8D, see APPENDIX B – Related Resources) ▪ Ratio of findings issued vs. actions issued over time per month/quarter/year ▪ Ratio of findings closed vs. actions closed over time per month/quarter/year 	<p>Safety Issue spreadsheet</p> <p>Software QA issue tracking</p> <p>Safety reporting processes (e.g., VSRP)</p> <p>EHS tracking database</p> <p>Quality Issue Resolution</p> <p>SW Triage Issue Resolution</p> <p>Existing project management tools</p>

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Category 5: SAFETY CULTURE				
Safety culture is highly valued and perceived as strong by all employees.	<p>Incorrect interpretation of culture feedback: Safety culture surveys are effective at discerning perception but shouldn't be treated as validated safety issues. There will also be biases in the data set, especially negative feedback. Data should be treated as informative on employee perception of safety culture.</p> <p>Lack of coordination: Care should be taken to de-conflict with other efforts. Culture surveys should be launched in partnership with the corporate communications section, if applicable.</p>	<p>Starter</p> <p>Intermediate</p>	<ul style="list-style-type: none"> ▪ Extent to which personnel consider safety as a value that guides their everyday work (e.g., on a scale from 1 = low to 5 = high) ▪ Extent to which personnel (e.g., on a scale from 1 = low to 5 = high): <ul style="list-style-type: none"> – Consider that safety is highly valued by their management – Believe that safety-conscious behavior is supported – Would report a safety issue – Have confidence that a safety issue will be resolved – Understand their role in safety – Have adequate knowledge of any key safety procedures (VSRP, Grounding procedures, internal standards) 	Periodic safety culture survey results

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Category 6: INDEPENDENT REVIEWS (AUDITS)				
External audits are conducted and appropriately responded to. Compliance is monitored.	<i>Interpreting findings as failures: Don't consider review findings as a bad outcome. Findings are opportunities for improvement. However, repeat findings should be avoided.</i>	Starter Intermediate	<ul style="list-style-type: none"> Number of repeat external findings Total number of internal findings Repeat findings, non-conformances, or non-compliances Trend of the average lead time for completing corrective actions per oversight planning cycle 	Audit Reports UL-4600 conformance assessment (§ 17.1) results
Category 7: MANAGEMENT COMMITMENT				
Leadership demonstrates a commitment to safety.	<i>Leadership outsourcing safety: While there is likely a Head of Safety, all persons in senior leadership positions need to be vocal and visual in their endorsement of safety programs.</i>	Intermediate	<ul style="list-style-type: none"> Number of senior management walk-arounds or ride-alongs per month/quarter/year Management adherence to Safety Committee meeting schedule and attendance Action rate from Safety Committees Resolution rate of actions from Safety Committees 	HR system (calendar) Safety Committee logs
Category 8: INCIDENT RESPONSE PREPAREDNESS				
Organization is prepared to respond to safety incidents quickly and effectively.	<i>Perfunctory incident response training: Drills can be difficult, and there is a temptation to use an easy scenario. Drills should be carefully planned to expose any gaps in readiness.</i>	Intermediate	<ul style="list-style-type: none"> Adherence to incidence response (IR) drill schedule Number of meetings with main partners and suppliers to coordinate IR per month/quarter/year 	Incident response preparedness reporting system

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Category 9: SAFETY CASE				
Organization's safety case accurately supports safety within the operational design domain (ODD).	False Confidence: <i>If not carefully constructed, a safety case may provide false confidence in safety given an ODD. SPIs must be considered within this context.</i>	Intermediate	<ul style="list-style-type: none"> ▪ Number of claims in place with evidence data sources ▪ Number of unfulfilled claims ▪ Number of contested claims ▪ Findings associated with safety case claims ▪ Coverage of UL-4600 in terms of conformance ▪ Fraction of claims instrumented with SPIs 	Safety Case documentation
Category 10: SAFETY RISK MANAGEMENT				
Organizational safety hazards are discovered and addressed methodically.	Data manipulation: <i>Avoid bringing in artificially inflated or suppressed data simply to check a box.</i>	Intermediate	<ul style="list-style-type: none"> ▪ Number of operational accidents and serious incident scenarios analyzed to support Safety Risk Management (SRM) over time ▪ Number and trend of new hazards identified through the VSRP over time ▪ Number of new risk controls validated over time ▪ Number of safety risk assessment (SRA) risk acceptances, mitigations, and rejections over time, tracked individually ▪ Number of SRAs conducted over time ▪ Action rate from SRAs ▪ Resolution rate of actions from SRAs 	Hazard analysis, simulation, and road testing

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Category 11: MANAGEMENT OF CHANGE				
Safety risk associated with unintended consequences of change is minimized.	Scope creep: <i>Change Management efforts can often suffer from scope creep when non-safety-critical elements or quality-related items are considered. These can make coming to a decision on whether a change affects safety more difficult. Scope discipline is recommended to focus Safety's involvement in change management on safety-related items only.</i>	Advanced	<ul style="list-style-type: none"> ▪ Number of organizational changes for which a formal safety risk assessment has been performed per month/quarter/year and trend ▪ Number of changes to Standard Operating Procedures (SOPs) for which a formal SRA has been performed per month/quarter/year and trend ▪ Number of technical and product changes for which a formal SRA has been performed per month/quarter/year and trend ▪ Number of risk controls implemented for changes per month/quarter/year and trend ▪ % of changes (organizational/SOP/technical, etc.) that have been subject to risk assessment 	<p>Safety Managers and Safety Owners</p> <p>Software configuration management (SCM)</p>

APPENDIX A – Safety Role Definitions

As part of implementing safety management systems, an organization defines roles that are accountable for different aspects of organizational safety. These roles are summarized in the Automated Vehicle Safety Consortium (AVSC) Information Report for Adapting a Safety Management System (SMS) for Automated Driving System (ADS) SAE Level 4 and 5 Testing and Evaluation ([AVSC00007202107](https://www.avsc.sae-itc.org/principle-7-5471WV-465590G.html)¹), specifically in Table 1 in § 5.1.3 and in text in § 5.1.2. These definitions are:

- **Accountable Executive (AE):** “Individual who is responsible for the safety performance of the organization’s testing and evaluation operations. This role may be assigned to a person with authority over multiple cross-functional departments.”
- **Safety Managers:** “Individual(s) responsible for the safety performance of a department or group of departments and determines the cross-functional nature of safety hazards.”
- **Process Owners:** “Individual(s) or small group with delegated authority which collect and support analysis, investigations, safety risk assessments, and/or provide programmatic support of the organization’s safety objectives.”
- **Safety Review Board (SRB):** “A committee...to actively monitor the effectiveness of an SMS implementation, issue resolution, and safety performance against the organization’s safety policy and objectives.” The SRB is often composed of the Accountable Executive, Safety Managers, and Process Owners.

APPENDIX B – Related Resources

Event Risk Classification: An aviation industry working group called Aviation Risk Management Solutions (ARMS) was created to develop better ways to do operational risk assessment (ORA). Part of this work was developing an event risk classification (ERC) process, which identifies urgency, need for further investigation, and risk value for an event. For more information, see [The ARMS Methodology for Operational Risk Assessment in Aviation Organizations](#)².

8D Process: Initially identified by the U.S. Department of Defense in MIL-STD-1520C, the 8D process has been updated and used in the automotive industry as a problem-solving methodology through a clear product-oriented process. The process has been modified to fit a variety of industries. For more information, see the [American Society for Quality \(ASQ\) overview on 8D](#)³. Trainings are available from organizations like SAE and TÜV SÜD.

AVSC Safety Metrics: The Automated Vehicle Safety Consortium (AVSC) has released a list of recommended metrics and methods for evaluating ADS safety. The SPIs from AVSC are focused on system safety, while this resource guide is focused on the organization level—but system-level metrics will feed organizational safety measures. For more information, see [AVSC Best Practices for Metrics and Methods for Assessing Safety Performance on Automated Driving Systems \(ADS\)](#)⁴.

¹ <https://www.avsc.sae-itc.org/principle-7-5471WV-465590G.html>

² <https://www.skybrary.aero/bookshelf/books/1141.pdf>

³ <https://asq.org/quality-resources/eight-disciplines-8d>

⁴ <http://go.sae.org/rs/525-RCG-129/images/AVSC00006202103.pdf>

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