FLIGHT SAFETY FOUNDATION

GLOBAL SAFETY INFORMATION PROJECT

Level 1 Intensity Toolkit

DECEMBER 2017

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Toolkit Introduction

What Is the Purpose of the Toolkits?

The Global Safety Information Project (GSIP) toolkits continue Flight Safety Foundation's leadership of innovative safety initiatives within the industry. They add to a legacy of pioneering U.S. and international aviation safety conferences, establishing formal education for accident investigation, and other consensus building on standards and guidance. We believe tomorrow's risk-mitigation advances will come from the way we use comprehensive safety data collected before accidents happen — not just isolated forensic or auditing data. We must know far more than which countries aren't passing International Civil Aviation Organization (ICAO) Universal Safety Oversight Audit Programme (USOAP) audits or what airline failed to meet standards of an International Air Transport Association (IATA) Operational Safety Audit (IOSA) audit, whether airlines appear on a blacklist, or when organizations experience a safety event that becomes headline news. Today's focus must be on combined, in-depth knowledge of both immediate and long-term risks, such as those in the safety reports that frontline operations staff are submitting to their safety departments, their analysis of routinely recorded data from all flights over time, and operational risk assessments by local and regional organizations around the world.

Aviation organizations like yours increasingly perform detailed safety studies of their operations. Their analyses of aircraft flight data re-corder parameters, for example, reveal insights that show where safety programs could be strengthened to avoid a hazard or mitigate an event. These studies are intensifying, and their pace is quickening. At the same time, given the human factors risks and the related necessity for procedural consistency, no organization should manage operations by making changes to procedures after every flight. So the longer-term trends are important, and changes need to be considered carefully — perhaps tested before they are even introduced to assure an acceptable level of risk.

Our GSIP toolkits consider critical components of the risk management process so you can make good decisions and share information among stakeholders that benefit the entire safety management system.

Who Are the Toolkits for?

We've designed the toolkits for any one of the multitude of aviation industry stakeholders.

Regulators, for example, want to make sure that the safety performance of their country steadily improves. They want to ensure that service providers are learning and applying safety insights. They want to trust that the industry is doing the right thing, while holding individuals and organizations accountable to standards that address critical risk issues. Data will help them set their priorities.

Airlines, too, want to manage their risk using the best data they can get their hands on. They realize improved safety performance is not assured solely by their compliance with standards or by creating more standards.

Air navigation service providers (ANSPs) want to ensure that hazards and risks affecting air traffic have been identified and managed to ensure safety.

Airports want to make sure their runways are in service and in a safe condition at all times for takeoff, landing and taxiing without confusion. Airport signage, marking and lighting to be clear and unobstructed, and communications must be clear to minimize the risk of runway or taxiway incursions. Preventing aircraft ground damage is critical for safe operations.

Aircraft and engine manufacturers want fleets to operate reliably and to be recognized throughout world markets as extremely safe. They perform safety analyses before any aircraft is built, and they continue to monitor operations globally to identify emerging safety challenges. They also proactively issue recommendations and respond to trends as operators report events or conditions, or ask for assistance with other technical issues.

Data Collection

In GSIP terminology, *Level 1 intensity* means any stakeholder's basic identification of risks (potential problems), issues (current problems) and opportunities (potential safety benefits) from the risk analyses of highest priority in operations. Our Data Collection Toolkit describes how a variety of safety data sources can be used to identify the major risk areas across a stakeholder's domain or organization. It also provides best practices to assure that data collection activities address your organization's top-priority risks.

Although the examples provided in this toolkit focus on commercial aviation, the underlying approaches can be tailored to address the specific operational needs of a variety of stakeholders.

Using Known Industry Risks to Drive Your Data Collection Activities

To begin developing a clear and focused risk picture, your organization must understand the major risk areas across your stakeholder's domain or organization. Identifying these areas enables you to prioritize near-term safety data collection activities. Valuable sources include global safety leaders (such as ICAO), regulators (for example, the U.S. Federal Aviation Administration [FAA] and the Australian Transport Safety Bureau [ATSB]), organizations that operate at high levels of safety data collection and processing system (SDCPS) intensity (for example, NATS U.K.), and your organization's operations experts.

Data will help you identify top priority risks, unforeseen risks and safety enhancement opportunities. For example:

- ICAO publishes an annual safety report to highlight important safety statistics and elevated risk categories. Sample categories include runway safety, loss of control–in flight (LOC-I), and controlled flight into terrain (CFIT). Annually, ICAO uses these categories to present data trends, comparative data views and performance-based insights.
- Regulators, such as the FAA, publish annual safety reports that detail the results of their safety reporting programs (for example, the Air Traffic Safety Action Program [ATSAP] and Technical Operations Safety Action Program [T-SAP]) that identify and respond to top priority safety risks.
- Organizations operating at the highest levels of data collection intensity, such as NATS UK, publish annual reports that highlight strategic safety goals, their progress in achieving those goals, and recent operational safety improvements.
- Your own operations experts can be periodically polled to identify the most vulnerable risk areas within your operation. They will have deep insight into your exposure rates in relation to hazards like adverse weather, gaps in workforce skills, low quality of training or equipment failures.

Table 1 — Data Collection Matrix at Level 1 Intensity

GSIP Toolkit Matrix	Level 1	Level 2	Level 3	Level 4
Data Collection	Data are collected to adequately identify and monitor the normal hazards an organization may encounter, and to support a functioning SMS.	Data are collected to understand hazards, the exposure of operations to those hazards, and primary causal factors (for example, through flight data acquisition systems).	Data are collected to advance a comprehensive understanding of causal and contributory factors (for example, data collected through LOSA).	TBD

LOSA = line operations quality assurance; SMS = safety management system; TBD = to be determined

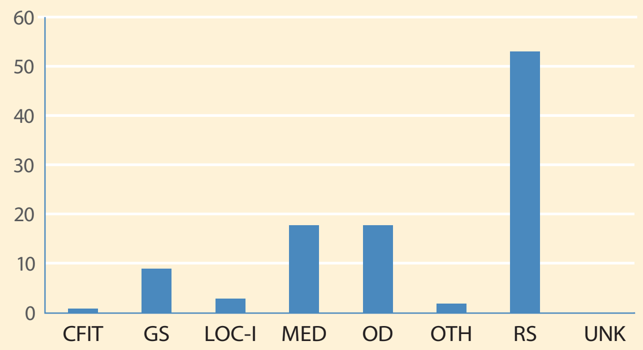
Table 2 — Sample Data Sources for Identifying and Mapping Events to Known Industry Risks

ICAO 2016 Safety Report	IATA Safety Report 2016	EASA Annual Safety Review
NATS Annual Reports and Accounts 2016: Strategic Report	FAA ATO 2015 Safety Report	Flight Safety Foundation Archived Publications
U.K. CAA Global Fatal Accident Review	RASG-Pan America Annual Safety Report	Aviation Safety Data Collection and Processing — Singapore's Experience

Relating Your Safety Data to Known Industry Risks

Major risk areas can also be used to locally categorize or map your safety data to the industry's top priority risks. Establishing these relationships provides the individual risks or categories of risks with industry-wide context. For example, as an ANSP, you may identify runway excursions and runway incursions as individual risks. When grouped, these risks can be mapped to the ICAO "runway safety" risk category.

Figure 1 — 2016 Accidents by ICAO Category



CFIT = controlled flight into terrain; GS = ground safety; LOC-I = loss of control–in flight; MED = injuries to and/or incapacitation of persons; OD = operational damage; OTH = other; RS = runway safety; UNK = unknown

Source: International Civil Aviation Organization

Data Collection Triggers

At Level 1 intensity, you may be prompted to understand your organization's top priority risk areas because of a series of operational event outcomes or because of your need to simply improve SDCPS risk management capabilities. When a significant event happens it creates a trigger to conduct deeper investigation of the underlying causes and relevant risks. The following sub-sections describe avenues under which such data collection is "triggered."

Mandatory Occurrence/Event Reporting (Reports to Your Civil Aviation Authority)

ICAO Annex 13, *Aircraft Accident and Incident Investigatio*n, defines occurrence types that require mandatory reporting by your personnel. Occurrences are accidents and serious incidents. While this Annex defines reporting criteria, the aviation regulations of individual countries often have more restrictive reporting criteria. For example, ICAO Annex 13 Attachment C states that "CFIT marginally avoided" is a serious incident. To clarify the term *marginally avoided*, a country may define specific lateral and vertical distances.

Your Company's Operational Reporting

Many companies have internal reporting requirements broader than the mandatory event reporting requirements of either ICAO Annex 13 or the requirements enforced by the country. For example, an air carrier may require a report from any flight crew that tells air traffic control (ATC) it is declaring "minimum fuel" in flight because undue delays will cause a flight crew to use their fuel reserves. In this case, the flight crew has exercised good safety judgment and mitigated a risk, and the air carrier independently has recognized hazardous conditions that might benefit from a company risk assessment.

Your Company's Internal Audits

Internal audit programs can influence your operational safety outcomes as effectively as they improve the quality of your air transportation products or processes. These programs typically examine compliance by individuals and groups with company standard operating procedures (SOPs) and industry standards. Audits may also evaluate the effectiveness of an entire organization or process and its indirect relationship to safety. Therefore, these programs become a valuable source of hazard intelligence that can be used during operational risk assessments.

External (Third Party) Audits

Audits conducted by external entities, also called *independent third parties,* can significantly benefit your aviation organization. They aim to examine without biases the safety "health" and quality of your organization or process. The results of these audits offer the opportunity to understand how your organization compares to others across the industry. Results take the form of findings and actionable recommendations in detailed reports. Examples of external auditing parties are IOSA, the ICAO Universal Safety Oversight Audit Programme (USOAP), the International Standard for Business Aircraft Operations (IS-BAO) and the Basic Aviation Risk Standard (BARS).

Voluntary Disclosure Safety Reporting Programs

In many countries, the civil aviation authority (CAA) maintains a non-punitive program in which a service provider can report a self-discovered noncompliance with regulations, or company procedures or company policies related to regulations. The program offers an aviation organization the opportunity to admit the discovery and to define a corrective action plan to address deficiencies. If accepted by the regulator, these voluntary reports and follow-up actions provide relief from enforcement. The characteristics of successful programs include:

- A means to ensure the discovery was not already known to the regulator and is under investigation.

- A safeguarding method for accepting appropriate reports while excluding those involving intentional acts that disregard safety norms.
- A monitoring and follow-up process that ensures that corrective action addressing the root cause of the noncompliance has been successfully carried out for all conditions identified at the time of discovery. Corrective actions also address similar situations that could lead to future cases of noncompliance.

Internal Safety Investigation

In some situations, a special investigation may be warranted if the severity of your regulatory noncompliance was recognized through ongoing safety data collection processes. The special investigation may be conducted by an independent team to examine the unique circumstances, including what led to any undesired outcomes. The final report should contain findings and recommendations. Historically, many aviation organizations also have decided that every mandatory occurrence report (MOR) demands an investigation. Each organization, however, may define its own threshold for initiating a special investigation. Each finding also becomes hazard intelligence for future risk assessments.

Types of Safety Data

To identify major risk areas, your teams should collect, merge and analyze safety data from multiple sources. This section suggests types of data that enhance your SDCPS risk management capabilities. These types of data are used across almost every stakeholder and can show up in more than one category of safety data sources that we mention later. Understanding the types of data is important for determining its limitations.

Audit Data

Audit data analysis primarily measures compliance with industry standards, regulations and procedures. Your data are used to understand how your organization, or a specific safety-related process, performs when compared to standardized benchmarks or regulatory requirements. The deficiencies are typically documented as *findings.*

Audit findings can reveal parts of your operation that are vulnerable to human factors errors, defects or failures. They may also reveal indirect impacts on safety, such as operational consistency issues or ineffective processes.

As noted, audits can be conducted by internal auditors or third parties. Examples of internal auditors are safety program managers and quality assurance managers. Examples of third party auditors are regulators and independent organizations such as ICAO, IATA and other aviation consultancy service providers. Both types of audits can identify significant findings. Examples include line operations (such as flight operations), operations support (such as maintenance and dispatch) and training (such as flight crew training).

Typically, you will assign responsibility for corrective actions by distributing audit findings to departments or individuals who then oversee implementation. Often, the corrective action plans are meant to address the root cause of an audit finding. This way, audits serve as an extremely valuable source of hazard awareness that informs your risk assessment.

Measured Data

Measured data are collected by an observer or automated system during routine operations. Their collection may also be triggered by an unexpected trend (for example, increased frequency of maintenance events) or by monitoring predetermined rates (such as heavy maintenance/D-checks of aircraft).

Measured data techniques often begin with data sampling that intentionally limits the number of measurements for statistical analysis. *Data sampling* means selecting a representative subset of what you want to measure to identify patterns and trends in your entire data set. You can define your subset by a specific time period or by a selected part of your operation. For example, during an audit, it may not be practical to assess every aircraft in your fleet, so you select a limited number of aircraft — possibly at random. So measured data techniques summarize either an entire operation (such as an entire flight) or a clearly defined part (such as the approach to landing phase). Depending on how the data are recorded (for example, by an observer versus by an automated system), they may be qualitative because of an element of subjectivity, and may differ in the degree of data consistency among observers. You can often apply measured data techniques to identify risks simply based on the frequency of observations within the data subset. Historical measured data are also a good resource for calculating probability during risk assessments.

Employee Safety Survey Data

Employee safety surveys are another key component for monitoring the effectiveness and integrity of your safety program. They enable your employees to report their perception of your program and their opinions of safety practices in day-to-day operations. For example, your employees can answer the following questions:

- Do you feel safe at work?
- Are you receiving appropriate training and support for risk-based decision making?
- Are you confident that safety concerns you raise are being addressed?

- Are you aware of our safety performance objectives?

Surveys can help you initiate your safety improvements. Surveys may also help you discover trends in your employees' safety-related perceptions and opinions.

In aviation risk management, your success depends on continuous improvement, especially your personal resolve to mitigate risk in every way possible. Perception and opinion measurements show you the degree to which your entire company has adopted the attitudes required for continuous risk reduction and mitigation. Keep in mind that variation in employee responses is normal. Ideally, negative employee perceptions in survey responses will be the exception, while your response data over time predominantly show a trend of positive engagement.

Sources of Safety Data

The sources of data often come from programs managed by different stakeholders. For the purposes of this Level 1 intensity GSIP toolkit, prospective safety data sources have been grouped, in Figure 2, into the following categories by type: public safety information, safety program information (which includes safety assurance and employee safety reporting) and reportable occurrence data.

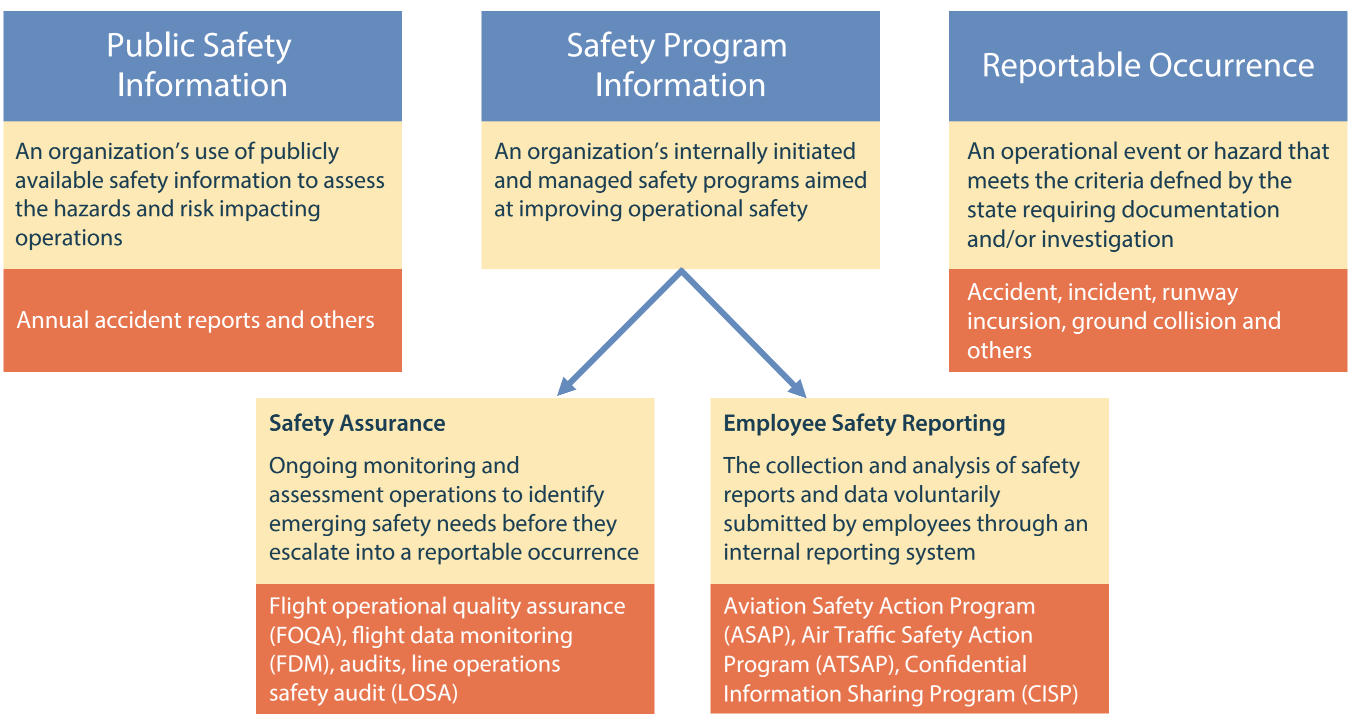
While any of these sources has potential value, carefully consider which would provide appropriate information. Your decisions typically will be driven by immediate needs (for example, your specific need to identify all your top priority risks rather than the cause of one accident). Throughout your data collection, potential types (such as audit data, measured data, employee survey data) should be collected by specialized teams working across organizational divisions. As you receive the teams' research observations and data, store them in a manner that will be easily accessible to other team members involved in SDCPS risk management. Your organization also must have mechanisms in place — whether manual or automated — to ensure that the data collected are secure, valid and free of errors before analysis.

The following sub-sections cover suggested data sources in more detail and best practices for safety data collection at Level 1 intensity.

Public Safety Information

Public safety information comprises government or non-government material published for access by individuals, news media and organizations within and beyond the aviation industry. Many users turn to this information with a particular focus on lessons learned from accidents and serious incidents. They intend to apply the facts and lessons to improve both flight operations and SDCPS risk management capabilities. Public safety information is readily available from

Figure 2 — Sources of Safety Data



sources such as ICAO, IATA, Boeing, Airbus and civil aviation authorities. You also can use public safety information to:

- Identify lessons learned from another organization or domain (such as their risk mitigations);
- Develop performance benchmarks based on industry-wide safety performance indicators (SPIs);
- Improve data collection processes and methods to the next higher level of intensity;
- Identify other organizations' experience with hazards that may impact your operation;
- Adopt targeted safety recommendations (such as those derived from accident investigation authorities);
- Pursue new policies or rulemaking (in light of CAA regulations, for example).

Best Practices for Public Safety Information Data Collection — Level 1 Intensity

- Collect high quality data from trusted sources. Then your analytical possibilities will be limited only by the quantity and depth of that data.
- Gather information from organizations operating within a similar sector of operations compared with yours. Consider accident reports, incident reports and supporting analyses that are available for relatively unrestricted use, as noted.
- Ensure the completeness of data you collect. Analysts will require as much information as possible (that is, taxonomy and context) to normalize what you have collected and want to apply to your operations.

Reportable Occurrences

Reportable occurrences data primarily come from your internal sources of information about operational events and hazards that fit criteria defined by ICAO, your state and/or your organization. The reporting requires you to provide documentation and/or investigate facts. Internal sources include people such as investigators, analysts or others who are a participant/party to the investigative process. You typically will obtain reportable occurrence data in response to the following events:

- Aircraft accidents of a specific type (for example, CFIT);
- Serious incidents (for example, runway incursion); and,
- Significant air proximity (airprox) events.

Best Practices for Reportable Occurrence Data Collection — Level 1 Intensity

If you collect reportable occurrence data, we recommend these best practices:

- Develop a secure system and processes with clear data-access controls. Protect these data to help build a high level of employee trust. This will have a positive impact on your ability to collect all the data you need.
- Introduce data collection checklists and/or procedures that streamline your data collection process and reduce variability across data sets. At Level 1 intensity, you should focus on meeting the requirements set by your organization and regulators.
- Avoid collecting ambiguous or non-specific data that may not be useable or cannot be analyzed.

Safety Assurance

Safety assurance is a common term for your ongoing monitoring and assessment of operational safety performance. This practice identifies your emerging threats before they escalate into reportable occurrences. You can collect safety assurance information and data from internal and external sources. Safety assurance information supports:

- Validation of operational performance targets (for example, number of maintenance-induced delays);
- Awareness of operational integration issues (for example, recurring hard landings at a specific runway); and,
- Identification of emerging human factors issues (for example, those revealed by audit findings).

Best Practices for Safety Assurance — Level 1 Intensity

We recommend the following best practices:

- Develop a safety assurance program that fosters a positive safety culture. The data collected should be used to educate employees, identify emerging risks and assess the effectiveness of existing risk controls.
- Collect data from internal sources (such as voluntary safety reporting program [VSRP] data, training data) and external sources (such as public safety information trends) to provide context and deeper insights into your safety assurance work.
- Establish a data storage and security strategy. Data collected should be stored, backed up and archived in an organized manner that will support audits, targeted "deep dives" by subject specialists and historical reviews to assess short-term and long-term performance (that is, they could be used to compute probability of a safety event).
- Collect and store safety assurance data that represent your entire operation to help you develop a comprehensive risk picture. Avoid information biases and collecting disjointed data that may negatively impact your analysis.

- Recognize that early in a program's development, the data collection may have been done with the best of intentions but did not have the foresight to understand how it might be used in the analysis. How data was collected on a paper form may not adequately meet the current desires for searching and sorting. Data fields may contain general text rather than a sortable field. Unless the data gets updated and transformed, these data structure will present analysis challenge.

Employee Voluntary Safety Reporting Programs

VSRPs comprise your efforts to collect and analyze the safety concerns, facts and event data voluntarily submitted by employees, on a non-punitive basis, through an internal reporting system. The program's database of reports and event-review team analyses provide insights into safety issues and events encountered in daily operations but that possibly could go unreported. Reports can be collected through internal company reporting systems.

VSRPs have become prevalent throughout the world as the aviation industry and regulators increasingly recognize the value of collecting safety information from frontline employees such as pilots, air traffic controllers and maintenance technicians. Many safety professionals now believe that the key to driving down risk is their continual flow of safety information disclosed by people who work daily in the system. These first-hand perspectives will help you:

- Identify close calls, often called "near miss" events, to prioritize near-term risk-mitigation efforts;
- Share lessons learned and best practices for managing specific types of hazards across your organization;
- Validate, confirm and explain other data (for example, pairing voluntary reports with analyses from flight data management); and,
- Target opportunities to improve organizational safety culture (for example, by gauging employees' safety program participation).

Best Practices for Employee Voluntary Safety Reporting Programs — Level 1 Intensity

We recommend the following best practices:

- Develop a VSRP that is scalable to meet the immediate and long-term needs of your organization.
- Implement a VSRP that enables employees to report safety concerns, facts and event data in a timely manner. Otherwise, critical details will be lost or forgotten.
- Develop a standardized reporting form or similar tool that makes it easy for frontline staff to describe their concern or details about the circumstances of what, when, where and how an event happened (in other words, facts such as phase of flight, weather, aircraft type).
- Establish clear company expectations regarding the types of safety events and/or issues that should be reported.
- Provide all employees with interesting examples of safety reports through training or awareness materials to establish expectations of quality. Materials should explain the differences between high quality reports and low quality reports. (See example in Table 3.) Employees need to understand what information should be reported and the depth of detail needed. Clearly explain the VSRP process so that employees

Table 3 — Example of High Quality and Low Quality Narrative in Safety Report From Cabin Crew

High-Quality Report Narrative	Low-Quality Report Narrative
15-20 minutes before landing we had strong cabin odor/fume that all 4 Flight Attendants (FA) smelled at the same time and never smelled before. A FA contacted Captain to complain of odor. The F FA said passenger in front of her seat noticed smell also. Felt pressure on my chest during descent. After landing felt very light headed, disoriented and shaky after deplaning. Paramedics met flight and did vitals. Whole crew went to the hospital upon Captain's suggestion. I had EKG, chest x-ray, arterial draw testing for neurotoxins and blood pressure. My blood pressure was 188/98 and 185/92 which is very high for me. Never had blood pressure issues. Concerned for my health for chemicals in uniforms and toxic fumes from job. My carbon monoxide level was 5 which they questioned. The smell on aircraft was very strong and different from anything I have ever smelled. To me the smell was like very stale musty air. ——— Indicates when and for how long and how many people were affected including passengers. Goes on to discuss medical checkout and some of the results.	During take-off a gust of fumes entered the entire cabin. I asked [the crew] who also experienced the same odor. [Another FA] notified flight deck. Flight deck advised returning to the [departure airport]. ——— Simply describes the basics of a fume event without references to how long and whether it was stronger in certain parts of the aircraft.

understand what happens after a report is filed and how they can monitor the status of their own report. Explaining how analysts will use reports to improve organizational safety will increase the quantity and quality of the reports.

- Establish collection agents who act independently to receive and capture the details of each report and perform the necessary de-identification work to protect the source.

Table 4 — Proposed Data Collection Map for Airlines at Level 1 Intensity

			Public Safety Data	Reportable Occurrences			Safety Program Information
Sample Risk Categories	**Accountable Department**	**Supporting Organizations**	**Accident and Serious Incident History**	**Company Operational Reporting**	**Mandatory Regulator Reporting**	**Company Self-Disclosure Reporting**	**Employee Voluntary Reports**
Controlled flight into terrain (CFIT)	Airline flight operations	ANSP (air traffic control)					
Loss of control–in flight (LOC-I)	Airline flight operations	Manufacturer		Operational event reports			Pilot safety reports
Runway safety (approach and landing accidents)	Airline flight operations	Air traffic			CAA reports		
Mechanical issues	Airline maintenance	Manufacturer		IFSD, ATB, RTO, DIV events			Mechanical safety reports
Near midair collision (NMAC)	ANSP (air traffic control)	Airline flight operations		Evasive action report from traffic conflict	Air traffic MOR		Pilot safety reports Controller safety reports
Runway safety (conflicts)	Airline flight operations	Airport authority		Operational event reports	CAA reports		Pilot safety reports Controller safety reports
Wildlife issues	Airport authority	Airline flight operations	Accident/incident investigation reports	Aircraft damage reports	Bird strike reports	Voluntary disclosure reports	Ramp safety reports Plot safety reports Ccontroller safety reports
Cabin safety	Airline inflght team	Airline flight operations		Turbulence injury, fume event, unruly passenger	Hospitalization of crew and/or passengers		Flight attendant safety reports
Fatigue and general fitness	Airline flight operations, airline inflght team, aircraft maintenance	Airline crew scheduling department, regulator		—	Drug and alcohol testing		Pilot safety/fatigue reports Maintenance safety/fatigue reports Flight attendant safety/fatigue reports
Dispatch safety issues	Flight planning and dispatch team	Airline flight operations		Operational event reports	CAA reports		Plot safety reports Dispatcher safety reports

ANSP = air navigation service provider; ATB = air turn-back; CAA = civil aviation authority; DIV = diversion; IFSD = in-flight shutdown; MOR = mandatory occurrence report; RTO = rejected takeoff

- Establish criteria for accepting reports into your VSRP and a process for managing any reports that do not meet the criteria.
- Establish key roles and responsibilities for people performing VSRP oversight. These include decision makers and independent safety specialists who provide one-on-one feedback to employees about safety event reports. For example, you may have a standing body of decision makers ready to engage the regulator's staff as necessary.

Reliability and Quality of Information

Give high importance to balancing the quantity and the quality of the data you collect. Focus on high quality data fitting your previously agreed scope and needs. As noted, apply methods that keep your data free of errors that may disrupt plans for future analysis. Common quality problems include duplicative data sets, incomplete data, inconsistent data, inaccurate data, ambiguous data and subjective data.

Additional problems may arise if you rely on manual processes or procedures to gather, enter, merge and check data. To mitigate that risk, assign a team member responsibility for checking your data. For example, when manual processes are used, this person ensures that fields are not left blank and avoids cases of data becoming undecipherable.

To ensure your safety program shows effectiveness and integrity, keep reinforcing at the planning stage that employees will likely distrust its analytical results if they doubt the underlying data quality. To reiterate the point, employees (including analysts, frontline employees, managers) who do not accept the validity of conclusions, mitigation plans or corrective actions later may doubt the value of other data collection efforts.

Data Collection Map

As your organization gathers and merges information from multiple safety data sources, we encourage you to prepare a data collection map. This map can be a valuable tool as you characterize your current data collection capabilities and see opportunities to advance to the next SDCPS intensity level. We recommend that your map identifies:

- Major risk areas selected to map or categorize your top priority risks;
- Sources of information you selected to collect data for each major risk area;
- Staff members or departments accountable for collecting data.

Table 4 (p. 10), prepared by Flight Safety Foundation, is a proposed data collection map for airline use.

Creating a Plan for Success

To consistently collect high quality data, we recommend that you prepare a data collection plan with a repeatable set of data collection and information management strategies. A typical plan should include:

- ☐ Data collection triggers —Criteria for when and why you collect data from each data source (see "Data Collection Triggers," p. 5);
- ☐ Roles and responsibilities — A matrix describing who is responsible for collecting and managing data (see "Employee Voluntary Safety Reporting Programs," p. 9);
- ☐ Data quality management — A plan for managing the desired attributes of your data, including data conditioning, filtering and a document change–management plan (see "Reliability and Quality of Information," p. 11);
- ☐ Storage — Information describing how and where safety databases will be kept and who has authorized access to them (see "Best Practices for Safety Assurance — Level 1 Intensity," p. 8);
- ☐ Data access — A description of how analysts will access each data source and who will be given access to each one; (see "Best Practices for Reportable Occurrence Data Collection — Level 1 Intensity," p. 8) and,
- ☐ Process improvement plan — A plan for your organization to continually improve safety data collection (General Best Practice).

Implementing your plan offers the opportunity to increase productivity, improve data consistency and reduce inefficiencies. At the first intensity level, the data collection plan provides a solid foundation for achieving your highest desired intensity level.

Data Analysis

GSIP Level 1 intensity means focusing on quantitative analyses of risks, problems and opportunities that are of the highest priority to your operation. This toolkit describes proven data analysis techniques to assess areas of interest and to begin tracking them on a safety management system (SMS) risk matrix. This toolkit also demonstrates how data analysis results can be applied to develop effective SPIs.

The following discussion and examples focus on commercial aviation. However, the underlying approaches can be tailored to your specific operational needs in other industry segments.

Optimization and Management of Safety Data

Robust data integrity is critical to producing analytical results that are statistically valid and significant. This goal first requires your organization to have an in-depth understanding of safety data sources. The current performance of your data collection program (for example, your employee VSRP, automated versus manual safety reporting systems) also must be monitored for objectivity. Accuracy, consistency, completeness and timeliness of all your selected safety data prevent low-quality data from degrading your analytical results and risk management.

To reduce your chance of data incompatibilities, normalize your organization's safety data early in your processes. Specifically, we recommend adjusting different sources of data representing different scales of measurement (for example, event rate per flights conducted, number of audit findings per audit performed, non-normal events per equipment movement) to predefined scales of measurement that will be compatible for analysis. This initial normalization will prevent data irregularities, incompatibilities or redundant information from degrading the quality of key inputs and outputs, or interrupting data processing. This recommendation especially holds true when you split or group safety data of varying statistical significance from different domains, departments, operations, sources, time periods, issues or deficiency types.

As your organization filters and merges raw data sources, beware of common data analysis problems. The issues include, but are not limited to, lack of data traceability (that is, failure to understand or document the original source), over emphasis and/or under emphasis on outlying data points, lack of consistent data preparation before analysis, biases of analysts and incorrect correlation of data. Understanding the intent, benefits and limitations of your data will help defend against these faults. For example, recall that audits measure an organization's compliance with industry standards. Analyzing audit data makes identifying noncompliance simple and objective. Another type of data previously discussed is measured data, also known as field data.

Measured data, however, typically are collected differently by an observer. This type of data may be qualitative (contain subjective elements) and show inconsistency across observers (also called *low inter-rater reliability).* While both data types are valuable, comparing them will generate analysis problems.

Assessment of Risk: Root-Cause Analyses

Flight Safety Foundation encourages the use of the cause-and-effect diagram originated by Kaoru Ishikawa, a renowned engineering professor, organizational theorist and quality control expert at the University of Tokyo, as part of SDCPS risk management. This root cause–analysis tool provides users with a repeatable process to identify the sources of risk by systematically determining the root causes of an undesired outcome such as an airplane crash.

Often, organizations spend too much time focusing on the symptoms of a problem rather than on the causes. Ishikawa's cause-and-effect diagram, also known as a *fishbone diagram,* is a tool that helps to reveal a problem's root causes through a simple and straightforward process. Fishbone diagrams

Table 5 — Data Analysis Matrix at Intensity Level 1

GSIP Toolkit Matrix	Level 1	Level 2	Level 3	Level 4
Data Analysis	Data are analyzed to determine acceptable risks. Safety performance indicators are monitored regularly to display status against objectives.	Data are analyzed to understand all direct hazards and their impact on undesired outcomes. Multiple hazards are examined for their influence on risk.	Data are analyzed to understand all potential direct and indirect hazards and their impact on undesired outcomes.	TBD

TBD = to be determined

typically are used in group settings in aviation safety. A facilitator or designated team member will be responsible for drawing the diagram and continually asking the group to brainstorm reasons why a situation, problem and/or factor occurs. While brainstorming, we recommend using appropriate evidence, *including safety data*, to develop the fishbone diagram, rather than relying on speculation.

Architecture of Cause-and-Effect Diagrams

Figure 3 shows that in fishbone diagram terminology, as adapted to aviation safety, the *problem* is represented at the "head" of the horizontal fish skeleton at the right end of the diagram. Trailing from the fish head is the backbone with off-shooting ribs forming the *major factors* (principal causal categories) related to the problem. Typically, there are three to six major factors per problem. Stemming from each of these ribs are the *sub-causes* that detail an aspect of why the problem occurs. These sub-causes may have their own sub-causes, which can be shown by adding additional levels of branching. Each level of branching is carried out as far as possible by asking "Why?" repeatedly for each cause-and-effect relationship. This identifies the root causes that lead to the main problem. When identifying root causes of some types of safety events, you may prefer a scalable and more flexible method called *cause-mapping.* This method is similar to Ishikawa's cause-and-effect diagram except it does not rely on major factors to sort causes. Instead, all causes stem directly from the problem (equivalent to the fish backbone). For each cause-and-effect relationship, this tool shows individual pathways. While cause-mapping does not usually result in a fishbone-like appearance, it accomplishes similar goals.

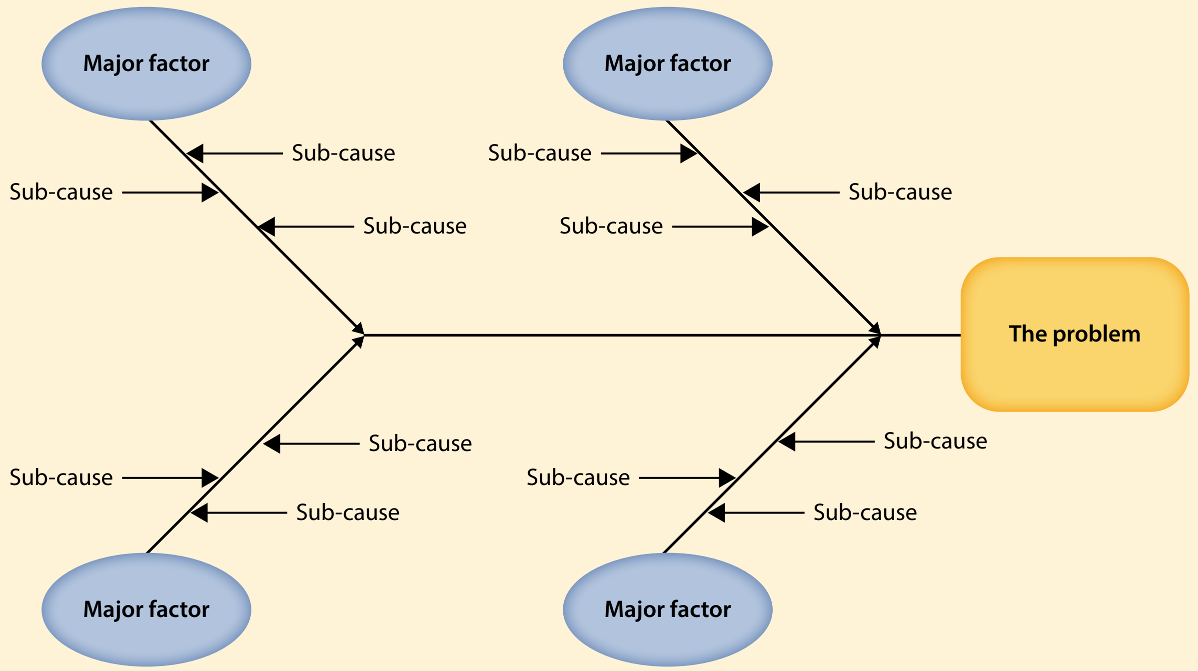
Using Cause-and-Effect Diagrams

To begin creating an Ishikawa cause-and-effect diagram, choose the problem to analyze. Your organization's problem might be identifiable through recent safety data analysis, a risk register for an operation, or your organization's top priority risks.

Then clearly document the problem at the fishbone head position. If you struggle to clearly document the problem, reconsider the fundamental questions of what, when, where and why your problem exists. Next, determine the major factors and add them as the ribs. You may need to customize the major factors to address your specific problem. However, if you have difficulty thinking of major factors, you may wish to use *methods, people, equipment* and *environment* as a default set of categories.

Next, fill out your diagram one rib at a time. For each major factor, list causes and sub-causes of the problem. This can be done by asking "why?" and listing the responses from group participants. Repeat this process until the root causes are clearly identified. Typically, this should require no more than five iterations of this question and additions of related diagram levels. Outputs from your cause-and-effect diagram comprise a list of a problem's root causes.

Figure 3 — Cause-and-Effect Diagram Architecture



Finally, we highly recommend using other data sources and analysis techniques to help prioritize and respond to these root causes. We elaborate on different data sources further in Levels of Intensity 2 and 3.

Example of Applying a Cause-and-Effect Diagram

Figure 4 shows an example of a cause-and-effect diagram shared with GSIP by an aviation organization that experienced runway incursions. The problem identified was "Runway incursions that were affecting safety of people and damage to property." To focus group brainstorming activities by a creating cause-and-effect diagrams, the organization used the following major factors (also called *categories):* methods, people, equipment and environment. Within each major factor, the organization identified various causes and sub-causes until the causes for each major factor were exhausted.

After further discussion and analysis of all the root causes, the highest-priority root causes were decided as follows. Regarding *People,* workers were not properly trained. Regarding *Environment*, the signage and markings for intersections of taxiways and runways led to an overly complex airport layout. Regarding *Equipment*, communications between aircraft crews, ATC and surface vehicles sometimes failed.

Level 1 Risk Analysis: Inputs, Outputs and Techniques

At each level of intensity, a *GSIP Data Analysis Toolkit* recommends analytical techniques to optimize the depth and richness of detail you will use to fill out a cause-and-effect diagram. Beyond Level 1 intensity, we recommend the bow-tie model (see the Level 2 toolkits for more information on bow-tie diagram–based analysis). Our proposed Level 1 risk analysis focuses on:

- Using public safety data and internal safety data to help identify your organization's top priority risks;
- Determining how to quantify the severity and probability* of an undesired aircraft state; and,
- Applying significant findings to develop effective SPIs.

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* It can be recognized that there are many methods to calculate probability and historical records are not always a good predictor of the future. The risk of something occurring however is measured in terms of a frequency based often on factual data. As you get more sophisticated in determining probability organizations may want to make adjustments for a difference between past history and future projections.

Figure 4 — Example of Applying a Cause-and-Effect Diagram to Runway Incursions

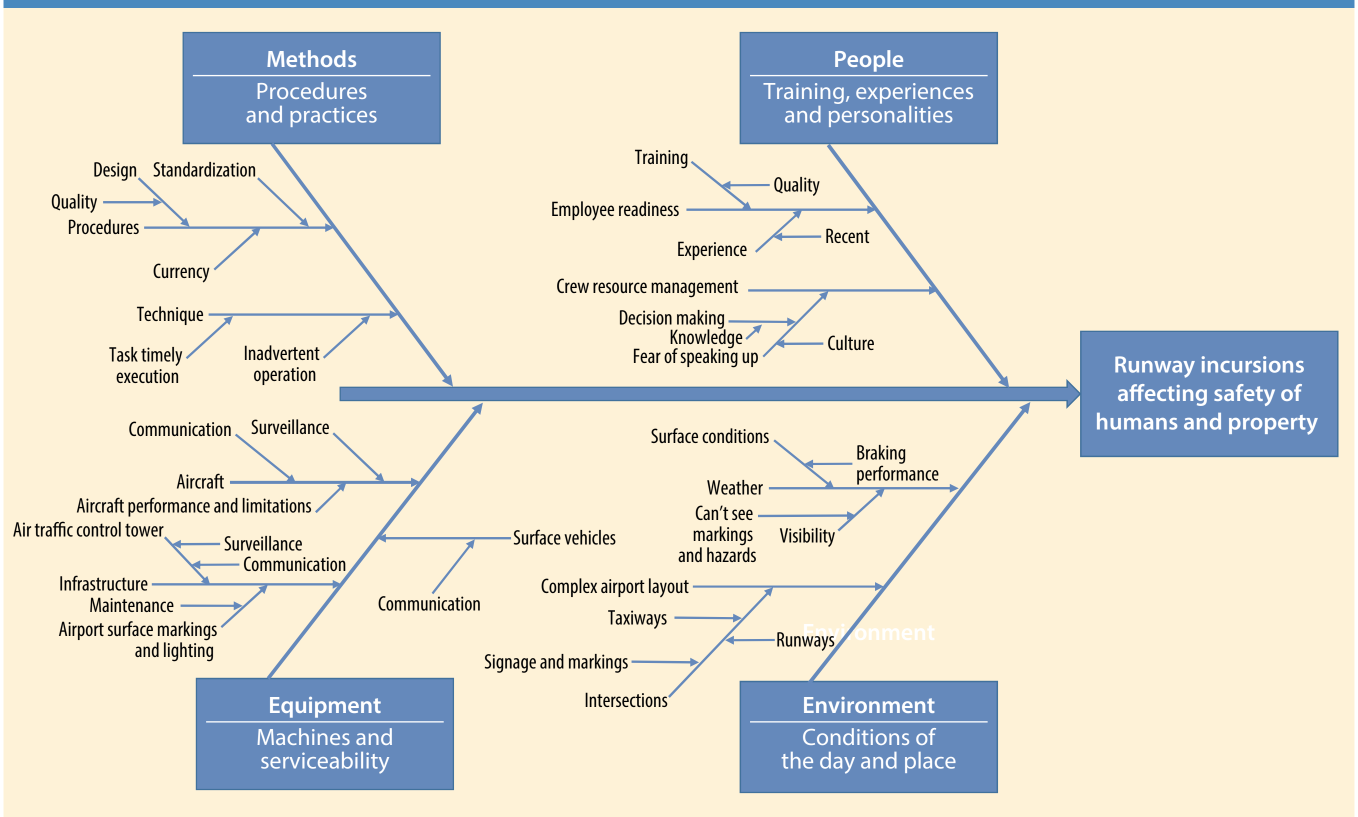


Table 6 — Examples of Inputs and Outputs in Frequency-Based Analysis

Data Sources	Example Analysis Inputs	Example Analysis Outputs (see Table 7)
Reportable occurrence data	Accident/serious incident reports describing safety event outcomes and probable causes	Most frequently cited accident/incident outcomes and probable causes
Employee safety reports	Frontline employee provides narratives describing observed safety events and/or issues	Most frequently cited event outcomes and causal factors
Safety assurance data	Survey measuring employee perception of an organization's safety program	Most frequently cited perceptions

To help you create cause-and-effect diagrams at Level 1 intensity, we describe in this section samples of data analysis inputs, output and techniques. These will help you identify your organization's top priority risks. The recommended analyses include a frequency-based analysis and a baseline analysis.

Frequency-Based Analysis

Many safety analyses begin with frequency-based assessments. They aim to identify the most frequently occurring hazards or safety event types (undesired aircraft states) that affect your operation. The results of a frequency-based assessment provide you with data to rank and prioritize safety issues that require additional analysis. Tables 6 and 7 show samples of frequency-based data sources, analysis inputs and analysis outputs.

At Level 1 intensity, you'll use frequency-based analysis results to identify:

- Leading negative outcomes by risk area (for example, runway safety, CFIT, LOC-I);
- Most common undesired aircraft states (safety events) that led to a specific negative outcome;
- Defense patterns from public safety information (that is, mitigations) for an undesired aircraft state; and,
- Top recovery measures cited by your internal organization for an undesired aircraft state.

Table 7 — Example of Frequency-Based Analysis Results

Deviation from clearance	43.73%
Incorrect or incomplete air traffic control instructions	18.99%
Flight crew situational awareness	15.2%
Controller situational awareness	7.36%
Movement area conflict	7.53%
Weather	7.19%

Baseline Analysis

A baseline analysis provides performance-based reference points you can use to assess the effects of operational changes, or to characterize current operational performance in comparison with predetermined thresholds. The results of a baseline analysis provide your organization with detailed insights into current and historical safety data from operations. This is especially helpful when trying to understand the effectiveness and integrity of your safety program. Table 8 shows examples of baseline data sources, analysis inputs and analysis outputs.

At Level 1 intensity, your baseline analysis, as depicted in Figure 5 (p. 16), results can be used to:

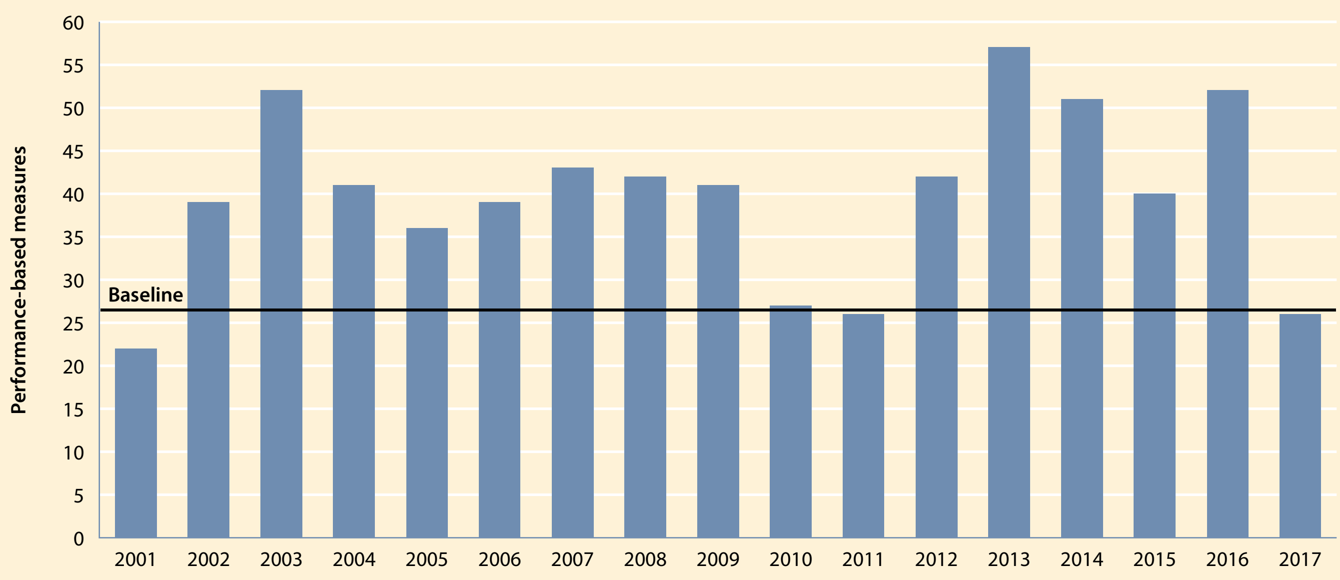
- Characterize current operations with performance-based reference points;
- Establish safety performance benchmarks to monitor undesired aircraft states (safety events); and,

Table 8 — Examples of Inputs and Outputs in Baseline Analysis

Data Sources	Example Analysis Inputs	Example Analysis Outputs
Employee safety reports	Frontline employee event narratives describing observed safety events and/or issues	Most frequently cited safety events and/or issues grouped by ICAO high-risk category
Public safety information	Annual safety reports detailing performance-based data	Average number of global safety events by ICAO high-risk category
Safety assurance data	Audit data describing regulatory compliance	Internal performance-based audit data by ICAO high-risk category
Reportable occurrence	Accident/serious incident reports describing safety event outcomes and probable causes	Average number of accident/serious incident outcomes by ICAO region and ICAO high-risk category

ICAO = International Civil Aviation Organization

Figure 5 — Example of Baseline Analysis Results



- Measure the impact of recent or proposed operational changes.

Quantitative Risk Assessment

Once you identify your organization's high-priority risk categories in the data collection map, and understand your organization's current issues and mitigation opportunities, you'll need to better define probability (likelihood) and severity (operational impact). Among many possible techniques for your secondary assessment, we recommend the ICAO SMS severity-versus-probability scales.

ICAO's SMS guidance defines levels of probability and severity. Your organization may wish to modify these definitions for better accuracy and standardization within your risk assessment process and to consider risks in a variety of contexts. We recommend that your definitions follow plain language guidance. You'll also want to apply them across your entire organization for consistency.

Risk Probability Assessment

Table 9 shows ICAO's safety risk probability (likelihood) scale definitions. When using the probability scale, you'll consider the internal and external safety data collected (such as safety reports, annual reports, occurrence data) to determine your rate of a safety event (that is, your exposure to a specified threat or undesired aircraft state in the context of daily operation). The greater your exposure, the greater the probability of a negative outcome. At Level 1 intensity, we have assumed that outcome data (for the frequency of accidents and serious incidents) will be used for this assessment. At higher intensity levels, we assume that you will consider in-depth data (for example, on contributory factors).

Risk Impact Assessment

Table 10 (p. 17) shows the ICAO safety risk severity (impact) scale definitions. When applying this scale during your risk assessments, you'll consider safety data to evaluate all potential (that is, reasonably credible) outcomes that may occur if your organization experiences an undesired aircraft state (safety event). This assessment will enable you to select and rate the worst outcome within the context of your operation. At Level 1 intensity, we assume that outcome-based data (for example, audit data, accident data, serious incident data) will be used to complete this assessment. At higher

Table 9 — ICAO Document 9859, Safety Risk Probability

Likelihood	Meaning	Value
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

Table 10 — ICAO Document 9859, Safety Risk Severity

Severity	Meaning	Value
Catastrophic	Equipment destroyed Multiple deaths	A
Hazardous	A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely Serious injury Major equipment damage	B
Major	A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency Serious incident Injury to persons	C
Minor	Nuisance Operating limitations Use of emergency procedures Minor incident	D
Negligible	Few consequences	E

intensity levels, we assume that in-depth data (for example, on close calls) will be considered during your risk severity assessments.

Assignment of Risk Ratings

After you complete risk probability and impact assessments, your organization will be able to assign a simple risk rating to the issue assessed. A risk rating represents the combined number-plus-letter values of the probability and severity assessment outputs, respectively. We recommend that you use the ICAO SMS risk matrix in Figure 6.

The global commercial air transport industry considers high risks (red-cell risk ratings in the table) to be unacceptable. Such risks must be immediately addressed. Medium risks (yellow-cell risk ratings in the table) may be acceptable if sufficient risk mitigations are in place; however, further assessments of any residual risks are highly recommended. Low risks (green-cell risk ratings in the table) may be acceptable. However, in the interest of continually improving safety, the industry consensus is for strong recommendations for airlines and other aviation service providers to thoroughly evaluate these risks, too, by assessment methods such as the cause-and-effect diagram.

As with risk probability and severity scales, we recommend that aviation organizations customize their high-risk, medium-risk and low-risk criteria. For example, the most risk-averse air carriers may define a risk rating of 3B as a high risk. On the other hand, an air carrier with a higher risk-tolerance threshold may consider the 3B risk rating to mean a medium risk. Therefore, we advise tailoring the criteria for high, medium and low risks to address your specific operational needs.

Examples of Probability, Severity and Risk Category Customization

Examples in Table 11 (p. 18), Table 12 (p. 19) and Table 13 (p. 20) demonstrate how your organization can tailor the SMS scale definitions to address your unique operational situation. Table 11 and Table 12 are customized probability and hazard-severity scale definitions developed by the FAA. Table 13 is a tailored hazard-severity scale developed by Flight Safety Foundation with the support of industry partners.

Documenting Your Risks and Top Safety Issues

Once you have validated and quantified top priority risks, your organization should actively track and monitor the status of these risks. The most common tool for doing this in commercial aviation is the risk register. Your risk register serves as a central repository that allows stakeholders within your organization to document active risks, to track the mitigation status of each risk, and to monitor potential

Figure 6 — ICAO Document 9859, Safety Risk Assessment Matrix (modified for printing)

Risk severity

Risk probability	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	1E

Low risk | Medium risk | High risk

Table 11 — FAA SRM Quick Reference Guide, Hazard Severity Definitions

Effect On:	Hazard Severity Classification				
	Minimal 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
	Conditions resulting in any of the following:				
ATC services	A minimal reduction in ATC services CAT D runway incursion Proximity event, operational deviation, or measure of compliance greater than or equal to 66 percent	Low risk analysis event severity, two or fewer indicators fail CAT C runway incursion	Medium risk analysis event severity, three indicators fail CAT B runway incursion	High risk analysis event severity, four indicators fail CAT A runway incursion	Ground collision Mid-air collision Controlled flight into terrain or obstacles
Flight crew	Discomfort to those on the ground Loss of separation leading to a measure of compliance greater than or equal to 66 percent	Low risk analysis event severity, two or fewer indicators fail Non-serious injury to three or fewer people on the ground	Medium risk analysis event severity, three indicators fail Non-serious injury to more than three people on the ground A reduced ability of the crew to cope with adverse operating conditions to the extent that there would be a significant reduction in safety margins Manned aircraft making an evasive maneuver, but proximity from Unmanned Aircraft remains greater than 500 feet	High risk analysis event severity, four indicators fail Incapacitation to unmanned aircraft system crew Proximity of less than 500 feet to a manned aircraft Serious injury to persons other than the unmanned aircraft system crew	A collision with a manned aircraft Fatality or fatal injury to persons other than the unmanned aircraft system crew
Flying public	Minimal injury or discomfort to persons on board	Physical discomfort to passenger(s) (such as extreme braking action, clear air turbulence causing unexpected movement of aircraft resulting in injuries to one or two passengers out of their seats) Minor injury to less than or equal to 10 percent of per-sons on board	Physical distress to passengers (such as abrupt evasive action, severe turbulence causing unexpected aircraft movements) Minor injury to greater than 10 percent of persons on board	Serious injury to persons on board	Fatal injuries to persons on board

ATC = air traffic control

Note: Severities related to ground-based effects apply to movement areas only.

threats that could escalate into significant risks. Your risk register also aids in determining when future investigations and analyses — such as cause-and-effect diagrams — may be appropriate. Another best practice is for multiple lines of business within an organization, company or industry segment to maintain their own risk register (in other words, to maintain separate risk registers for airline maintenance and flight operations).

We also advise documenting all your decisions to exclude potential threats, so you can show the direct relationship between the most current version of your risk matrix and your

Continued on p. 21

Table 12 — FAA SRM Quick Reference Guide, Hazard Likelihood Definitions

	Hazard Severity Classification				
	Minimal 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
	Conditions resulting in any of the following:				
National airspace equipment	Flight crew inconvenience Slight increase in ATC work-load	Increase in flight crew work-load Significant increase in ATC workload Slight reduction in safety margin	Large increase in ATC workload Significant reduction in safety margin	Large reduction in safety margin	Collision between aircraft and obstacles or terrain
Flight crew	Pilot is aware of traffic (identified by traffic collision avoidance system traffic alert, issued by ATC, or observed by flight crew) in close enough proximity to require focused attention, but no action is required Pilot deviation where loss of airborne separation falls within the same parameters of a proximity event or measure of compliance greater than or equal to 66 percent Circumstances requiring a flight crew to initiate a go-around	Aircraft is in close enough proximity to another aircraft (identified by traffic collision avoidance system resolution advisory, issued by ATC, or observed by flight crew) to require specific pilot action to alter or maintain current course/ altitude, but intentions of other aircraft are known and a potential collision risk does not exist Pilot deviation where loss of airborne separation falls within the same parameters of a low risk analysis event severity Reduction of functional capability of aircraft, but overall safety not affected (such as normal procedures as per airplane flight manuals) Circumstances requiring a flight crew to abort takeoff (rejected takeoff); however, the act of aborting takeoff does not degrade the aircraft performance capability	Aircraft is in close enough proximity to another aircraft (identified by traffic collision avoidance system resolution advisory, issued as a safety alert by ATC, or observed by flight crew) on a course that requires corrective action to avoid potential collision; intentions of other aircraft are not known Pilot deviation where loss of airborne separation falls within the same parameters of a medium risk analysis event severity Reduction in safety margin or functional capability of the aircraft, requiring crew to follow abnormal procedures as per airplane flight manuals Circumstances requiring a flight crew to reject landing (i.e., balked landing) at or near the runway threshold Circumstances requiring a flight crew to abort takeoff (for example, rejected takeoff); the act of aborting takeoff degrades the aircraft performance capability	Near mid-air collision results due to a proximity of less than 500 feet from another aircraft, or a report is filed by pilot or flight crew member that a collision hazard existed between two or more aircraft Pilot deviation where loss of airborne separation falls within the same parameters of a high-risk analysis event severity Reduction in safety margin and functional capability of the aircraft requiring crew to follow emergency procedures as per airplane flight manuals	Ground collision Mid-air collision Controlled flight into terrain or obstacles Failure conditions that would prevent continued safe flight and landing

ATC = air traffic control

Note: Severities related to ground-based effects apply to movement areas only.

Table 13 — Tailored Example of Flight Safety Foundation's Severity Assessment Criteria

Area for Assessment	Consequences					
	Insignificant	Minor	Moderate	Major	Severe	Catastrophic
General	Negligible impact upon objectives.	Minor effects that are easily rectified.	Some objectives are affected.	Some important objectives cannot be achieved.	Most objectives are affected.	Most objectives cannot be achieved.
People/injury	Injuries or aliments not requiring first aid treatment.	Minor injury or first aid treatment case.	Serious injury causing hospitalization or multiple medical treatment cases.	Life threatening injury or multiple serious injuries causing hospitalization.	Multiple life threatening injuries. Less than 10 fatalities.	Multiple fatalities, 10 or more.
Reputation	Internal review.	Scrutiny required by internal committees or internal audit to prevent escalation.	Scrutiny required by external committees or auditor general's office, etc.	Intense public, political, and media scrutiny (for example, an inquest, front page headlines, TV coverage).	Government inquiry or commission of inquiry or adverse national media in excess of 1 week.	Government inquiry and ongoing adverse international exposure.
Airworthiness	There are no operational or safety-of-flight implications and there is suitable redundancy. The deviation can be rectified using standard procedures.	Reliability is impacted with sufficient redundancy in place and no operational or safety-of-flight implications. The deviation requires either non-standard physical rectification or extensive troubleshooting to restore to normal operations.	Reliability is impacted but there is not sufficient redundancy in place. There are small operational, or safety of flight implications (not threat). The deviation requires either physical rectification or extensive troubleshooting to restore to normal operations.	Although there is redundancy, the deviation requires non-standard measures to be taken by flight or ground crew to re-establish safe and stable operations, or to ensure the safety of crew, passengers, or the public.	There is no redundancy and the deviation presents a clear and immediate threat to aircraft safety. Emergency measures by the flight or ground crew are required to preserve aircraft integrity and the lives of crew, passengers or the public.	Potential to directly cause an aircraft accident leading to a hull loss, or affects multiple aircraft to the extent that continued safety networking operations are put into immediate jeopardy.
Environment	Minor breach in internal procedures, insignificant impact to environment.	Minimal impact to environment, contained within operational area.	Medium impact to environment, possible migration outside operational area, containment required. Significant impact to environment on-site.	Significant impact to environment on-site.	Long-term impact to environment on-site.	Long-term environmental implications and potential impacts to third parties.
Organizational/ client impact	Small delay, internal inconvenience.	May threaten an element of the service delivery function. Business objective delayed. Easily remedied, some impact on external stakeholders.	Considerable remedial action required with disruption to a group for a period of up to 1 month. Some business objectives not achieved.	Significant loss of critical information. Disruption to one or more groups for up to 3 months. Some major objectives not achieved.	Permanent loss of critical information, substantial disruption to organization or external intervention for over 3 months. Threatens existence of a group within national civil aviation authority. Major objectives not achieved.	Threatens ongoing existence of organization.
Operations	Aircraft grounded for less than 3 hours.	Aircraft grounded 3–48 hours.	Aircraft grounded more than 2 days.	Sub-fleet grounded up to 2 days.	Sub-fleet grounded more than 2 days.	Complete fleet and sub-fleet grounded an extended period (more than 3 days).
Legal	An offense which could breach a single regulation.	An offense which breaches more than one regulation.	An offense for which company prosecution is contemplated and legal response is required.	An offense for which company prosecution is imminent and legal response is compulsory.	An offense which results in company prosecution, and/ or regulatory intervention, issuance of a a notice, a substantial fine or show cause action.	An offense which results in company prosecution and may result in directors/ executives/senior managers jailed or loss of regulatory approval to operate.

Table 14 — Risk Register Template

Risk ID	Develop a unique risk ID for tracking and eventual archiving purposes
Risk title	Formulate a risk title that clearly describes the risk
Risk statement	Insert a risk IF/THEN (cause and effect) statement
Severity	Insert value from impact assessment results
Likelihood	Insert value from probability assessment results
Risk rating	Insert combined severity/likelihood value
Mitigation strategy	Insert each mitigation step and assign due dates
Residual risk rating	Insert expected level of risk after mitigations are in place
Current status	Document progress toward completing mitigation steps
Point of contact	Assign person(s) the responsibility for overseeing and mitigating the risk

risk register. For historical and auditing purposes, we highly recommend that you archive previous versions of your organization's risk register(s). For more information explaining how to develop a risk register, see Table 14 and Table 15.

Table 14 is one recommended risk register template. Core elements in this template include risk traceability information (risk ID, risk title), descriptive risk information (the if/then statement), risk assessment data (severity, probability, risk rating, residual risk rating), and risk response plan information (mitigation strategies, current status, point of contact).

Table 15 is an example of the application of a risk register, focusing on the airline's training risk and risk-response plan.

Safety Performance Indicators

As described in other GSIP toolkits, SPIs are measurements (selected from broader operational performance metrics) that express the level of safety performance achieved in an aviation system. In ICAO terminology, SPIs are linked to your safety performance targets. They enable you to assess your current performance against the current targets. Establishing SPIs enables your organization to ensure that the necessary mitigations or controls are being implemented to address your top priority risks. SPIs essentially serve as a mechanism to assess the effectiveness of your existing risk mitigations and controls. Awareness of not meeting an SPI target will help your organization to identify risk areas that require attention, further review or corrective action.

Table 15 — Risk Register Example

Risk ID	Training 01
Risk title	Flight crew surface training at Airport ABC
Risk statement	*If* flight crew training is not updated to address known Airport ABC surface complexity issues *then* the likelihood of a runway incursion will increase
Severity	B
Likelihood	4
Risk rating	4B (High)
Mitigation strategy	Step 1: 60 days prior to initiating service at Airport ABC, update flight crew training materials Step 2: 45 days prior to initiating service at Airport ABC, begin training flight crews Step 3: 10 days prior to initiating service at Airport ABC, all required flight crew training must be completed
Residual risk rating	1B (Low)
Current status	Step 1 completed 70 days prior to initiating service at Airport ABC. Step 2 will be started on Jan. 1, 2017, 10 days ahead of schedule.
Point of contact	John Smith, Chief Pilot

Different organizations may have all types of operational and business performance metrics. Some of these measurements may have a relationship to safety. In the context of our toolkits we suggest true SPIs do not include every performance metric that relates to safety but rather those key measurements that have been chosen to reinforce top organizations priorities for safety. Therefore some performance metrics can be monitored and analyzed to determine what impact they might have on a top level SPI. By carefully choosing these SPIs each would be established with safety performance target (SPT).

To develop meaningful SPIs, the leadership of your organization must agree about the top priority issues relevant to daily operations. Once those issues are identified, you must decide how an individual SPI will be measured or what existing operational performance metric might become and SPI (that is, you must answer the question "What should our metric be?"). The metric could be a lagging indicator, such as the number of runway overruns per 1,000 takeoffs. The metric could be a leading indicator, such as the percentage of your aircraft that have had routine maintenance inspections completed on or before their required due date. But to truly gauge performance improvement it is useful to pick a metric that has room for improvement. Extraordinarily rare events will not allow assessments on regular intervals on progress. Next, develop measures of success to help drive all personnel toward attaining operational safety performance objectives and identifying future data collection priorities. Tables 16 through 19 contain SPIs identified during 2015–2016 GSIP workshops against the higher level accident categories; they have been modified to fit the purposes of this toolkit.

Controlled Flight Into Terrain

Table 16 — CFIT SPI Example

Domain	Example Operational Performance Metric	Example Performance Target
ANSP	Number of MSAW alerts per month	Reduce the number of MSAW alerts to a specified number per month. Regularly review ANSP safety assurance data (for example, ATC radar feeds) to monitor progress.
Airline operator	Number of near-CFIT events per year	Reduce the number of near-CFIT events to a specified number per year. Regularly review employee voluntary safety reports to monitor trends and progress.

ANSP = air navigation service provider; CFIT = controlled flight into terrain; MSAW = minimum safe altitude warning; SPI = safety performance indicator

Loss of Control–In Flight

Table 17 — LOC-I SPI Example

Domain	Example Operational Performance Metric	Example Performance Target
Airline operator	Number of approach to stall events per month (stick shaker activation)	Reduce the number of approach to stall events to a specified number per month. Regularly review employee voluntary safety reports to monitor trends and progress.

LOC-I = loss of control–in flight; SPI = safety performance indicator

Near-Midair Collision

Table 18 — NMAC SPI Example

Domain	Example Operational Performance Metric	Example Performance Target
ANSP	Number of airprox events per 1,000 flight operations	Reduce the number of airprox events to a specified number per 1,000 flight operations. Regularly review ANSP safety assurance data (such as ATC radar feeds) to monitor progress.

ANSP = air navigation service provider; ATC = air traffic control; NMAC = near-midair collision; SPI = safety performance indicator

Runway Safety

Table 19 — Runway Safety SPI Example

Domain	Example Operational Performance Metric	Example Performance Target
Airline operator	Number of unstabilized approaches per 1,000 flight hours	Reduce the number of unstabilized approaches to a specified number per 1,000 flight hours. Regularly review employee voluntary safety reports to monitor trends and progress.
Airport	Number of runway incursions per 1,000 flight operations	Reduce the number of serious runway incursions to a specified number per 1,000 flight operations. Regularly review employee voluntary safety reports to monitor trends and progress.

SPI = safety performance indicator

To meet safety performance targets, establish lines of accountability for each safety performance indicator. Typically, you'll assign departments or individual specialists to track one SPI or a set of SPIs. For example, your maintenance department might be assigned to an SPI related to system reliability. A flight safety department may be assigned to an SPI related to runway safety.

Assigning the most appropriate people or departments to track an SPI will be critical to achieving your operational performance objectives. Once assigned to an SPI, a department or individual must take responsibility for collecting safety data and coordinating with the safety department to calculate SPIs. Initially, we recommend establishing a pre-SPI baseline order to chart safety improvements. Once target SPIs are set, direct the respective departments or individuals to work as teams to achieve their target SPIs.

Monitoring Risk Areas Beyond Your SPIs and Top Safety Issues

Your organization, like others, may introduce SPIs involving issues that deeply affect your top safety performance issues. We therefore recommend monitoring the compliance issues and related subjects that deserve increased awareness across your organization. Many operation al performance metrics can provide insight to the necessary mitigations to improve a SPI. These data and metrics could emerge later as root causes that you will need to monitor separately from safety performance indicators.

Maintaining this separation will be critical to an employee or manager who is attempting to collect safety data unconstrained by SPIs. People in these roles also face competing

Selecting Chart Types

Comparison	Distribution	Trends	Compositon
Compare values such as low and high	Detect outliers, gauge range and normal tendency	Detect patterns of gradual change over time	How individual parts make up the whole
Line graphs, bar charts, scatterplots (x/y)	*Line graphs, bar charts, scatterplots (x/y)*	*Line graphs, bar charts*	*Pie charts, stacked bar charts, tree maps*

problems caused by the availability of high volumes of aviation system data that can be overwhelming. In a typical airline, for example, a top safety performance indicator might be the rate of unstable approaches. Yet, the airline also might want to understand how many unstable approaches were affected by high descent speeds. High descent speeds then may be an underlying factor/root cause of unstable approaches that is worth monitoring in addition to existing indicators that already account for much of the airline's current unstable approach performance.

You could collect high-descent-speed data for use in safety analysis, but it does not need to be communicated to the entire organization on a regular basis if your objective is reducing the rate of unstable approaches. As the analytical capabilities of your organization improve, however, you may discover many reasons to tap into sources of additional safety-related data worth monitoring.

Best Practices for Representing and Summarizing Data

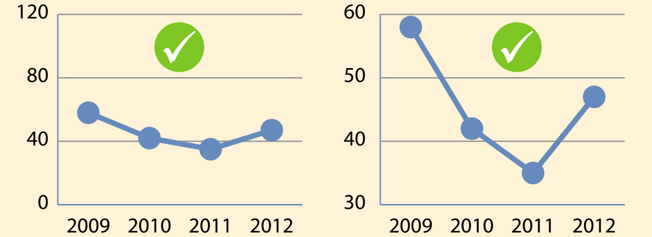
Conventional infographics, graphs, tables, charts and figures, and/or advanced data visualizations are valuable for communicating your results of safety data analysis. We urge caution, however, about correctly presenting data so that they do not mislead decision makers or stakeholders. To avoid common data misrepresentation errors, we've compiled the following sub-sections as best practices so you can maximize effectiveness, accuracy and credibility.

Selecting Chart Types

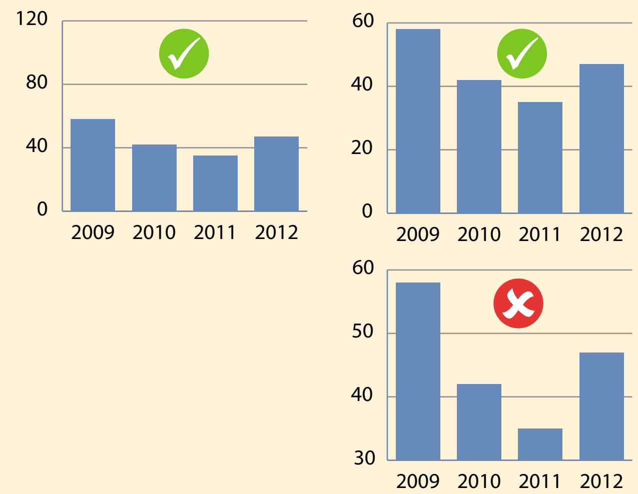
Line graph — Line graphs are used to track changes over short and long periods of time. When changes are smaller, line graphs are better to use than bar graphs. Line graphs can also be used to compare changes over the same period of time for more than one group. Use solid lines only. Avoid plotting more than 4 lines to limit visual distractions. Use the correct height so the lines take up roughly two-thirds of the Y-axis height. For this, it may be acceptable to start your Y axis at a value other than zero. Label the dependent axis (usually the Y axis).

Bar Graph — Bar graphs are used to compare data between different groups or to track changes over time. However, when

Line Charts

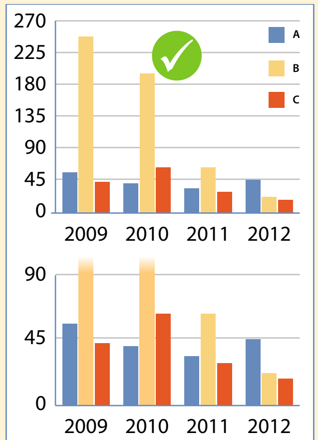


Bar Charts

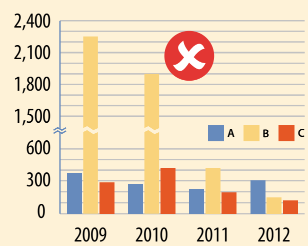


Truncated chart

Bar Charts — Panel and Discontinuous



Panel chart



Discontinuous chart

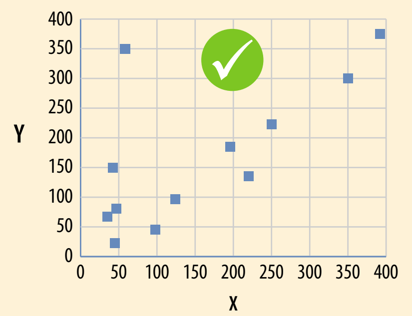
trying to measure change over time, bar graphs are best when the changes are relatively large. Bars can run vertically, like columns, or horizontally.

Start the numerical axis (often the Y axis) at zero. Our eyes are sensitive to the area of bars, and we draw inaccurate conclusions when those bars are cut short (truncated). See the difference between the truncated chart and a non-truncated chart. The chart on the left makes it look like the difference between the bar height is much greater when, in reality, starting the axis at zero shows a more accurate difference. If you have one or two very tall bars, consider using multiple charts to show both the full scale and a "zoomed in" view — also called a *panel chart.* Breaking the axis scale also misrepresents the data. Label the dependent axis. Rotate bar charts to be horizontal if the category names are long.

Scatterplot or X-Y plot — Scatterplots are used to determine relationships between the two different things. The X axis is used to measure one event (or variable) and the Y axis is used to measure the other. If both variables increase at the same time, they have a positive relationship. If one variable decreases while the other increases, they have a negative relationship. Sometimes the variables don't follow any pattern and have no relationship. A scatterplot can also reveal the distribution trends. It should be used when there are many different data points, and you want to highlight similarities in the data set. It is also useful for identifying outliers.

When building a scatterplot, include another variable using a different symbol size, shape or color to incorporate more data. Start the Y axis at 0 to represent data accurately. If you

Scatterplot Chart



add trend lines, use a maximum of two to make your plot easy to understand. Label the dependent axis.

Pie Graph — Pie charts or pie graphs are best used when you are trying to compare parts of a whole. They are often overused and many can be difficult to interpret. They do not show changes over time. Only use them for a percentage breakdown in cases in which each slice represents a percentage of 100

Pie Charts

percent. Alternative charts that can be used to show parts of the whole are stacked bar charts, tree maps and area charts.

Avoid illustrating too many categories to ensure differentiation between your pie slices. Avoid using a pie chart if it has more than five slices, and never make it "3D." Three-dimensional effects reduce comprehension and make it difficult to compare and judge areas. Ensure the slice values add up to 100 percent and order the slices according to their size for readability.

Safety Data Analysis and Making Conclusions

Be careful with averages — the mean, median or mode. Often, showing only the mean average will hide or misrepresent overall distribution. Avoid basing conclusions on small sample sizes or when using a very narrow or controlled data set. A good way of testing your sample is to check the statistical significance of findings. In any experiment or observation that involves drawing a sample from a population, there is always the possibility that an observed effect would have occurred due to sampling error alone. But if your finding is statistically significant, an analyst may conclude that the effect reflects the characteristics of the whole population.

Beware of unchecked extrapolation (that is, assuming that a trend based on a small set of data will continue in the future). Avoid generalizing findings when comparing elements that are, by their nature, scale and context, very different (comparing apples and oranges). For example, avoid comparing small samples with large samples, and then expecting them to behave the same way. Avoid basing conclusions on data that are irrelevant. Avoid confirmation bias, which is the tendency to interpret information in a way that confirms one's pre-existing beliefs or hypotheses, while giving disproportionately less consideration to alternative possibilities.

Be aware that a *correlation* alone is not enough to prove *causation.* Causation is often confused with correlation, which merely indicates the extent to which two variables tend to increase or decrease in parallel. Correlation by itself does not imply causation. There may be a third factor, for example, that is responsible for the fluctuations in both variables. One example would be that, as ice cream sales increase, so do drownings. Ice cream sales do not cause drownings, but a third factor — warm summer weather — increases both ice cream sales (because people want to enjoy eating a cold treat) and people's tendency to cool off by swimming. Remember:

- Correlation could hint at actual causation: A causes B.
- Correlation could be reverse causation: Windmills do not cause wind, although they are correlated.
- Correlation could be common-cause causation: Ice cream sales and drownings are correlated, but a common cause (warm summer months) increases both.
- Correlation could be indirect causation: A causes C, and C causes B.
- Correlation may be a coincidence: If you look for patterns in random samples, you can find something.

Finally, validate your findings. Don't assume your findings are correct. Use additional tests, or other measures, to help confirm your findings to ensure they are correct.

Create a Plan for Success

The following items are a starting point or checklist when you are creating a plan for successful safety data analysis:

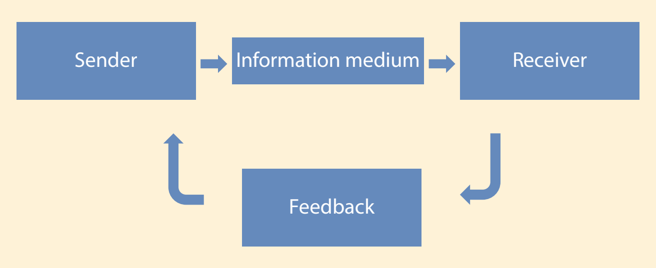
- ☐ Develop a strict and complete process to prepare safety data for analysis. Prevent data irregularities or redundant information from affecting key safety analysis inputs and outputs (see "Optimization and Management of Safety Data," p. 12).
- ☐ Educate employees on the benefits and limitations of individual data sources. This can serve as a safeguard to common data analysis issues (such as confusing causation with correlation) (see "Optimization and Management of Safety Data," p. 12).
- ☐ Establish an internal process to train employees how to create a cause-and-effect diagram. This includes facilitator and participant roles, responsibilities and expectations, and key outputs (see "Architecture of Cause-and-Effect Diagrams," p. 13).
- ☐ Develop customized SMS severity, probability and risk classification scales. These scales should be compliant with ICAO guidance while addressing the specific needs of your organization (see "Quantitative Risk Assessment," p. 16).
- ☐ Develop a standardized risk register template that can be used by the various lines of business within your organization. Provide templates with an operation-specific example (see "Documenting Your Risks and Top Safety Issues," p. 17).
- ☐ Implement and regularly check the status of safety performance indicators that are meaningful and an accurate representation of your operational safety priorities (see "Safety Performance Indicators," p. 21).

Information Sharing

GSIP Level 1 intensity includes sharing or exchanges of your high-priority safety information with organizations that are directly impacted by your data collection and analysis findings. This toolkit describes information-sharing best practices that promote increased safety program engagement. We also cover techniques to improve the effectiveness and integrity of your organization's SDCPS.

The examples provided in this toolkit focus on commercial aviation; however, the underlying approaches can be tailored to address your specific operational needs.

Figure 7 — Communication Model



General Information Sharing: Best Practices and Recommendations

The effectiveness and integrity of your safety program is dependent on the consistent engagement of all employees. This includes frontline employees (such as air traffic controllers and pilots), operations support employees (such as aircraft mechanics and airport operations employees), supervisors and managers, executives, and other relevant stakeholders.

At Level 1 intensity, we focus primarily on the exchange of safety information within a single organization (such as flight operations or maintenance) with the intent to increase safety program participation, safety data quality and operational performance. This toolkit provides various information sharing methods and techniques so that employees understand the effectiveness of their organization's data collection mechanisms (such as VSRP participation levels), the results of their organization's data analysis efforts (for example, the relationship between voluntary employee safety reports and an organization's top priority risks), and their organization's plan to integrate and use its safety program data (including storage of data, use of analysis results, relationship between safety program data and daily operations).

To build employee trust in your organization's safety program, effective communication is critical. If a safety program poorly conveys or inadequately shares high priority safety information, these problems can quickly result in the erosion of employee confidence in the program. Examples of good communication are presentation of focused information, use of employee inputs to reflect safety program information, the engagement of the correct audience, the use of clear media to communicate high priority information, and praise for employee participation in the safety program.

Examples of poor communication are presentation of irrelevant information (such as emphasizing outlying data points from analyses rather than the statistically significant findings), lack of clarity in safety data (for example, use of overly complex materials to convey simple points), the engagement of the wrong audience (for example, an airport authority would not take interest in an ANSP's airprox rates) and the use of safety program information solely for the purpose of being critical or negative when describing human performance.

The following sections detail specific techniques and best practices to effectively share high priority safety information within your organization.

Table 20 — Information Sharing Matrix at Level 1 Intensity

GSIP Toolkit Matrix	Level 1	Level 2	Level 3	Level 4
Information Sharing	Information sharing of performance results is performed within an organization (for example, within one organization).	Information sharing of performance and key areas of linked performance is comprehensive within an organization.	Information sharing is across the industry for key risks and mitigations. Generally, this is through presenting detailed independent investigative work in the data (for example, airline to airline, ANSP to airline).	TBD

ANSP = air navigation service provider; TBD = to be determined

Building Safety Teams and Work Groups

Safety teams are a valuable component of your organization's overall safety program. They encourage employee engagement and bottom-up awareness of top priority issues. Safety teams also are an effective mechanism to exchange safety information within an organization. These teams typically include representatives from each of an organization's major lines of business (such as flight operations, maintenance and ground operations). We expect them to meet on a regular basis. During their meetings, team members often discuss their organization's general safety performance and current safety concerns. These needs are identified through all the SDCPS sources (such as public safety information, reportable occurrence data and safety program information).

At Level 1 intensity, we expect safety teams to focus on development and monitoring of their organization's key objectives and top priority risks. We also expect safety teams to serve as a forum for brainstorming (for example, imagining where new audits or investigations might be needed to supersede existing policies and procedures). Safety teams also review the status of existing risk mitigations.

Airline Example — Large airlines may create a safety team for each operational unit. Each of the units may have a different set of safety metrics, safety performance indicators and priorities. The common objective among these teams is making measurable safety improvements to achieve their operational safety performance targets. Team members, individually and as a group, discuss new hazards, review the effectiveness of mitigations in reducing risk, and seek insights into regulatory compliance and safety culture.

As your organization grows in size and complexity, you also may find safety work groups beneficial. Work groups assist in addressing safety needs at the local facility or operations level. For example, ANSPs may establish safety work groups at individual facilities. Airlines may establish these work groups for each line of business (for example, flight operations, maintenance, ground services and dispatch). As these work groups are formed, they often monitor whether specific performance metrics or SPIs are being achieved. Typically, each work group will have a designated representative who is responsible for communicating the status of these metrics or SPIs to management, and possibly to senior leadership.

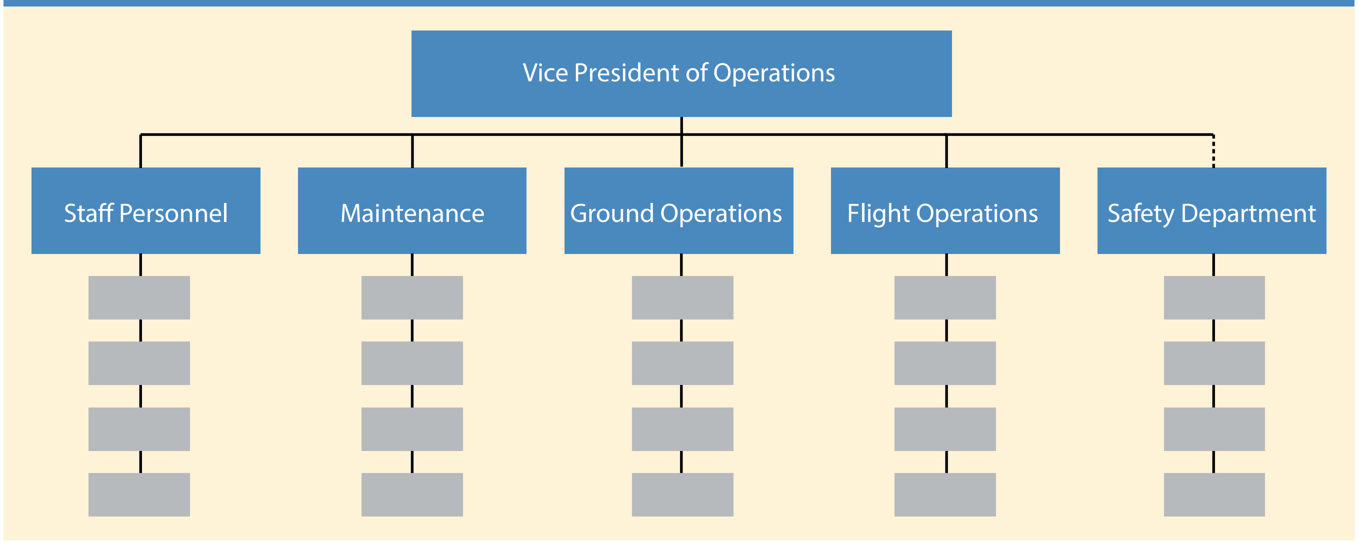
Information-sharing at Level 1 intensity tends focus on exchange of safety information within a single organization (either through safety teams or safety work groups). Higher levels of SDCPS intensity focus on the exchange of information with additional stakeholders.

Coordination With Senior Leadership

It is important that senior leadership establish and share a strategic safety vision that promotes increased safety program participation by all employees. This vision may be shared through regularly scheduled meetings, engagement with an organization's safety team, or other direct modes of communication. While working toward this vision, it is important that senior leadership recognize safety program accomplishments, provide feedback based on significant safety program findings, and consistently uphold safety program accountability.

To build bottom-up safety program credibility and employee trust, top-level safety managers should regularly engage with

Figure 8 — Sample Airline Organizational Chart by Lines of Business



senior leadership. And likewise, a healthy organization will have employees engaging with their top level managers on safety. During these engagements, top-level safety managers should inform senior leadership of their safety program's ongoing status. This status report includes what safety program metrics they are using, the status of their safety performance objectives, and the names of the designated person(s) who are accountable and/or responsible for their achievement. Depending on the size and needs of an organization, the interval (such as, monthly, quarterly) and format (such as, formal presentations with slides, email exchange with a written report attached) of these engagements may vary. For example, large organizations may require safety programs to engage with senior leadership on a quarterly basis. This could permit larger organizations to implement various course corrections and/or measurable changes over time. On the other hand, smaller organizations may engage with senior leadership more frequently. These engagements might be completed alongside other performance reviews due to their frequency.

Voluntary Safety Reporting Programs

The success of a VSRP relies heavily on employee buy-in and consistent employee participation. To increase the use and bottom-up support of a VSRP, it is essential to provide employees with feedback that promotes engagement throughout all SDCPS activities, including data collection, data analysis and the applied use of safety program data in day-to-day operations.

Best Practices for VSRP Information Sharing — Level 1 Intensity

Provide Feedback to Individual Employees. Successful communication is a two-way street. In other words, employees who submit safety reports should receive direct and timely feedback regarding their reports. Feedback should be delivered with respect, without bias and with clear communication. While individual programs may have different feedback approaches (for example, confirmation that a report was received, a notice that risk assessment is in-process, or a notification when a report is closed), the common goal is to ensure a strong safety culture through open communication and employee engagement. When providing feedback, it is recommended to do the following:

- Acknowledge the successful receipt of a safety report (verbally, through a website or portal).
- Provide employees with an updated status of their safety report (for example, review in-progress, additional information needed, report closed). This will increase employee confidence in the system.
- Educate submitters on the quality and completeness of their safety report to refine future report quality.
- Describe the positive contributions that a submitter's safety report made to a VSRP (for example, if the report identified an emerging safety issue). While not all reports lead to changes in processes or procedures, they can still be rich in information.
- As a part of the report closing process, provide a submitter with the corrective actions that will be further explored to address the safety need described in his or her report, explaining any caveats such as necessary approvals and processes that could affect the ultimate decision to implement various corrective actions. Depending upon the size of an organization, this may be through an automated process or through one-on-one verbal communication.

Provide Constructive Feedback about Safety Report Quality to Employees. Programs are encouraged to provide constructive feedback to employees regarding the depth, consistency and usability of their safety report(s). To encourage future reporting and the quality of those reports, one-on-one feedback is extremely valuable. The following is an example of how report quality can impact potential analyses and corrective actions.

Pilot Submits a Vague Safety Report: A pilot submits a safety report that states, "Better taxiway signage is needed at this airport." While this report is valuable, it is not actionable due to the lack of clarity and detail.

Pilot Submits a Detailed Safety Report: A pilot submits a safety report that states, "Mandatory signage near Runway 36 at the (specific} airport was obstructed by tall grass." This report is extremely valuable because it is clear and specific. This report can easily be assigned to the correct department for corrective action.

Provide Feedback to All Employees Within an Affected Organization. To increase employee participation and VSRP buy-in, it is important to provide aggregate feedback to all employees within an affected organization. This feedback could be delivered through a variety of mediums (team meetings, safety memos, online web portals, newsletters, etc.) and should occur over regularly scheduled time intervals (monthly, quarterly and annually). When providing group feedback, the following activities are recommended:

- Provide periodic VSRP summaries (monthly, quarterly, annually) that detail things like key issues, levels of participation, significant outcomes, corrective actions or long-term trends.

Table 21 — SPI Status Example

Risk Area	Example Safety Performance Indicator	Example Performance	Status/Comments
CFIT	1.0 MSAW alerts per month	1.1 per month	SPI metric not achieved. Reviewing data from recent events to understand the cause.
LOC-I	1.0 number of approach to stall events per month (stick shaker activation)	1.9 per month	Exceeding the SPI metric. Reviewing employee inputs on how to improve this performance.
Runway Safety	1.0 runway incursions per 10,000 flight operations.	3.5 per 10,000	SPI metric not achieved. Reviewing causal factors and implementing corrective actions.
NMAC	1.0 airprox events per 100,000 flight operations.	2.1 per 100,000	SPI metric not achieved. Reviewing data from recent events to understand the cause and develop corrective actions.

CFIT = controlled flight into terrain; LOC-I = loss of control–in flight; MSAW = minimum safe altitude warning; NMAC = near-midair collision; SPI = safety performance indicator

- Convey the status of the VSRP's health and integrity (detail the number of reports received, number of open/in-progress reports, closed reports, etc.).
- Contextualize VSRP findings so that employees understand the applied value of VSRP participation.
- Describe how an organization's VSRP has impacted or changed daily operations (for example, in training, rest requirements).
- Report the progress on achieving organizational SPIs or metrics.

  Flight Safety Foundation believes that an organization's SPIs and current SPI status should be directly communicated with all employees. When providing an SPI status, an organization should include the risk area (for context), the SPI target, the organization's current performance, and actions that are under way to improve performance and/or close any potential performance gaps. In some organizations, this can be communicated with a simple chart or even verbally during regularly scheduled safety meetings. (See Table 21 for an example.)

Create a Plan for Success

The following items can be used as a starting point or checklist when creating a plan for successful information sharing:

- ☐ Educate employees through memos or other training materials on effective communication best practices. Effective communication is critical to building employee trust in your safety program (see "General Information Sharing: Best Practices and Recommendations," p. 26).
- ☐ Establish safety teams from each line of business to encourage employee participation in safety program objectives (see "Building Safety Teams and Work Groups," p. 27).
- ☐ Develop safety work groups to address local safety needs or risks. These work groups are an effective mechanism to develop bottom-up safety solutions (see "Building Safety Teams and Work Groups," p. 27).
- ☐ Develop a high-level schedule that promotes the regular engagement of top-level safety managers and senior leadership. This schedule can add a layer of top-down safety program accountability (see "Coordination With Senior Leadership," p. 27).
- ☐ Establish a plan to provide individual and groups of employees with constructive feedback on voluntary safety reports. This will assist in demonstrating the value of their inputs to your VSRP (see "Voluntary Safety Reporting Programs," p. 28).
- ☐ Consider including your regulator in safety program meetings or updates to give them insight into routine safety issues (General Best Practice).

Information Protection

Level 1 intensity focuses on the key policies, laws and internal company policies necessary for effective protection and sustained use of this information while ensuring the trust of the participants in the voluntary programs.

Standards and Recommended Practices on the Legal Protection of Safety Information

Main Concepts: ICAO Annex 19, *Safety Management*, includes discussion of principles of safety information protection, principles of exception to such protection, guidance for public disclosure, responsibilities of persons who have safety information, and the protection of recorded information. ICAO Annex 13, *Aircraft Accident and Incident Investigation*, requires the de-identification of investigation records and limits use for purposes other than safety.

Laws, Regulations and Policies to Protect Voluntarily Reported Safety Information

Main Concepts: Mechanisms — including laws, regulations and policies — that protect voluntarily reported safety data and safety information in the aviation industry at both the organizational and state levels rely on the use of a balancing test that takes into account safety versus the need for the proper administration of justice. The protection would not extend to acts that violate state criminal laws or demonstrate a serious disregard for safety.

Example: Safety reports are a good source of hazard information to use in a safety program within any aviation-related entity. At the company level, if employers want to encourage the voluntary disclosure of safety data by employees who are in the best position to identify safety threats, then policies and procedures should be developed and implemented, including SMS. Together, these programs may result in the suspension of operations if the compliance issue is related to:

- Airworthiness directives;
- Performance/life limitations; and,
- Any threat indicating an unsafe condition in current operations.

SMS should incorporate voluntary safety reporting programs within the company as well as company self-disclosures to the regulator. These complementary levels of reporting ensure that potential safety risks are shared and addressed within the industry and the appropriate civil aviation authorities, and that applicable safety assurance monitoring is conducted of implemented corrective actions.

Example: Regulators in various states have implemented laws, regulations and policies to allow notification of regulators when a discovery is made on noncompliance for the protection of a person reporting the information. These programs allow aviation stakeholders to conduct their own investigations and determine potential findings and root causes of safety threats, and to propose corrective actions to maintain and improve safety.

Protection of information through safety programs at the state level is successful in situations that include:

- A regulator or judicial officer protecting the use or disclosure of safety data or information collected through a safety program in enforcement proceedings against an individual or an organization; and,
- A regulator or judicial officer taking part in the safety mitigation discussion to address safety issues.

Table 22 — Information Protection Level 1 Intensity Matrix

GSIP Toolkit Matrix	Level 1	Level 2	Level 3	Level 4
Information Protection	Individuals and organizations are protected against disciplinary, civil, administrative and criminal proceedings, except in case of gross negligence, willful misconduct or criminal intent.	The protection extends to certain mandatory safety reporting systems. In Annex 13, the protection extends to final reports and investigation personnel.	Protection is formalized at the highest level between countries through memorandums of understanding or similar agreements.	TBD

TBD = to be determined

Protecting the Safety Data and Safety Information Within the Organization

Main concepts: De-identification mechanisms (names, dates, etc.) are key to protecting safety data and safety information.

Examples: When voluntary safety reports are collected, the data or information may need to be distributed for analysis and the identification of safety threats. De-identification will protect the reporter or the person related to the report, while allowing aviation stakeholders to assess and address potential safety issues. For example, de-identification could mean deleting personal information from a printed or copied report by using a marker, or printing only the relevant excerpts from a report through a template that is designed to omit certain fields.

The larger the organization, the more formal these protective methods may need to be. In large organizations, information can be passed easily from one group to another, and a recipient may not be aware of existing protection mechanisms within the organization. If the identifying information is not contained in a released copy, it is less likely that the information could be used against the individual.

In small organizations, the protection of safety reports may be more challenging. For example, efforts to restrict the release of identified risks and related information may be unreasonable with the close relationships between management and employees. Such circumstances require particular and special attention to the protection of safety data and information, as well as those persons sharing the information. Thus, those in charge of the organization's SMS, and specifically the reporting of safety information, must develop policies and training to raise awareness among employees of the need to protect persons that report safety data and safety information.

As mechanisms and systems become more sophisticated, technical solutions to de-identify safety reports and ensure protection through software and password-controlled methods may be developed.

Developing and Implementing Policies Within the Organization

Purpose: The purpose of developing policies within the organization is to achieve the highest level of commitment to safety and protection of individuals and organizations who report safety data and information.

Main concepts: Safety mechanisms to protect data and information within the organization may include:

- Developing safety policies to be implemented within the organization with the support of labor groups and management;
- Encouraging the de-identification of voluntary safety reports;
- Training accountable representatives to hold safety meetings on specific events; and,
- Implementing de-brief meetings with crewmembers submitting safety reports.

Other examples to encourage the reporting of safety data and information, while protecting the reporter, include:

- Safety posters and other regular means of communication to employees on opportunities for safety reporting; and,
- The publication of reported issues that led to corrective actions.

One method of implementing a safety program is a written policy to establish a voluntary reporting system for all employees. Appendix 2 to Annex 19 mandates organizations to "define its safety policies in accordance with international and national requirements." This includes indicating "which types of behaviors are unacceptable related to the service provider's aviation activities and [indicating] the circumstances under which disciplinary action would not apply." This means that persons who report safety data or information will be protected from disciplinary actions when carrying out their jobs in an acceptable manner.

Managers should be the first to implement the policy. Top level managers must remind their employees of the provisions of the policy and how it applies to current events within the organization. The managers' leading role in implementing the safety policies is key to building a trusting environment between managers and employees. This trusting environment is also called a *just culture*.

Most Annex 19 provisions are based on just culture principles. Some aviation organizations define just culture as "a culture in which frontline operators and others are not punished for actions, omissions or decisions taken by them which are commensurate with their experience and training, but where gross negligence, willful violations and destructive acts are not tolerated." If the organization's culture reflects the belief that all employees perform their duties to the highest standards of professionalism, this creates an environment of trust, and encourages the reporting of safety information to maintain or improve aviation safety. If the evidence points to a serious disregard for safety and actions that fall outside of acceptable behaviors, then employees should be held accountable.

The boundaries of acceptable and unacceptable behavior should be defined by the regulators and the companies. The regulator — through laws, regulations and policies — may adopt a specific language to define the boundaries of a behavior. Concurrently, aviation organizations should draw from these definitions to further explain and clarify the regulator's language, and adapt those definitions to their own culture and industry practices.

The decision to pursue disciplinary action remains with the supervisors, the regulator or the judicial officer implementing the language and principles of the state's or organization's rules or policies. Disciplinary actions generally include time off without compensation, loss of employment, restriction of duty or assignments, certificate action or a record in an employee's personnel file that may affect future career opportunities.

The Role of Labor Organizations

Main concepts: : Labor organizations or unions can play an important part in helping protect safety data and information through their participation in safety teams.

Examples: In many organizations throughout the world, labor associations are involved with supporting SMS. When a company creates a safety policy, the company may address the interests of the labor association that have been raised in previous company/union discussions. Both labor and management should support SMS, including the protection of safety data and information reported within the organization, as well as the implementation of policies to maintain the flow of safety reports and ensure the highest level of safety.

At times, it may be necessary to de-brief directly with a employee who has submitted a safety report to ensure all the information contained in a report is well understood. These briefings should be handled with great care, discretion and confidentiality to ensure a report is not used against an employee or the organization. The greater the protections in place, the greater the trust between the employers and employees.

Creating a Plan for Success

- ☐ At the state level, laws and regulations should facilitate voluntary reporting within companies and to the regulator, including protection of individuals and companies (see "Laws, Regulations and Policies to Protect Voluntarily Reported Safety Information," p. 30).
- ☐ A state-established balancing test should be used to determine whether the data and information should be protected for safety reasons or whether they may be used for the proper administration of justice (see "Laws, Regulations and Policies to Protect Voluntarily Reported Safety Information," p. 30).
- ☐ State policies should encourage the reporting of safety data and information from the company to the appropriate civil aviation authority (see "Laws, Regulations and Policies to Protect Voluntarily Reported Safety Information," p. 30).
- ☐ Acceptable and unacceptable behaviors by states and organizations should be defined and explained (see "Developing and Implementing Policies Within the Organization," p. 31).
- ☐ Internal company policies should encourage development of a just culture environment and highlight the need for voluntary safety reports from employees to identify safety hazards in daily operations as well as the need to protect the individuals who have submitted this safety information (see "Developing and Implementing Policies Within the Organization," p. 31).
- ☐ An efficient process should be in place to de-identify voluntary safety reports at the state and organization levels (see "Protecting the Safety Data and Safety Information Within the Organization," p. 31).
- ☐ Efforts should be made to ensure continued understanding of the importance of collecting data and information to identify safety threats but not to apportion blame or liability (see "Developing and Implementing Policies Within the Organization," p. 31).
- ☐ Labor organizations should be involved in the company's safety programs where labor agreements exist (see "The Role of Labor Organizations," p. 32).