FLIGHT SAFETY FOUNDATION

GLOBAL SAFETY INFORMATION PROJECT

GSIP Toolkits Introduction Notes

Level 1–Level 4 Intensity

DECEMBER 2017

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FLIGHT SAFETY FOUNDATION

Welcome

Welcome to Version 2 of Flight Safety Foundation's Global Safety Information Project (GSIP) toolkits.

If you are familiar with our GSIP work to date and our Version 1 toolkits, you will notice that this collection of toolkits offers enhanced explanations, tools and examples from front-line risk managers working in various aviation segments and operations.

If you haven't been exposed to GSIP, we hope this introduction will bring you up to speed. We point out key facts and advice from previous toolkits and direct you to other available resources. See our website Frequently Asked Questions page for some basic information on this project. We have included highlights of the toolkits' content, notes on additional resources, and a glossary of frequently used acronyms.

Commercial air transport has benefited the most from the advanced risk management we'll be discussing, but the information in our toolkits is applicable to business aviation, charter/on-demand carriers, helicopter operators, remotely piloted aircraft systems operators and other service providers.

These revisions contained in the Version 2 toolkits fulfill our commitment to disseminate the lessons we have learned from our research and stakeholder communication in the past three years. Expertise and funding obtained through Flight Safety Foundation's cooperative agreement with the U.S. Federal Aviation Administration (FAA) made our GSIP research, analysis and toolkit development possible.

Before discussing our toolkits, it would be helpful to address safety management systems (SMS). We expect that most safety professionals are aware of SMSs, which are required under International Civil Aviation Organization (ICAO) Annex 19, *Safety Management.*

ICAO's Annex 19 also calls for hazard identification processes that are reactive, proactive and predictive. It suggests that you should study what has happened and learn from your mistakes; that you should put controls in place to understand risky situations as they occur and take appropriate actions as situations warrant; and that you should try to plan and predict what could happen but hasn't yet.

There is a great deal of material available to help your organization develop and build a functioning, data-driven SMS. Using an SMS provides a methodology for nearly every stakeholder to become an active manager of its own safety. The overall system expects that your organization will "use data from its own operations" to guide itself to safer performance. The methodology is intended to be scalable to fit your business model and size of operation, and there is much room for creativity in applying an SMS to your organization.

But SMS does not always obtain optimum results. Within the large scale deployment of SMS and state safety programs (SSPs), there can be some limitations. We are concerned about issues that can affect continued progress in safety, such as lack of standardization and training for data analysts; duplication of effort within and between organizations; lack of coordination between parallel programs; limited protections for safety data and information; and insufficient development of programs that encourage open reporting of safety issues.

Despite these limitations, the Foundation believes that a performance-based process for safety improvement is necessary as the main accident prevention strategy in today's ultra-safe industry. The challenge is to collaborate on how the industry learns from so many independent risk managers and safety performance trackers. It will not be helpful for all industry stakeholders to "use their data" and come to conflicting conclusions on the actions to be taken.

Our GSIP research shows that industry and government want to continue to improve their safety performance. Organizations that have been examining data for hazards and risks for a long time are always pushing for better data, understanding the risks at a deeper level and suggesting how this understanding can be improved.

That's where our GSIP toolkits come into play. This spirit of pushing boundaries in the search for better performance is what drove us to want to make our Version 2 toolkits aspirational. We set our sights not only on today's best risk management practices, but also on which combination of efforts and collaboration between industry and government might produce the best outcomes for aviation safety.

Our toolkits are an attempt to begin to document some of the basic data sources used as industry-recognized safety performance measures and to discuss the typical methods being used in aviation risk management processes. Our toolkits also recognize the reactive, proactive and predictive nature of hazard identification.

GSIP Background

Why does Flight Safety Foundation feel confident that GSIP recommendations will be relevant to your situation? Our GSIP research efforts, backed by our 70-year history of improving aviation safety, show that aviation stakeholders experience diverse risks but share common risk-management aspirations.

We've interacted with a large number of aviation safety professionals who demonstrate a willingness to share safety knowledge and safety information.

We launched GSIP research in 2015, focusing on cities in the Asia-Pacific and Pan America regions — both of which have high volumes of commercial air transport traffic. Volunteer participants and advisers from these locations took part in surveys and discussions as focus group participants, workshop participants and, subsequently, contributors and commenters. Our Version 1 toolkits and other GSIP reports detail our research rationale, methodology, confidentiality agreement, the states involved, and the numbers and affiliations of participants.

Participants typically said they favor a high level of global standardization of safety data collection and processing system (SDCPS) practices. They also welcome interfaces with the parallel domain of aviation quality standards. Stakeholders want their organizations' SDCPSs to produce optimal and reliable analyses with robust quality assurance; for instance, standards equivalent to those of accident investigations.

Aviation service providers — such as airlines, aircraft maintenance and repair organizations, and air navigation service providers — and civil aviation authorities (CAAs) also favor rapid advancements in SDCPS. Some see no alternative. Sharing global and regional knowledge, operational outcomes of initiatives, and safety information must guide risk-mitigation processes, they say.

In summary, they realize SDCPS techniques will take us all closer to truly knowing how all aviation accidents occur — before they occur.

During 2017, Flight Safety Foundation received additional expert validation and continued discussing with stakeholders their best practices, methods and structures. We urge aviation organizations and individual safety professionals to internally and externally compare their safety performance indicators (SPIs) and safety performance targets (SPTs), following ICAO's guidance. Monitoring of selected SPIs is one of the high-priority GSIP recommendations.

One reason for nearly everyone's intense focus on risk data metrics is the close relationship of these metrics to the concept of an *undesired state*. An undesired aircraft state, for example, is a condition that — in the absence of an adequate response — may lead to an unwanted outcome. The unwanted outcome might be the triggering of a special warning to the flight crew, exceeding an operational limit or contributing to fatalities, injuries and/or damage in an accident.

In this context, our toolkits encourage a common taxonomy. Ideally, the efforts eventually will facilitate your consideration of any other stakeholder's SPIs, SPTs, bow-tie diagram–based analyses and other best practices.

Levels of Intensity

As we examine hazards in aviation, we make assessments about which types of events are likely to lead to specific accident categories and whether they could lead to fatalities. We know, for example, that runway excursions are less likely to cause fatalities than a loss of control–in flight. We know that some hazards are far less likely to lead to catastrophic events.

So, while we may want to strengthen our capability to defend against most hazards, there are times when we must choose between acceptable and unacceptable risks. Beyond this choice, the depth to which we understand the underlying causes and contributing factors may require additional focus on certain topics because of their relationship to fatal risks. Some hazards present themselves across many different accident categories, and knowing what these common hazards are could lead to solutions providing significantly improved overall performance. The depth and breadth of the effort need to be recognized in risk management. In some cases, knowing what your objective is for risk management may lead you to broader or deeper study.

This leads to the use of *Levels of Intensity* in our toolkits. Some problems are solved with simple data collection and a response, while others require more robust methods of data collection, analysis and information sharing in order to propose adequate solutions. We used the level of intensity to distinguish the common everyday approach to risk management from more extensive efforts.

GSIP introduced the term *intensity level* as a way to meet our risk objectives — and especially to self-assess and consider additional program features over time — by targeting improvements in SDCPS scope and sophistication of data collection and analysis. As your organization adopts higher level intensity features, data analysts will have increasingly comprehensive ways of mapping accident causality.

For some tools — such as bow-tie diagram–based analysis — our researchers have found fresh insights compatible with the idea of intensity levels. Such insights can help you to focus on SPIs, to perform better analysis, to standardize discussions of data, and to enhance your prospects for de-identified data exchange and/or safety information sharing.

At SDCPS Level 1 intensity, your SMS (if you are a service provider) or SSP (if you are a regulator) typically obtains quantitative data about accidents, serious incidents and reported operational hazards. You collect these limited types of risk data primarily to understand the most probable and significant threats your organization faces.

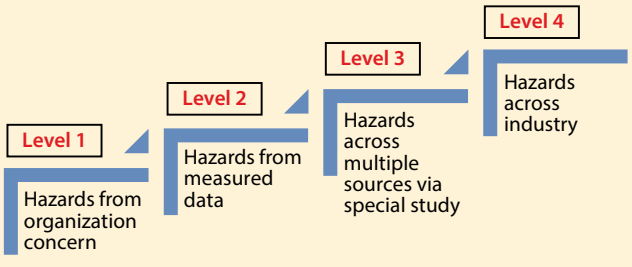
You also conduct qualitative analysis of employee voluntary safety reports. The scope of Level 1 intensity includes investigating special events per CAA criteria and generating data from auditing and maintenance/engineering checks and inspections.

At SDCPS Level 2 intensity, your SMS/SSP adds sources to focus on the main drivers of the events and seeks front-line reports of high interest. You add risk data to compare your organization's threats with well-known causes of accidents and hazardous aircraft states. Airlines, for example, use data analyses from flight data monitoring programs. Your analysts then combine multiple data streams to study correlations and causes of safety events.

At SDCPS Level 3 intensity, your SMS/SSP also performs "deep dives" into data that enable you to understand underlying factors. You also seek to understand your organization's most significant safety events in relation to probable causes and contributing factors.

These causes and factors — for example, specific distractions, fatigue, misunderstandings and uncommon disturbing effects — might be contributors to accidents. You would also collect and analyze broader data on causal factors and circumstances. This includes probing many different data streams to thoroughly understand causation and the linkages in a chain of events that could lead to an undesired aircraft state and, if recovery actions fail, to an unwanted outcome.

Figure 1 — Focus of Hazard Identification Within Each Level of Intensity



We think there is a Level 4 intensity, but have left that level undefined for now.

Possibilities for Level 4 Content

Often, the organizations that have been practicing deeper levels of risk management ask themselves if they are really working on the highest priority risks or if there is something they could understand better by looking across the entire industry and gathering knowledge from a larger pool of information. Some countries and parts of the industry are trying to put together these processes to consolidate all the safety reporting systems and flight data management systems, combined with public safety information and mandatory reporting systems, to make sense of the data across many operators and organizations.

We have purposely left out the details of anything in Level 4 of these toolkits. We think it takes more time and collaborative effort to gather the characteristics of these kinds of mega-systems and joint efforts. There are only a few examples worldwide.

One is the FAA's Aviation Safety Analysis and Information System (ASIAS), which combines the employee reporting systems from its aviation safety action program (ASAP), several carriers' flight operational quality assurance (FOQA) programs and many forms of data and information from the FAA's systems, including the radar and threaded track information that make up the U.S. air navigation provider operational data.

In time, there will be more efforts like this, and we believe some may be produced without a heavy IT infrastructure. If this is true, we think it may be worthwhile to describe the next level of our toolkits in some way that defines methods to produce a much more integrated approach to hazard identification and study for risks at an international level. For now, keep that in mind as we seek future input from industry stakeholders.

Our Body of Knowledge

The GSIP webpages <flightsafety.org/gsip/> link you to resources to obtain practical information and to communicate with peers and other stakeholders. (The Version 1 toolkits on the website also note the absence of certain resources that participants urgently need.)

Think of the Version 2 collection of GSIP toolkits as a structure of aviation risk management methods as practiced today. Flight Safety Foundation especially welcomes contributions to the GSIP web pages of de-identified examples that illustrate key points of the concepts we discuss for everyone's benefit.

How you've set up SDCPS structures and documented outcomes of risk-mitigation initiatives would be extremely valuable for us to know. We'd also appreciate any feedback about our other content.

Tell us, for example, which GSIP intensity level best characterizes your risk-mitigation activities and why; your predominant SDCPS tools, methods and techniques; your definitions of terms; your specific efforts in external information sharing; and what aspects of information protection you find unsettling.

We're also trying to curate data-visualization examples of ways that safety event data, rates and correlations between one data stream and others enhance your comprehension and inspire replication of these techniques.

Your fellow stakeholders worldwide will appreciate the chance to learn from your experiences and opinions. Rest assured that as we use your feedback, we will follow confidentiality standards recommended by the FAA and Flight Safety Foundation on vetting materials and protecting your privacy.

Version 2 Highlights

As noted, any of the GSIP toolkits in our Version 2 collection could match your organization's intensity of SDCPS activities for key situations. Before you make this selection, take cues from the following highlights and scan each new toolkit's table of contents.

The *GSIP Level 1 Intensity Toolkit* offers a full breakdown and explanation of basic safety data sources with examples. They include mandatory occurrence/event reporting (like reports to your CAA), your company's operational reporting, your company's internal audits, external (third-party) audits, employee voluntary disclosure safety reporting programs, internal special-investigation safety reports, audit data, employee safety surveys, public safety information, and internal and external safety assurance program reports.

This toolkit also contains advice about building and preserving the trust of your people in safety data collection systems, the systems' quality and integrity, and how they are perceived and used. Featured planning methods are to create a data-collection map of your capabilities, to introduce the root cause–analysis tool and to use Kasuo Ishikawa's cause-and-effect diagram, also known as a "fishbone" diagram.

Other methods cited are baseline analysis, frequency-based assessments of safety events, ICAO's safety risk probability scale, a risk matrix and a risk register. Information sharing at this level most often refers to 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.

The *GSIP Level 2 Intensity Toolkit* offers an enhanced briefing on the bow-tie model and the causal factors checklist. Its data collection section highlights ways to collect outcome-based data from automated/system-based data sources (such as flight data monitoring and air traffic control radar data). The data analysis section tells why stakeholders often limit themselves to identifying only the primary causal factors of a safety event or risk.

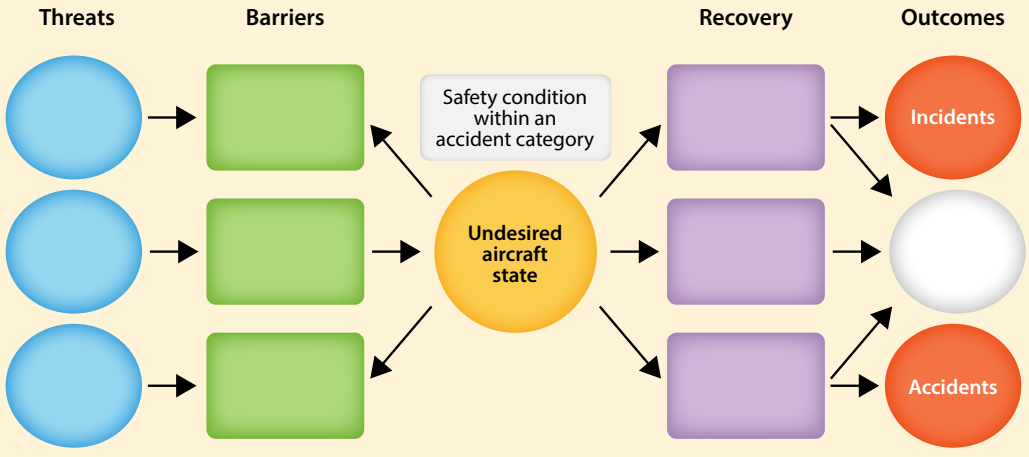
There are exceptions, however, such as when a data collection prompt (or trigger) creates the need for more safety data to pinpoint probable causes and contributing factors for an event. Data storage systems and error-checking procedures become significantly more prominent and critical here than at Level 1 intensity.

High volumes of data and new data types at this level drive the use of sophisticated technologies and demand strong protections of data integrity and accuracy. Organizations at this level often perform trend analysis with data-visualization methods or statistical methods. Visual trend analysis typically involves plotting data points in software and examining their dispersion.

Our Version 2 toolkits also provide new insights into SIP. For example, the *GSIP Level 2 Intensity Toolkit* emphasizes several aviation-relevant issues, including legal measures called *advance arrangements*. These are ICAO-recommended laws, agreements, policies and practices designed to enhance your protection, increase your confidence in reporting systems and encourage you to continue sharing safety information through voluntary programs. Advance arrangements and advance inter-agency arrangements ensure that safety information will not be used for purposes other than safety.

Another measure calls for helping to implement ICAO's newly recommended policies and practices that extend your existing protection. For example, states can extend accident

Figure 2 — Bow-tie Analysis of Safety Issues



information protection through inter-state cooperation, protecting you from certain uses of the content of final reports of accidents, accident data and findings generated by transportation accident investigation authorities. These arrangements also can protect safety information that is shared within the government, including with agencies whose primary function (for example, the function of administration of justice) is not aviation safety.

Extending existing protection of employee voluntary safety reporting systems to CAAs' mandatory occurrence reporting systems also now warrants attention as a major international issue. Certain information may have to be disclosed because of 'freedom of information' and/or other laws. This may result in safety information being used for reasons other than aviation safety.

The *GSIP Level 3 Intensity Toolkit* offers methods that assume you have sufficiently high volumes of data for advanced bow-tie models, which are introduced here for the first time in a GSIP toolkit. For a given undesired state, these data sources can provide comprehensive insights disseminated through software dashboards, case studies, safety newsletters, charts, tables and comprehensive computer-generated visualizations of analytical results.

Combining a contributory-factors checklist with a causal-factors checklist helps you contextualize and focus your safety investigators' preliminary questions about how a safety event occurred. Many analysts, however, face unrealistic expectations of high analytical granularity. This expectation can push them into overextending their capability to perform deep dives into safety data to access fine details of every imaginable undesired aircraft state. While immensely valuable in theory, using that capability often is inadvisable.

A primary objective of safety management at this intensity level is to create a process for continual SPI refinement. Advanced data analyses would help you apply detailed risk data and insights to precisely adjust your SPI metrics and targets. The contributory factors data and advanced bow-tie model analyses also support effective SDCPS action plans.

Getting more complex on the data collected, analyzed and shared brings on bigger challenges in protecting the data. This may be because of acute sensitivity to any suggestion or hint of inadequate protection of voluntarily submitted safety information. Organizations at this intensity level are likely to delve into qualitative data about individual human performance, so even internal information sharing raises difficult new communication challenges.

Additional Toolkit Notes

Our Version 1 toolkits grouped data sources for elementary risk mitigation into three categories: *public safety information, reportable occurrences* and *safety program information.* The first toolkits outlined the data collection, data analysis, information sharing and information protection activities within the industry, and included a brief discussion on how the levels of intensity were perceived.

In Version 2 of our toolkits, we provide much more content on the risk management steps and methods for each level of intensity. Instead of separate documents on data collection, data analysis, information sharing and information protection, the new toolkits are broken down by intensity level covering each of the SDCPS activities within each level.

It should be noted that once an organization follows the contents through the increasing levels of intensity and collaborative suggestions at Level 3 and greater sharing is realized, safety information protection takes on increased importance. Very few organizations can operate with a broad level of sharing without some assurances that the sharing of safety information will not lead to an undesired effect on the organization.

Flight Safety Foundation encourages strong SMS processes as your first step in data collection and data analysis. Next, information sharing is a critical complementary addition for evolving a highly effective SDCPS. Sharing gives you a broader perspective on risk, especially in detecting hazards that may not be visible in your normal data streams. Many stakeholders have told us they attribute successful SPIs, or enhancing their SPIs, to recent initiatives in safety information sharing. Some of the benefits of information sharing include benchmarking SPI status with similar organizations and operations; pooling data with others for structured analysis; conducting a structured information exchange of risk data with other organizations; sharing data analysis techniques and results; and publishing lessons learned from the outcomes of mitigation efforts.

If you already conduct risk management at Level 3 or beyond, you're undoubtedly aware these intensity levels are possible only under strict safety information protection agreements with equally strict governance and operating policies for all parties. We're not implying that safety information protection is of less consequence if you conduct risk management at Level 1 intensity or Level 2 intensity. The need for this protection is universal. If you compare the Version 2 toolkits, however, the reality of the need to escalate protection activity is clear.

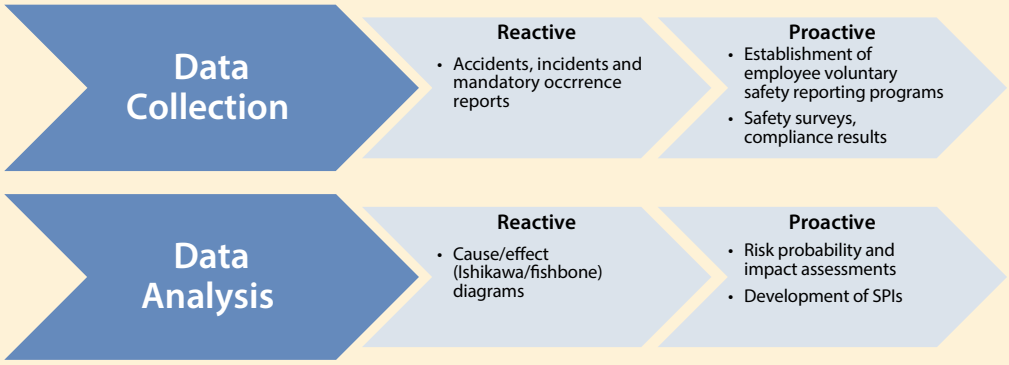
Mapping Reactive, Proactive, Predictive Toolkits

In addition to covering our toolkits by a level of intensity, we have also attempted to include methods to conduct reactive, proactive and predictive methods of data collection and analysis. The following figures (3, 4 [p. 9] and 5 [p. 9]) provide an easy reference to places where these methods are spelled out within each level of intensity.

Information Protection

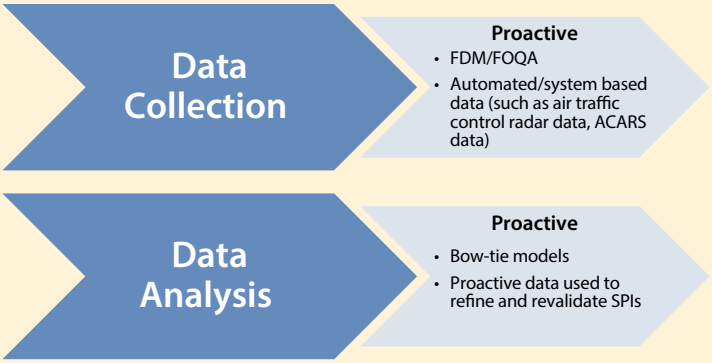
The ICAO term *safety information protection* (SIP) implies having a formal process that supports your SDCPS. Our overriding recommendation continues to be consistent across all intensity levels: "Ensure you remain aware of the latest ICAO standards and recommended practices (SARPs) for SIP." The Information Protection sections of our toolkit are targeted for a slightly different audience than the other sections. The audience for our safety collection, safety analysis and information sharing are aimed at safety risk managers and top level safety leadership within service providers or regulators. Yet, when it comes to Information protection the recommendations shift

Figure 3 — GSIP Level One Intensity



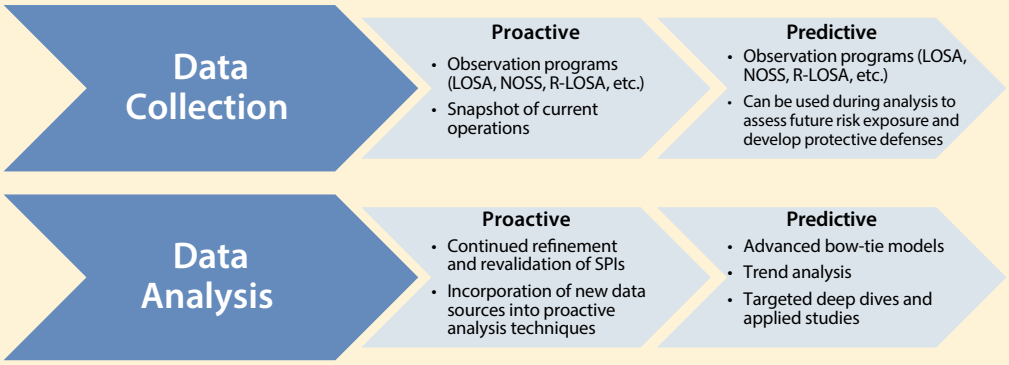
SPI = safety performance indicator

Figure 4 — GSIP Level Two Intensity



ACARS = aircraft communications addressing and reporting system; FDM = flight data management; FOQA = flight operational quality assurance; SPI = safety performance indicator

Figure 5 — GSIP Level Three Intensity



LOSA = line operations safety audit; NOSS = normal operations safety survey; R-LOSA = ramp LOSA; SPI = safety performance indicator

more towards the safety leadership and the regulators that eventually carry out the ICAO SIP protections.

ICAO's existing and upcoming SARPs provide principles of protection and principles of exception. The SARPs also require stakeholders to protect against the public disclosure of safety information; to have a competent authority that balances the interests of safety and the need for the proper administration of justice; and to apply appropriate safeguards to ensure safety information is protected.

Flight Safety Foundation strongly recommends that you regard the protection of safety data and safety information as critical to ensuring that this safety information continues to be reported and remains available to your SDCPS.

Our Version 1 SIP toolkit also outlined a long-term plan for producing SIP training modules, educational assistance on SIP issues to various stakeholder groups (such as guides for handling sensitive data, model regulations and legislation) and an architecture to communicate changes.

The Foundation's Legal Advisory Committee still anticipates sharing case studies of best practices. Examples are effective de-identification of safety data, routine non-disclosure agreements used by aviation service providers and summaries of information for public presentations with awareness of potential legal implications. Another is reinforcing commitments by individuals to securely handle any information that identifies people.

Glossary

AAIB	U.K. Air Accidents Investigation Branch
ACARS	aircraft communications addressing and reporting system
ADREP	ICAO Accident/Incident Data Reporting System
ALA	approach and landing accident
ANSP	air navigation service provider
ASAP	aviation safety action program
ASIAS	FAA Aviation Safety Information Analysis and Sharing System
ASRS	NASA Aviation Safety Reporting System
ATB	air turn-back
ATC	air traffic control
ATCO	air traffic control officer
ATSAP	Air Traffic Safety Action Program
ATSB	Australian Transport Safety Bureau
BARS	Basic Aviation Risk Standard
BEA	French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile
CAA	civil aviation authority
CADORS	Transport Canada Civil Aviation Daily Occurrence Reporting System
CAHRS	South African CAA Confidential Aviation Hazard Reporting System
CASA	Civil Aviation Safety Authority of Australia
CEDAR	comprehensive electronic data analysis and reporting
CEO	chief executive officer
CFIT	controlled flight into terrain
CICTT	Commercial Aviation Safety Team/ICAO Common Taxonomy Team
CPS	Crown Prosecution Service
DIV	diversion
EGPWS	enhanced ground-proximity warning system
EU	European Union
FAA	U.S. Federal Aviation Administration
FARs	U.S. Federal Aviation Regulations
FDAP	flight data analysis program
FDAU	flight data acquisition unit
FDM	flight data monitoring
FDR	flight data recorder
FMEA	failure mode and effects analysis
FOD	foreign object damage
FOQA	flight operational quality assurance
FRMS	fatigue risk management system
GNE	gross navigation error
GPWS	ground-proximity warning system
GSIP	Global Safety Information Project
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFR	instrument flight rules
IFSD	in-flight shutdown
ILS	instrument landing system
IOSA	IATA Operational Safety Audit
IS-BAO	International Standard for Business Aircraft Operations
LHD	large height deviation
LOC-I	loss of control–in flight
LOSA	line operations safety audit/assessment
MCA	minimum controllable airspeed
MEL/CDL	minimum equipment list/configuration deviation list
M-LOSA	maintenance LOSA
MOR	mandatory occurrence reporting
MOU	memorandum of understanding
MSAW	minimum safe altitude warning
MTCD	medium-term conflict detection
NASA	U.S. National Aeronautics and Space Administration
NMAC	near-midair collision
NOSS	normal operations safety survey
NOTAM	notice to airmen
NTSB	U.S. National Transportation Safety Board
PDC	pre-departure clearance
QA	quality assurance
QAR	quick access recorder
QC	quality control
RA	resolution advisory
R-LOSA	ramp LOSA
RNAV	area navigation
RTO	rejected takeoff
SDCPS	safety data collection and processing system
SDR	service difficulty report
SID	standard instrument departure
SIP	safety information protection
SMS	safety management system
SOP	standard operating procedure
SPI	safety performance indicator
STAR	standard terminal arrival
TBD	to be determined
TCAS	traffic-alert and collision avoidance system
TEM	threat and error management
TOGA	takeoff/go-around
T-SAP	Technical Operations Safety Action Program
TSI	Transport Safety Investigation Act
USOAP	Universal Safety Oversight Audit Programme
V_{MC}	minimum control speed with critical engine inoperative
V_{REF}	reference landing speed
VFR	visual flight rules
VP	vice president
VSRP	voluntary safety reporting program