International Civil Aviation Organization (ICAO)

Regional Aviation Safety Group
(Asia & Pacific Regions)

Asia Pacific Regional Aviation Safety Team

FLIGHT CREW PROFICIENCY

developed by

DCA Malaysia, Malaysia Airlines and AAPA

Executive Summary

ICAO has identified loss of control in flight (LOC-I) as one of three high-risk accident occurrence categories. The utilization of Flight Data Analysis (FDA) as part of the Safety Management System (SMS) allows for a predictive approach to identification of potential risks of events leading to LOC-I. This is achieved through trend analysis of the data captured from safety reports and flight data monitoring. The outcome of this analysis would necessarily be incorporated in the specific flight crew training program to enhance crew proficiency in managing the related threat.

The purpose of this guidance material as the combined outputs of SEI LOC/2 and SEI LOC/4 is to provide air operators guidance on the integration of SMS processes for hazard identification and risk management with operational decision making in utilizing safety trend information to address LOC-I events through performance based training, and guidance for regulators in assessing air operators' utilization of safety trend information in the development and implementation of performance based flight crew training.

Version 1 dated May 2017

Preamble

Background on Regional Aviation Safety Group – Asia & Pacific (RASG – APAC)

The Regional Aviation Safety Group Asia-Pacific (RASG-APAC) was established in 2011 by the Council of ICAO. The RASG-APAC is tasked with improving aviation safety in the Asia & Pacific regions by developing and implementing a work programme, in line with the ICAO Global Aviation Safety Plan, aimed at identifying and implementing safety initiatives to address known safety hazards and deficiencies in the region.

The Asia Pacific Regional Aviation Safety Team (APRAST), a sub-group of the RASG-APAC, assists the RASG-APAC in its work by recommending safety interventions which will reduce aviation safety risks.

The full commitment and active participation of APAC States/Administrations and the industry partners is fundamental to the success of the RASG-APAC in reducing aviation safety risks and accident rates in the Asia and Pacific regions.

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FLIGHT CREW PROFICIENCY

INTRODUCTION

The purpose of this guidance material as the combined outputs of SEI LOC/2 and SEI LOC/4 is to provide air operators guidance on the integration of SMS processes for hazard identification and risk management with operational decision making in utilizing safety trend information to address LOC-I events through performance based training, and guidance for regulators in assessing air operators' utilization of safety trend information in the development and implementation of performance based flight crew training.

BACKGROUND OF SAFETY ENHANCEMENT INITIATIVE (SEI)

Loss of control in flight is the leading cause of jet fatalities worldwide. Aside from their frequency of occurrence, accidents resulting from loss of aircraft control seize the public's attention by yielding a large number of fatalities in a single event. International Civil Aviation Organization (ICAO) has identified LOC-I as one of three high-risk accident occurrence categories. LOC-I accidents represents only 3 percent of all accidents in 2015, but 33 percent of fatal accidents, according ICAO statistics. In response to the rising threat to aviation safety, Aviation Safety Programs are regulated for implementation.

IATA LOC-I accident investigation and analysis conducted between 2010 and 2014 concluded that the trigger that very often initiates LOC-I accidents sequence is an external factor, predominantly meteorological or potentially traffic related in the form of wake turbulence. Human performance deficiencies, including improper, inadequate or absent training, automation and flight mode confusion, distraction, the 'startle' factor and loss of situational awareness frequently compounded the initial upset and precluded an effective recovery until it was too late.

Causal factors that contribute to loss of control are segregated into three categories:

a) Pilot or human induced;
b) Environmentally induced; and
c) Systems induced.

(refer to Appendix 2 for expanded list of causal and contributory factors to LOC-I event)

The analysis found that pilots often missed or ignored readily available indications that could have alerted them to an impending upset or LOC-I event. These included icing conditions, flight control system malfunctions and turbulence. Ultimately, the failure to recognize these precursors to loss of control led to inadvertent or in some cases even deliberate pilot-induced upsets and LOC-I accidents.

Hence, there is a clear need to enhance flight crew proficiency in preventing LOC-I events by incorporating into their training program any identifiable gaps or deficiencies, based on trend monitoring of aggregate information available from FDA and other SMS parameters.

Since the establishment of Flight Data Analysis Program (FDAP) as part of SMS from 1 January 2005, various initiatives were undertaken to leverage on the potential capabilities of this program. This includes creating a safety database generated from FDA reports and

performing appropriate trend analysis to identify any potential or emerging risks to the safety of flight operations in general. Apart from FDAP, other safety reports from hazard reporting program, air, ground incident reports, audits and reports from other safety related function can be used for the same purpose.

A survey was conducted among Asia Pacific air operators and regulators in 2014 to gauge the extent of implementation and effectiveness of the flight data analysis among the individual air operators. Survey response from 38 participants were collated and presented during the APRAST/4 meeting held in Manila in 2014. The result from the survey draws attention to the need to further expand the scope of implementation among the air operators and regulators within this region.

This guidance material is aimed at utilizing trend information from SMS, such as FDAP, Safety Reports, Audits, and other non-punitive safety reporting program in enhancing the flight crew training curriculum (recurrent and type-rating training), aimed at mitigating safety risks, incidents or accidents related to LOC-I. This is also aligned with the current shift in regulatory oversight across the globe, from a prescriptive to performance based approach. Customized flight crew training and qualification program based on the air operator's individual performance, with appropriate level of regulatory oversight, are essential in mitigating LOC-I related risks.

APPLICABILITY TO STATES / INDUSTRY

This guidance material proposes guidance for regulators and air operators to ensure that their policies, procedures and training reflect the methods and best practices described in this guidance material. The guidance material is outlined as follows:

Appendix 1: Survey on policies and practices among the Asia Pacific air operators in relation to establishment of "performance based" training curriculum utilizing lessons learned and Flight Data Monitoring (FDM) analysis.

Appendix 2: The causal and contributory factors to loss of control events.

Attachment A: Model Regulations in relation to mitigating LOC-I events utilizing aggregate and safety trend information.

Attachment B: Guidance for regulatory inspectors to utilize in assessing air operator utilization of their own aggregate and safety trend information in the development and utilization of performance based flight crew training.

Attachment C: Guidance for air operators in utilizing safety trend information to address LOC-I events through performance based training.

Consideration of the guidance proposed in this guidance material will be a positive contribution to flight safety.

SEI CONTENTS / PHASES

Broadly, the phases for this SEI project are as follows:

Output 1

Conduct a survey of Asia Pacific air operators on the policies and practices to establish and maintain "performance based" training curriculum utilizing lessons learned and FDM analysis.

Output 2

Based on results of Output 1, draft model regulations, guidance and checklists focusing on mitigating LOC-I events that utilize aggregate and safety trend information.

Output 3

Develop guidance materials for regulatory inspectors to utilize in assessing air operator utilization of their own aggregate and safety trend information in the development and utilization of performance-based flight crew training.

Output 4

Develop and provide guidance material to the region's air operators on performance based training in order to encourage movement toward recurrent training curricula that utilize each carriers aggregate and safety trend information from FDM, non-punitive reporting programs, or other sources within a company, as well as regionally produced safety information.

ACTION / COMMENTS BY RASG

The meeting is invited to approve the proposed guidance material as the combined outputs of both SEI LOC/2 and SEI LOC/4 on Flight Crew Proficiency.

APPENDIX 1

Survey on policies and practices among the Asia Pacific air operators in relation to establishment of "performance based" training curriculum utilizing lessons learned and FDM analysis.

Based on the survey conducted on 38 air operators in the Asia Pacific region, it was concluded that:

1. 100% of the respondents have an established flight data monitoring and analysis program in the form of Flight Operations Quality Assurance (FOQA), Air Safety Reports (ASR), or less frequently collected data such as Line Operations Safety Audit (LOSA), and other internal or external audits.
2. 64% of the respondents perform data analysis specific to LOC-I events.
3. From the 64% of respondents, approximately 70% incorporated the outcome from their data analysis into their flight crew training programs.
4. 79% have the training program documented in Part D of their Operations Manual (Training Manual).

77% of the respondents indicated that their respective regulators have not promulgated regulations requiring emphasis on LOC-I performance based training, while 85% noted that no guidance materials were issued by the State with regards to the same.

Conclusion

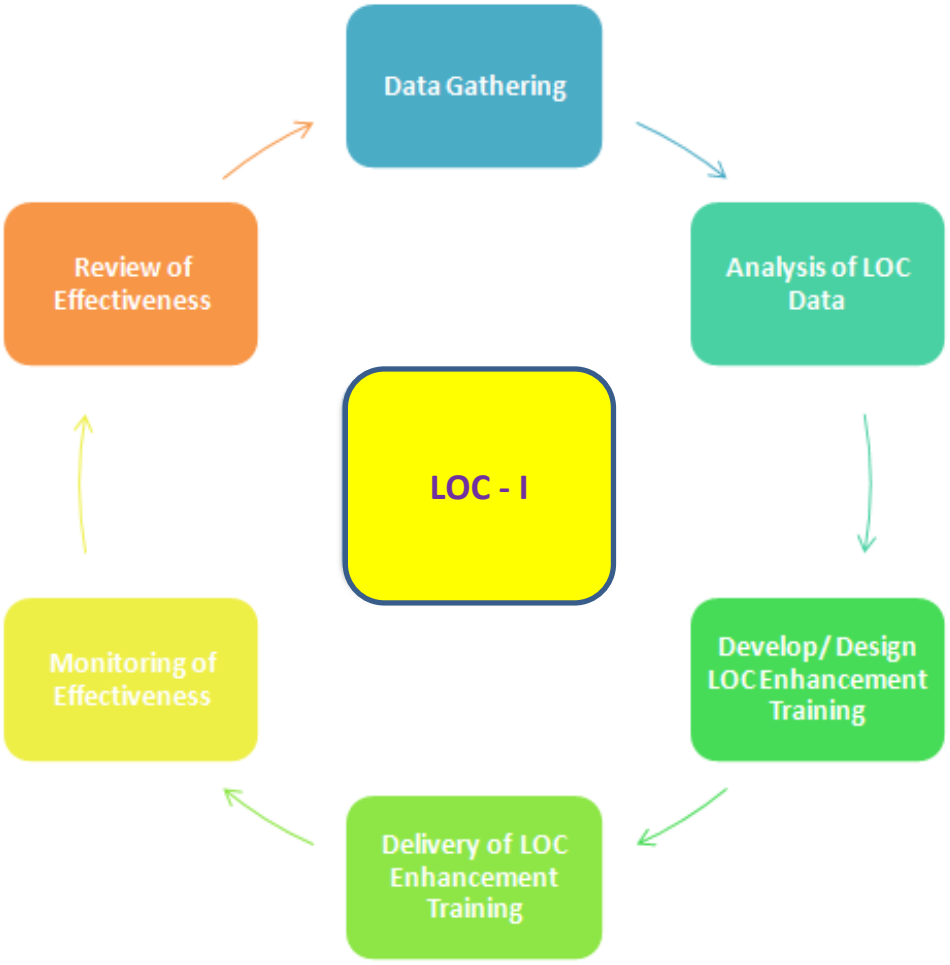
From the survey results, it is evident that 36% of respondents do not perform data analysis specific to LOC-I events, despite having established respective Flight Data Monitoring program. It is also found that 7 out of 38 air operators that were surveyed indicated that they do not have a performance based training program incorporated in Part D of their Operations Manual. A large number of operators surveyed indicated that their regulator's participation in promoting this safety enhancement initiative had been relatively low.

This number is estimated to rise further in the coming years with air traffic projected to double in the next 15 years. (ICAO Global Aviation Safety Plan 2014-2016).

Hence, there is a need to address the current and emerging safety risks proactively to ensure that this significant capacity expansion is carefully managed and supported through strategic regulatory and infrastructure development.

Whilst the major focus of ICAO and State Regulators remain on compliance monitoring, a different approach in delivering continuous improvement in aviation safety is needed. This can be achieved through a performance based approach to training and qualification, be it in the oversight function of regulators, as well as compliance responsibility of operators, with the use of safety trend monitoring and analysis devices such as Flight Data Analysis (FDA), Air Safety Report, LOSA program, internal and external safety audit findings and other related means of establishing a trend data.

The proposed LOC-I flight crew training implementation plan is illustrated below:



APPENDIX 2

The causal and contributory factors to loss of control events with reference to individaul categories are illustrated in the following. The list is not in the order of risk priority.

1. **Pilot or human-induced:**

    a. Improper training
    b. Poor energy management
    c. Changing pilot skill base
    d. Spatial disorientation
    e. Poor pilot awareness
    f. Distraction
    g. Automation confusion or mode confusion
    h. Automation and human factors
    i. Improper procedure
    j. System integration issues (complexity, interdependencies and lack of standard interfaces)
    k. Pilot actions leading to destabilized approaches
    l. Faulty loading or shifting of cargo
    m. Incompetence

2. **Environmentally-induced**

    a. Weather (turbulence, icing, adverse winds, wind shear)
    b. Wake vortices
    c. Hail leading to loss of control (engine performance)
    d. Visibility degradation
    e. Foreign object damage (hail, bird strike, volcanic ash)

3. **Systems-induced**

    a. Poor design
    b. Poor energy management (systems-induced)
    c. Propulsion related (asymmetric thrust, energy management)
    d. Erroneous sensor data
    e. Air traffic operations leading to destabilized approaches
    f. Loss of control power, authority, or effectiveness
    g. Aircraft system failures (non-propulsion and propulsion)
    h. Faults or failures or damage of or to any or all of the aircraft control effectors
    i. Pilot-induced oscillation (PIO)

Model Regulations in relation to mitigating LOC-I events utilizing aggregate and safety trend information

1. REFERENCE

a) ICAO Annex 19, Safety Management, 1st Edition, June 2013
b) ICAO Doc 9859, Safety Management Manual, Third Edition, 2013
c) IOSA Standards Manual, Edition 10 Revision 1, September 2016
d) IATA Loss of Control In-Flight Accident Analysis Report, 2010-2014, 1st Edition

2. DEFINITION

Acceptable Level of Safety Performance (ALoSP). The minimum level of safety performance of civil aviation in a State, as defined in its State safety program, or of a service provider, as defined in its safety management system, expressed in terms of safety performance targets and safety performance indicators.

Flight Data Analysis Program (FDAP). A process of analyzing recorded flight data in order to improve safety of flight operations. (ICAO annex 6 – Operations of aircraft)

Loss of Control-Inflight (LOC-I). The definition of LOC-I as stated in the IATA Safety Report is “Loss of Aircraft Control While In-Flight”. This includes events such as aerodynamic stalls and upset following failures of aircraft systems.

Loss of control in-flight is an extreme manifestation of a deviation from intended flight path.
LOC-I accidents often result from failure to prevent or recover from stall and upset.
(Refer Appendix 2 for causal factors to LOC-I)

Operator means a person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Risk Mitigation. The process of incorporating defenses or preventive controls to lower the severity and/or likelihood or a hazard’s projected consequence.

Safety Management System (SMS). A systematic approach to managing safety, including necessary organizational structures, accountabilities, policies, and procedures.

Safety Performance. A State’s or service provider’s safety achievement as defined by its safety performance target and safety performance indicators.

Safety Performance Indicator (SPI). A data-based safety parameter used for monitoring and assessing safety performance.

Safety Performance Target (SPT). Define the required level of safety performance of a system.

Safety Risk. The predicted probability and severity of the consequence or outcome of a hazard.

The following Model Regulations are intended to provide reference to the implementation of performance based oversight in addressing LOC-I events using FDAP and other safety trend data information.

(i) Operators should ensure that their training and qualification processes utilize trend information from Flight Data Analysis (FDA), Safety Reports, LOSA, internal audits, and other safety performance monitoring tools prescribed under SMS, to mitigate the risk of a LOC-I incident.

(ii) The Operator should have processes for setting performance measurement as a means to monitor the operational safety performance of the organization and to validate the effectiveness of safety risk controls.

(iii) The operator should establish a program to identify and monitor events leading to LOC-I with the aim of developing specific Safety Performance Indicator (SPI) and its corresponding Safety Performance Target (SPT). These elements should be used in the development of a performance based training program to address LOC-I.

(iv) The operator should establish a safety performance working group to provide an on-going monitoring and periodic review of the LOC-I Safety Performance Indicator (SPI) and Safety Performance Target (SPT).

(v) The selection and effectiveness of the LOC-I Safety Performance Indicator (SPI) and its corresponding Safety Performance Target (SPT) remain the responsibility of the operator, with concurrence from the regulatory authority.

(vi) The effectiveness of the flight crew proficiency training using data derived from FDAP and other safety performance monitoring tools related to SMS should be periodically reviewed by the operator, and subjected to periodic regulatory oversight.

Guidance for regulatory inspectors to utilize in assessing air operator utilization of their own aggregate and safety trend information in the development and utilization of performance based flight crew training

CONTENTS Page

1. INTRODUCTION

This document was written to provide background information and guidance material for Regulatory Inspector that intends to develop and establish an assessment program to enable oversight on Air Operators in relation to managing their own aggregate and safety trend information in the context of implementing a performance-based flight crew training, aimed at mitigating LOC-I events. This assessment program must be applied consistently across the Air Operators.

2. BACKGROUND

Performance based oversight.

Performance based oversight has gained significant momentum with the worldwide implementation of State Safety Program and Safety Management System. This in turn encouraged Regulator and Air Operators alike to move towards complementing the existing prescriptive approach to safety with performance based oversight using data as a basis of achieving safety assurance.

In a conventional compliance-based regulatory environment, approach to safety management is relatively rigid and prescriptive, where safety regulations are used as administrative control. Within this context, the regulatory framework is supported by inspections and audits to assure regulatory compliance. Compliance based safety oversight was the predominant characteristics of safety regulation from the early days of aviation and it is still valid, particularly for small organization, or when the regulatory environment is not fully matured. However, in large organizations or regulatory environment that has reached the level of maturity, further safety improvements cannot be achieved by following a purely compliance-based approach. Hence, a shift from a reactive compliance based approach to a proactive and performance based oversight is necessary to ensure an adequate level of safety across the highly regulated industry.

In a performance based environment, certain performance-based elements are introduced within a prescriptive framework. In addition to being fully compliant with the applicable regulations and safety requirements, this new proactive model of performance based oversight ensures that specific lead indicators or precursor to incidents or accidents are continuously monitored, measured and managed to an acceptable level of safety performance. Consequently, the Air Operator would benefit not only from the having a good safety record, and but also have the opportunity to possibly earn “credit points” from their own Authority. This enables “compliance” aspect of a regulation to be more flexible, risk–based and dynamic, while providing greater visibility in the achievement of the required safety performance.

3. SCOPE

The scope of this document is to provide guiding principal to Regulators in providing effective oversight on Air Operators of aeroplanes of a maximum certified take-off mass in excess of 27,000 kg, in the development, implementation and management of an effective performance based training utilizing safety trend information to address LOC-I events.

4. REFERENCE

a) ICAO Annex 19, Safety Management, 1st Edition, June 2013
b) ICAO Doc 9859, Safety Management Manual, Third Edition, 2013
c) IOSA Standards Manual, Edition 10 Revision 1, September 2016
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Safety Performance Indicator (SPI). A data-based safety parameter used for monitoring and assessing safety performance.

Safety Performance Target (SPT). Define the required level of safety performance of a system.

Safety Risk. The predicted probability and severity of the consequence or outcome of a hazard.

6. APPLICABLE REGULATIONS (Model Regulations)

These regulations shall apply to all operators of aeroplanes of a maximum certified take-off mass in excess of 27,000kg.

(i) Operators should ensure that their training and qualification processes utilize trend information from Flight Data Analysis (FDA), Safety Reports, LOSA, internal audits, and other safety performance monitoring tools prescribed under SMS, to mitigate the risk of a LOC-I incident.

(ii) The Operator should have processes for setting performance measurement as a means to monitor the operational safety performance of the organization and to validate the effectiveness of safety risk controls.

(iii) The operator should establish a program to identify and monitor events leading to LOC-I with the aim of developing specific Safety Performance Indicator (SPI) and its corresponding Safety Performance Target (SPT). These elements should be used in the development of a performance based training program to address LOC-I.

(iv) The operator should establish a safety performance working group to provide an on-going monitoring and periodic review of the LOC-I Safety Performance Indicator (SPI) and Safety Performance Target (SPT).

(v) The selection and effectiveness of the LOC-I Safety Performance Indicator (SPI) and its corresponding Safety Performance Target (SPT) remain the responsibility of the operator, with concurrence from the regulatory authority.

(vi) The effectiveness of the flight crew proficiency training using data derived from FDAP and other safety performance monitoring tools related to SMS should be periodically reviewed by the operator, and subjected to periodic regulatory oversight.

7. IMPLEMENTATION

7.1 STEP 1 – Development of policy and regulatory framework relating to enforcement of performance based oversight.

The Civil Aviation Authority is responsible for safety regulation and oversight of the civil aviation industry within the respective state. In achieving this, the state need to establish a framework which is, wherever practicable, consistent and compliant with ICAO Annexes. Model Regulation outlined in section 6 of this document prescribed the requirement consistent with the policy and propose set forth to further enhance safety management throughout the aviation system.

Define and establish the safety management responsibilities and accountabilities of the respective regulatory organization, including a State aviation safety coordination platform and the applicable documentation. This will ensure that the safety policy, safety indicators, enforcement policy, safety data collection, analysis and exchange, safety performance monitoring and oversight are carried out in an integrated and coordinated manner.

7.2 STEP 2 - Provide appropriate training to the inspectors in relation to requirements for performance based training in addressing LOC-I and conduct of oversight function.

One of the major challenges for regulators involve adapting to the shift from prescriptive to performance based regulatory oversight. This would likely require new technical and non-technical knowledge and skill set of the inspectors in order to effectively analyze and determine the acceptability of the operator's performance, based on the set targets. Training should include elements of performance based training program, familiarization with available FDA reports, identification of Safety Performance Indicators (SPI) which are essentially precursors to LOC-I events, and the related Safety Performance Targets (SPT) that are appropriate for the individual operators.

7.3 STEP 3 - Encourage consistent engagement and collaboration with operators to develop and enforce an effective performance based training.

In this respect, the responsibility for overall aviation safety is shared between the regulator and the operator to a certain degree. The regulator shall endeavor to reach an agreement with the operators on SMS's short, medium and long-term objectives on safety performance. This includes evaluating and endorsing the outcome of the performance based training employed by the individual operator, while providing the guidance necessary to achieve the required target.

The performance based elements within an SSP/SMS framework include the process for safety performance monitoring and measurement at the air operator and State level. This element allows the organization to selects its own safety monitoring indicators and the setting of relevant alerts and targets that are pertinent to its own context, performance, history and expectations. There are no fixed (mandatory) prescribed safety indicators or alerts levels or prescribed values under this SSP/SMS expectation.

While the goal is to ensure that such assessment is consistently applied across all air operators, there are concerns regarding start-up operators which may not have any historical data, expertise or experience for the initial setup, and effective participation in the performance based training and flight crew proficiency. In such cases, the regulator may provide the necessary framework and guidelines, including list of typical safety indicators as well as industry or expected targets which commensurate with the type, size and scope of operation, or any other parameters suitable for the purpose of capturing safety lead indicators related LOC-I events.

7.4 STEP 4 – Monitor and assist in the development of SPI and setting of SPT by air operator.

Performance based safety management is dependent on having safety indicators that are monitored using basic quantitative data trending tools that can generate graphs and charts that incorporate alerts/targets. The safety indicators consist of high (accidents and serious incidents) and low consequence events as hazard reports, audits findings, FDA, safety observations and others. Low consequence events are sometimes termed 'proactive/predictive' indicators that are used to monitor and assess safety performance in relation to the high consequence (reactive) events. In this respect, the Safety Performance Indicators (SPI) of LOC-I can be developed based on the contributory factors to the LOC-I occurrence and their related safety risks.

SPTs which define long term safety performance objectives, are expressed in numerical terms (absolute or relative value) and must be concrete, measurable, acceptable, reliable, relevant and contain timeline (milestone) for completion. When setting the targets, consideration should be given into factors such as applicable level of safety risk, the cost and benefits attached to the expected safety improvement, and achievability of the set target, with reference to recent historical performance of that particular safety indicator, industry standards, regulatory requirement and expert opinion.

A corresponding alert level is identified for each SPI, quantifying the acceptable and unacceptable performance threshold during a specific monitoring period. The use of objective data-based criteria for setting alert levels is essential to facilitate consistent trending or benchmark analysis.

In general, the use of population standard deviation (STDEVP) provides a basic objective method for setting alert criteria, the method derives the standard deviation (SD) value based on the preceding historical data points of a given safety indicator. This SD value plus the average (mean) value of the historical data set forms the basic alert value for the next monitoring period. The SD principal (a basic MS Excel function) sets the alert level criteria based on the actual historical performance of the given indicator, including its volatility (data point fluctuations). Guidance on SPI, SPT and alert level setting using SD criteria is provided in ICAO Doc 9859 Safety Management Manual.

Sample of Safety Performance Indicator and Target:

Risk Ref	Safety Performance Indicator	Source	Target	YTD 2016 Performance	Rating	B/Threshold (1)	Threshold (2)	On Target (3)	Exceeding (4)	Outstanding (5)
A-02	**Loss OF Control In-Flight Risk**									
	Unstable Approach	FDA	4-6	10	1	>9	7-9	4-6	2-3	1
	Engine (Turbine/Turboprop) Failure	ASR	2-3	0	5	>5	4-5	2-3	1	0
	Flight Control Malfunction	ASR	2-3	1	4	>5	4-5	2-3	1	0
	Pressurization malfunction	ASR	2-3	2	3	>5	4-5	2-3	1	0
	Windshear	ASR	5-6	7	2	>8	7-8	5-6	3-4	<3

7.5 STEP 5 - Develop audit program to specifically monitor the implementation of performance based training in addressing LOC-I.

The audit program may be tailored to address individual operator's specific risks and priorities. The frequency of audits on performance based training with respect to LOC-I may vary between air operators depending on the level of safety performance exhibited by individual air operators.

7.6 STEP 6 - Monitor and assess the effectiveness of the data gathering, analysis and overall efficiency of the performance based training program.

This is the monitoring and measurement of safety performance and related processes through appropriate safety performance measures that continuously track system safety performance as necessary to determine whether an operator's system is truly operating in accordance with design expectations.

Targeting regulatory oversight on areas of greater concern or need in training, based on the data and performance report obtained. Focus must be on ensuring continuous improvement. A yearly review is recommended, however this may be adjusted based on the level of performance achieved by the Air Operators and the maturity of the program within the system.

7.7 STEP 7 - Verify that the safety performance achieved by the operator meets the agreed level of safety performance (ALoSP) as intended, with regard to flight crew proficiency in managing LOC-I.

An oversight on the program should be applied consistently across all air operators. Unlike auditing of prescriptive requirement which often ends with a pass/fail decision, the performance based process require the assessor to be aware of the context of the process/element within its overall regulatory framework as within the complexity of the audited organization. In this respect, it is crucial that an agreement is reached between the regulator and operator on the selected SPIs and SPTs to ensure effective implementation. Although this may vary considerably between different operators depending on the type and scope of operations, the inspectors however, should ensure that the outcome meets the acceptable level of safety performance (ALoSP) as established by the operator and agreed by the regulator. The outcome of the safety performance achieved by the operator in managing each of the SPI essentially reveals the efficacy of the training program in improving flight crew proficiency in LOC-I.

7.8 STEP 8 – Ensure periodic review of ALoSP is conducted by the Operators.

To ensure that the ALoSP safety indicators remain effective and appropriate over time, they need to be reviewed periodically to determine if any modifications or additions to the existing indicators, target or alerts are needed.

Refer Appendix B for the Data Integration and Safety Performance Enhancement Process flow chart.

Refer Appendix C for the Checklist for Implementation of Performance Based Methodology for Flight Crew Training Enhancement.

Appendix A

The causal and contributory factors to loss of control events with reference to individual categories are illustrated in the following. The list is not in the order of risk priority.

1. Pilot or human-induced

a. Improper training
b. Poor energy management
c. Changing pilot skill base
d. Spatial disorientation
e. Poor pilot awareness
f. Distraction
g. Automation confusion or mode confusion
h. Automation and human factors
i. Improper procedure
j. System integration issues (complexity, interdependencies and lack of standard interfaces)
k. Pilot actions leading to destabilized approaches
l. Faulty loading or shifting of cargo
m. Incompetence

2. Environmentally-induced

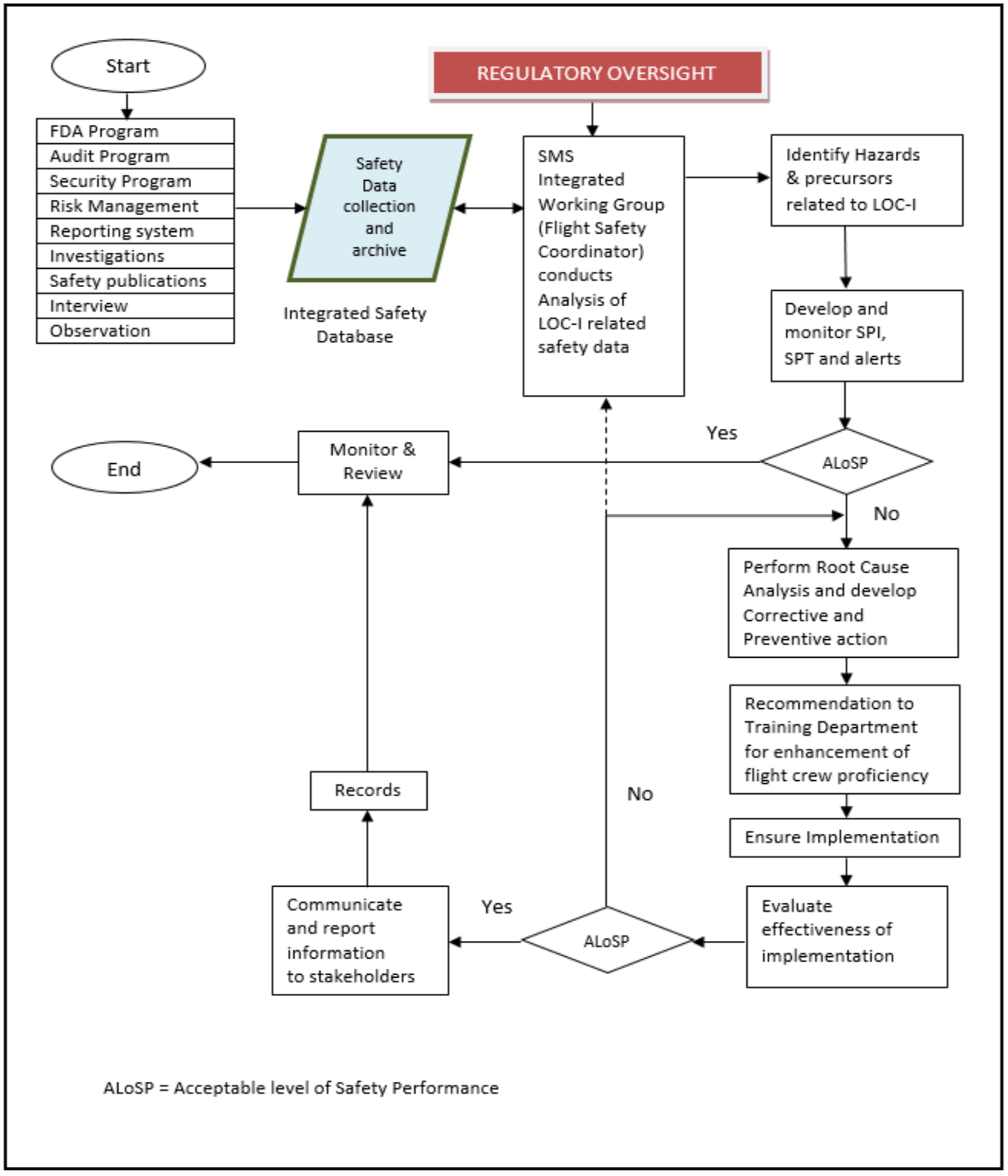
a. Weather (turbulence, icing, adverse winds, wind shear)
b. Wake vortices
c. Hail leading to loss of control (engine performance)
d. Visibility degradation
e. Foreign object damage (hail, bird strike, volcanic ash)

3. Systems-induced

a. Poor design
b. Poor energy management (systems-induced)
c. Propulsion related (asymmetric thrust, energy management)
d. Erroneous sensor data
e. Air traffic operations leading to destabilized approaches
f. Loss of control power, authority, or effectiveness
g. Aircraft system failures (non-propulsion and propulsion)
h. Faults or failures or damage of or to any or all of the aircraft control effectors
i. Pilot-induced oscillation (PIO)

Appendix B

Data Integration and Safety Performance Enhancement Process - SMS Working Group (headed by Flight Safety Coordinator)



Appendix C

Checklist for Implementation of Performance Based Methodology for Flight Crew Training Enhancement

Item	Question	Response	Reference	Remarks
1.1	Are there regulations in place with regard to establishment of performance based training relating to LOC-I events for the State?			
1.2	Are there specific regulations which provides a standardized operational procedures, equipment, and infrastructures (including safety management and training system), in conformance with the Standard and Recommended Practices (SAPRs) contained in the Annexes to the Convention on International Civil Aviation?			
1.3	Has the operator established the following safety programs:			
	a. Safety Management System			
	b. Flight Data Analysis			
	c. Open Reporting			
	d. Audit program			
	e. Flight Crew Training program			
	f. Flight Monitoring program			
	g. Engineering & Maintenance program			
	h. Communication and coordination program			
	i. Operating manual revision and updating processes and procedure			
	j. Cargo packing loading, weight and balance program/processes			
	k. Equipment reliability program			
	l. Weather monitoring and reporting system			
	m. Security program			
1.4	Does the organization have an integrated safety database? Alternate means of compliance include obtaining data from individual operational units.			
1.5	Are the participants in the safety working group:			
	a. Suitably qualified			
	b. Knowledgeable			
	c. Skilled			
	d. Experienced			
	e. Have attended the relevant training			

Item	Question	Response	Reference	Remarks
1.6	Does the organization have a process for data analysis?			
1.7	Is the safety working group independent of any management influence?			
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Guidance for air operators in utilizing safety trend information to address LOC-I events through performance based training

CONTENTS Page

1. INTRODUCTION

This document was written to provide background information and guidance material for Air Operators that intends to develop and establish performance based flight crew training program using their own aggregate and safety trend information, specifically with regard to mitigating LOC-I events.

2. BACKGROUND

Operators and Regulators alike are placing increased emphasis on performance-based methods and performance-based compliance to regulation. Such mechanisms allow for greater operational flexibility without degrading the safety performance of an operational activity. This presumption is primarily dependent on the presence of specific organizational and operational capabilities, the results of safety risk management activities and the determination of acceptable standards of safety performance.

In order to establish an effective performance-based methodology and performance-based compliance program to address risks, Operators must possess the requisite knowledge, skills, experience, processes including: resources and technologies necessary to implement and oversee the many systems and processes required to support performance-based compliance.

a) The development of policy and procedure.
b) The staffing of positions with an appropriate number of qualified personnel.
c) Training to the operator's policy and procedure and to ensure personnel remain competent and qualified.
d) Implementation or the demonstration of performance in accordance with policy and procedure.
e) Data reporting, measurement and analysis for the purpose of monitoring the effectiveness and efficiency of systems, processes, policies and/or procedures.
f) An adjustment component or subsystem to respond to any underperformance or deviation and for the purpose of continuous improvement.

3. OBJECTIVE AND SCOPE

This document is intended to provide guiding principal to Air Operators of aeroplanes with maximum certified take-off mass in excess of 27,000 kg, in the development, implementation and management of an effective performance based training utilizing safety trend information to address LOC-I events. The scope covers hazard identification and risk management in relation to LOC-I events, determination of Safety Performance Indicator and Targets, evaluation and monitoring of the training performance outcome.

4. REFERENCE

a) ICAO Annex 19, Safety Management, 1st Edition, June 2013
b) ICAO Doc 9859, Safety Management Manual, Third Edition, 2013
c) IOSA Standards Manual, Edition 10 Revision 1, September 2016
d) IATA Loss of Control In-Flight Accident Analysis Report, 2010-2014, 1st Edition

5. DEFINITION

Acceptable Level of Safety Performance (ALoSP). The minimum level of safety performance of civil aviation in a State, as defined in its State safety program, or of a service provider, as defined in its safety management system, expressed in terms of safety performance targets and safety performance indicators.

Flight Data Analysis Program (FDAP). A process of analyzing recorded flight data in order to improve safety of flight operations. (ICAO annex 6 – Operations of aircraft)

Loss of Control-Inflight (LOC-I). The definition of LOC-I as stated in the IATA Safety Report is "Loss of Aircraft Control While In-Flight". This includes events such as aerodynamic stalls and upset following failures of aircraft systems.

Loss of control in-flight is an extreme manifestation of a deviation from intended flight path. LOC-I accidents often result from failure to prevent or recover from stall and upset. (Refer Appendix A for causal factors to LOC-I)

Operator means a person, organization or enterprise engaged in or offering to engage in an aircraft operation.

Risk Mitigation. The process of incorporating defenses or preventive controls to lower the severity and/or likelihood or a hazard's projected consequence.

Safety Management System (SMS). A systematic approach to managing safety, including necessary organizational structures, accountabilities, policies, and procedures.

Safety Performance. A State's or service provider's safety achievement as defined by its safety performance target and safety performance indicators.

Safety Performance Indicator (SPI). A data-based safety parameter used for monitoring and assessing safety performance.

Safety Performance Target (SPT). Define the required level of safety performance of a system.

Safety Risk. The predicted probability and severity of the consequence or outcome of a hazard.

6. APPLICABLE REGUALTION (Model Regulation)

These regulations shall apply to all operators of aeroplanes of a maximum certified take-off mass in excess of 27,000kg.

(i) Operators should ensure that their training and qualification processes utilize trend information from Flight Data Analysis (FDA), Safety Reports, LOSA, internal audits, and other safety performance monitoring tools prescribed under SMS, to mitigate the risk of a LOC-I incident.

(ii) The Operator should have processes for setting performance measurement as a means to monitor the operational safety performance of the organization and to validate the effectiveness of safety risk controls.

(iii) The operator should establish a program to identify and monitor events leading to LOC-I with the aim of developing specific Safety Performance Indicator (SPI) and its corresponding Safety Performance Target (SPT). These elements should be used in the development of a performance based training program to address LOC-I.

(iv) The operator should establish a safety performance working group to provide an on-going monitoring and periodic review of the LOC-I Safety Performance Indicator (SPI) and Safety Performance Target (SPT).

(v) The selection and effectiveness of the LOC-I Safety Performance Indicator (SPI) and its corresponding Safety Performance Target (SPT) remain the responsibility of the operator, with concurrence from the regulatory authority.

(vi) The effectiveness of the flight crew proficiency training using data derived from FDAP and other safety performance monitoring tools related to SMS should be periodically reviewed by the operator, and subjected to periodic regulatory oversight.

7. IMPLEMENTATION

7.1 STEP 1: Develop policy and procedure in regard to effective implementation of performance based training.

Development of policy and procedures on the use of FDA and other non-punitive safety data for the purpose of enhancing flight crew proficiency should be carried out appropriately.

7.2 STEP 2: Ensure that the Safety practitioner responsible for the management of aggregate data for the purpose of providing performance based training information is adequately trained and qualified.

The operator shall set the criteria for selection of the personnel required to lead and manage the program.

The safety personnel should be trained with respect to analyzing data and providing recommendation for the training department, based on the information gathered from FDA and other aggregate safety reporting.

7.3 STEP 3: Gather data from all safety programs and audits with regard to LOC-I.

This can be achieved by having a systematic data acquisition and monitoring program established through Flight Data Monitoring (FDM), Air Safety Reports, Audit reports and other means of acquiring trend data, including the use of integrated safety database.

Integrated Safety Database

In addition to having a basic database to capture and archive safety information is essential for the conduct of safety performance analysis on LOC-I events, greater benefit can be realized by linking the existing safety database within the organization such as database for air safety reports, FDA, audit reports, investigation findings, etc., in order to provide integrated analysis of events or lead indicators to incidents or accidents.

This integration of all available sources of safety data provides the organization viable information on the overall safety health of the operation, including prevention of LOC-I events.

For example, failure to extend landing flaps during an approach may be captured by:

a. Air safety report submitted by the flight crew
b. FDA event captured
c. Engineering report

In this instance, the crew report provides the context, the FDA event provides the quantitative description, and the engineering report provides in depth technical information of the defect and the rectification performed.

Alternatively, safety information can be obtained from individual department and resources in the absence of an integrated safety database.

7.4 STEP 4: Develop flight safety analysis program focusing on identification of hazards related to LOC-I events.

A primary function of flight safety analysis program is hazard identification supported by data analysis capability, which is an element of Safety Risk Management component of SMS.

Hazard identification and risk management is a prerequisite to establishing a performance based training. Information gathered from safety database is evaluated to identify hazards and its associated risks related to LOC-I events, particularly those hazards that are deemed to be contributors factors to LOC-I incidents or accidents. Among the LOC-I indicators that are available from Flight Data Analysis Program (FDAP) include: high pitch rate, dual input, thrust asymmetry, excessive bank angle, early configuration change, flight control malfunction, windshear, and others.

Following identification of hazard, the next step is to perform a risk assessment for each of the hazards using a risk matrix in relation to the likelihood and severity of the consequence of the risk related. Typically, a 5 x 5 risk matrix is used (as shown below), although there are several variations that are available such as 4 x 4 and 3 x 3 matrix. The matrix selected will depend upon the size and complexity of the organization and the risks being assessed.

Likelihood \ Impact	Negligible	Minor	Moderate	Significant	Severe
Very Likely	Low Med	Medium	Med Hi	High	High
Likely	Low	Low Med	Medium	Med Hi	High
Possible	Low	Low Med	Medium	Med Hi	Med Hi
Unlikely	Low	Low Med	Low Med	Medium	Med Hi
Very Unlikely	Low	Low	Low Med	Medium	Medium

Diagram 1: Risk Matrix

Note: Information on the method of performing risk assessment is covered extensively in ICAO Document 9859.

Determination of the level of risk provides the air operator guidance with regard to the allocation of resources and the priority accorded to eliminate or mitigate the risks identified.

A mitigation is an action taken to reduce the risk of exposure to a hazard. Based on System Safety Science, once a hazard is identified the priority for addressing the hazard should be:

a. Hazard elimination (intrinsic safety)
b. Hazard reduction
c. Hazard control
d. Damage reduction

Hazard and risk management will require a pragmatic approach and will require conducting realistic or credible and plausible appraisals of the hazards and associated risks faced by the air operator's operational activities (See figure below). A common approach may be applied but the hazards, risks and mitigation may vary due to the operating equipment, type of operation, and operating environment including supporting infrastructure.

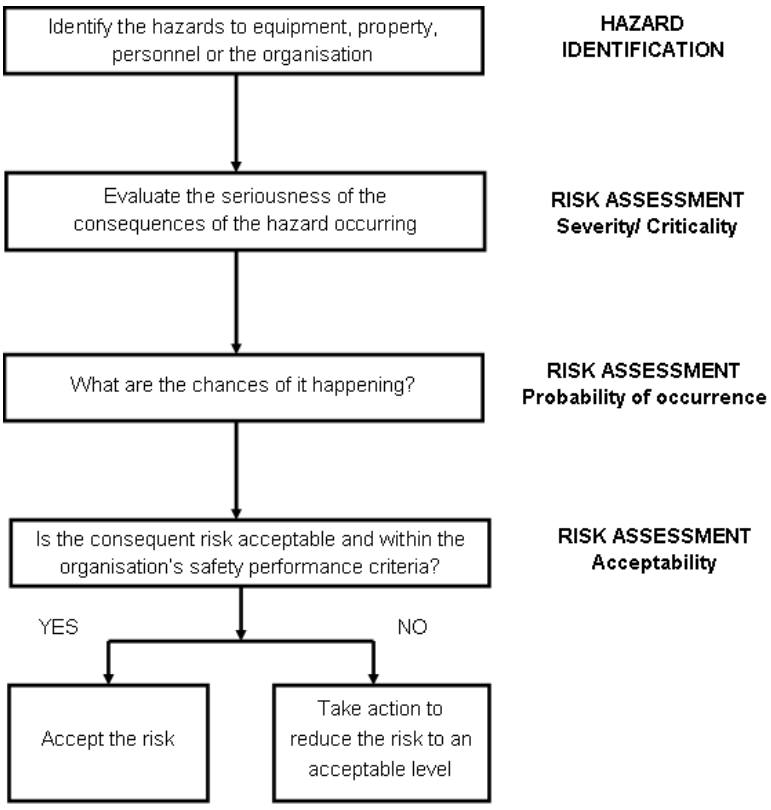


Diagram 2: Risk Assessment Process

For aircraft loss of control, hazard elimination is a desirable but difficult-to-reach goal, given the nature of performance demands in atmospheric flight. Thus, research should focus on hazard reduction, hazard control, and damage reduction.

Prevention of loss of control events are more important strategies when compared to recovery based mitigations, however, development of recovery-based mitigations are also required in order to ensure complete coverage when "breaking the chain" of events in a loss of control scenario.

Onboard systems that eliminate, or protect the aircraft from entering a loss of control scenario are most effective. Avoidance and detection of loss of control events should not be limited to real-time, onboard systems, but should include data mining of incident reports, accidents reports, and flight operations quality assurance data to identify trends and conditions that lead to loss of control so that the precursors may be eliminated or minimized. Continued diligence by operational, research, and regulatory organizations is required in order to improve aviation safety record.

Another technique commonly employed by air operators in risk assessment is the Bowtie methodology. It is described as a risk evaluation method that can be used to analyze and demonstrate causal relationships in high risk scenarios. Taking its name after the shape of diagram which looks like a man's bowtie, the methodology serves to provide a visual summary of all plausible accident scenarios that could exist around a certain hazard, while it identifies the control measures that are put in place to mitigate the consequence of the hazard. (See diagram below)

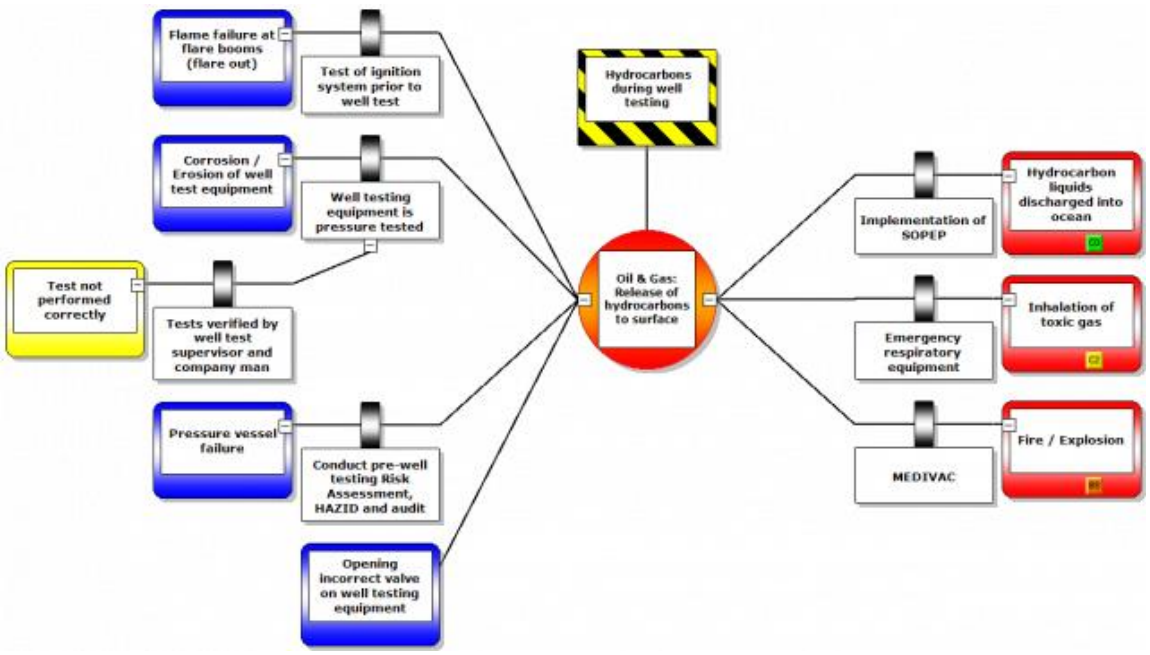


Diagram 3: Bow Tie Sample

The bowtie application may be integrated with organization's management system to provide an overview of the activities that keeps the control working and the persons responsible over the controls.

Ultimately, the risk management system established within the organization must be capable of identifying and addressing the current operational and systemic issues, as well as detecting any emerging risks that would affect safety of operations.

7.5 STEP 5: Development of Safety Performance Indicator (SPI) and setting of Safety Performance Target (SPT) by air operator.

Performance based safety management is dependent on having safety indicators that are monitored using basic quantitative data trending tools that can generate graphs and charts that incorporate alerts/targets. The safety indicators consist of high (accidents and serious incidents) and low consequence events as hazard reports, audits findings, FDA, safety observations and others. Low consequence events are sometimes termed 'proactive/predictive' indicators.

SPTs which define long term safety performance objectives, are expressed in numerical terms (absolute or relative value) and must be concrete, measurable, acceptable, reliable, relevant and contain timeline (milestone) for completion. When setting the targets, consideration should be given into factors such as applicable level of safety risk, the cost and benefits attached to the expected safety improvement, and achievability of the set target, with reference to recent historical performance of that particular safety indicator, industry standards, regulatory requirement as well as expert opinion.

A corresponding alert level is identified for each SPI, quantifying the acceptable and unacceptable performance threshold during a specific monitoring period. The use of objective data-based criteria for setting alert levels is essential to facilitate consistent trending or benchmark analysis.

In general, the use of population standard deviation (STDEVP) provides a basic objective method for setting alert criteria, the method derives the standard deviation (SD) value based on the preceding historical data points of a given safety indicator. This SD value plus the average (mean) value of the historical data set forms the basic alert value for the next monitoring period. The SD principal (a basic MS Excel function) sets the alert level criteria based on the actual historical performance of the given indicator, including its volatility (data point fluctuations). Guidance on SPI, SPT and alert level setting using SD criteria is provided in ICAO Doc 9859 Safety Management Manual.

Sample of Safety Performance Indicator and Target:

Risk Ref	Safety Performance Indicator	Source	Target	YTD 2016 Performance	Rating	B/Threshold (1)	Threshold (2)	On Target (3)	Exceeding (4)	Outstanding (5)
A-02	**Loss OF Control In-Fliight Risk**									
	Unstable Approach	FDA	4-6	10	1	>9	7-9	4-6	2-3	1
	Engine (Turbine/Turboprop) Failure	ASR	2-3	0	5	>5	4-5	2-3	1	0
	Flight Control Malfunction	ASR	2-3	1	4	>5	4-5	2-3	1	0
	Pressurization malfunction	ASR	2-3	2	3	>5	4-5	2-3	1	0
	Windshear	ASR	5-6	7	2	>8	7-8	5-6	3-4	<3

Diagram 4: Safety Performance Indicator and Target

7.6 STEP 6: Establish and maintain a flight data analysis program (FDAP) as part of its Safety Management System, in addition to maintaining an effective open reporting system.

A flight data analysis program shall be non-punitive and contain adequate safeguards to protect the source(s) of the data. In addition, having an open reporting initiatives supported by “Just Culture” principals, is aimed at identifying and managing potentials hazards and risks associated with on-going aviation activities. They serve as a useful tool to ensure sufficient information is available to make appropriate decisions and operational controls with regard to managing emerging safety threats. This is achieved by offering the ability to track and evaluate flight operations trends, identify risk precursors, and taking appropriate remedial action.

The parameters analyzed on FDA framework should reflect elements that could contribute towards of LOC-I event.

The de-identified data is processed in accordance with the flow chart shown below:

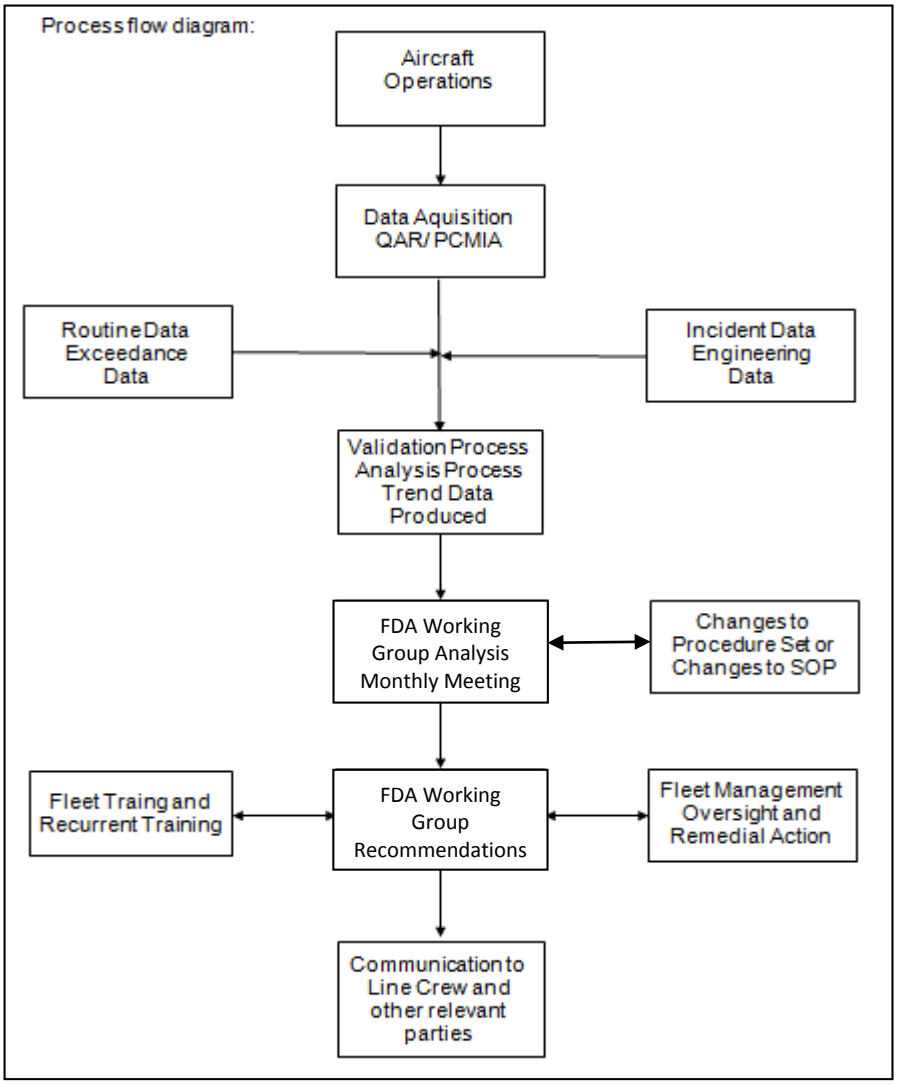


Diagram 5: FDM Process Flow

7.7 STEP 7: Analyze collected data to identify events leading to an LOC-I.

Based on the analysis of data collected, lead indicators to LOC-I event could be identified from the list of probable cause outlined (human, system and environmentally induced), FDA outputs, safety/audit reports, investigation findings, and others, which may be translated into Safety Performance Indicator (SPI). The corresponding Safety Performance Target (SPT) value can be developed based on quantification of its potential outcome, taking into consideration the risk factors identified for each of the elements. These include applying various combinations of high/low probability against severity of occurrence, as prescribed by the Safety Risk Assessment Matrix, to formulate the appropriate target in relation to past performance, industry standards or regulatory requirement. This provides the basis for the Operator to develop/design specific LOC-I training enhancements.

An alert level can be set prior to reaching the target limit, in order to provide early notification to Training Department of the imminent risks and to initiate enhancement program to improve on related flight crew proficiency.

This analysis of LOC-I related safety data, identification of SPI and setting of SPT and the corresponding alerts should be undertaken by the SMS Integrated Working Group who will be the subject matter experts in the related field.

7.8 STEP 8: Develop and design LOC-I enhancement training specifically in preventing LOC-I events, identification of impending LOC-I and recovery.

From the trend analysis and safety reports, areas of greater safety concern can be identified and the training department will be notified to develop a safety action plan to address the impending unsafe concerns identified. The training department will then notify the working group of the action plans, and on agreement between both parties, implement the training program which shall be accomplished within a period of 6 months (proficiency check intervals).

Simultaneously, the training department shall incorporate such specific training curricula in the training syllabus and the relevant operations manual in concurrence with the manufacturer. Emphasis must also be given in developing training program in the prevention of LOC-I incidents through a more effective flight path monitoring function.

7.9 STEP 9: Deliver the enhanced LOC-I training through both simulator training and appropriate literature.

Once established, the training curricula will be incorporated in the Part D of the Operations Manual approved by the regulator, which will then be referenced for the proper conduct of the training and qualification. The delivery method shall include the use of simulator, computer based training (CBT) or literatures highlighting the safety event and the follow up action established. Appropriate revisions and syllabus enhancement may be referenced from lessons learned both internally and from other operators around the globe.

The simulator used in the conduct of LOC-I training must be suitably programmed and capable of simulating possible scenarios or conditions that can lead to this specific event. In this respect, consultation with the aircraft and simulator manufacturer is crucial in the development of appropriate simulator training program, whilst ensuring that the flight instructors are suitably trained and qualified to conduct the relevant training.

The operator may incorporate this into Evidence Based Training (EBT) Program.

7.10 STEP 10: Monitor the effectiveness of the training program through quality assurance program.

Internal audits and Safety Assurance Program should be established to monitor the effectiveness of the performance-based training in achieving the required safety objective. Operators should develop or propose specific LOC-I training enhancement performance indicator to facilitate effective assessment of the training program.

7.11 STEP 11: Review and modify the training program to meet overall safety performance.

In the event that a short fall in training and safety performance in the areas relating to LOC-I is evident, it is necessary to conduct an immediate review of the process involved to ascertain whether the prescribed safety action plan is indeed effective and appropriate to realize the desired outcome. If this cannot be accomplished, a new or updated follow up plan must be executed and subsequently monitored for any deviation from the required target.

Refer Appendix B for the Data Integration and Safety Performance Enhancement Process flow chart.

Refer Appendix C for the Checklist for Implementation of Performance Based Methodology for Flight Crew Training Enhancement.

Appendix A

The causal and contributory factors to loss of control events with reference to individual categories are illustrated in the following. The list is not in the order of risk priority.

1. **Pilot or human-induced**

    a. Improper training
    b. Poor energy management
    c. Changing pilot skill base
    d. Spatial disorientation
    e. Poor pilot awareness
    f. Distraction
    g. Automation confusion or mode confusion
    h. Automation and human factors
    i. Improper procedure
    j. System integration issues (complexity, interdependencies and lack of standard interfaces)
    k. Pilot actions leading to destabilized approaches
    l. Faulty loading or shifting of cargo
    m. Incompetence

2. **Environmentally-induced**

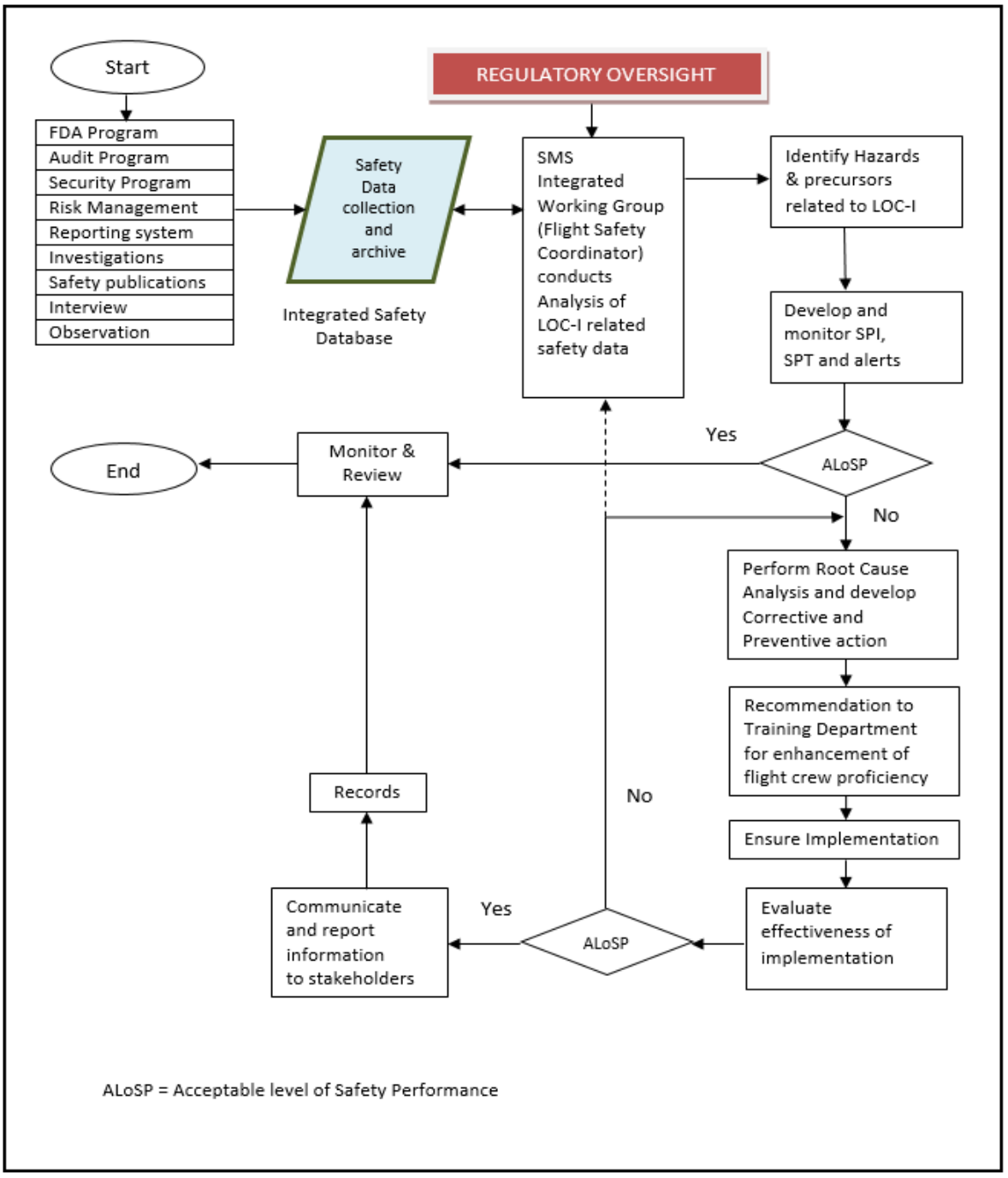
    a. Weather (turbulence, icing, adverse winds, wind shear)
    b. Wake vortices
    c. Hail leading to loss of control (engine performance)
    d. Visibility degradation
    e. Foreign object damage (hail, bird strike, volcanic ash)

3. **Systems-induced**

    a. Poor design
    b. Poor energy management (systems-induced)
    c. Propulsion related (asymmetric thrust, energy management)
    d. Erroneous sensor data
    e. Air traffic operations leading to destabilized approaches
    f. Loss of control power, authority, or effectiveness
    g. Aircraft system failures (non-propulsion and propulsion)
    h. Faults or failures or damage of or to any or all of the aircraft control effectors
    i. Pilot-induced oscillation (PIO)

Appendix B

Data Integration and Safety Performance Enhancement Process - SMS Working Group (headed by Flight Safety Coordinator)



Appendix C

Checklist for Implementation of Performance Based Methodology for Flight Crew Training Enhancement

Item	Question	Response	Reference	Remarks
1.1	Are there regulations in place with regard to establishment of performance based training relating to LOC-I events for the State?			
1.2	Are there specific regulations which provides a standardized operational procedures, equipment, and infrastructures (including safety management and training system), in conformance with the Standard and Recommended Practices (SAPRs) contained in the Annexes to the Convention on International Civil Aviation?			
1.3	Has the operator established the following safety programs:			
	a. Safety Management System			
	b. Flight Data Analysis			
	c. Open Reporting			
	d. Audit program			
	e. Flight Crew Training program			
	f. Flight Monitoring program			
	g. Engineering & Maintenance program			
	h. Communication and coordination program			
	i. Operating manual revision and updating processes and procedure			
	j. Cargo packing loading, weight and balance program/processes			
	k. Equipment reliability program			
	l. Weather monitoring and reporting system			
	m. Security program			
1.4	Does the organization have an integrated safety database? Alternate means of compliance include obtaining data from individual operational units.			
1.5	Are the participants in the safety working group:			
	a. Suitably qualified			
	b. Knowledgeable			
	c. Skilled			
	d. Experienced			
	e. Have attended the relevant training			

Item	Question	Response	Reference	Remarks
1.6	Does the organization have a process for data analysis?			
1.7	Is the safety working group independent of any management influence?			
1.8	Does the policy provide authority to the working group to ensure that all recommendations by the working group shall be implemented?			
1.9	Does the State have an oversight program with regard to performance based methodology?			
2.0	Does the operator have an internal audit or inspections program with regard to performance based methodology to ensure that the organization continues to meet the established requirement and functions at the level of competency and safety required by the State?			
2.1	Does the operator have an escalation process to Board of Safety and Security to address immediate high risk and long standing issues?			