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Line Operations Safety Audit (LOSA)

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AMENDMENTS

The issue of amendments is announced regularly in the *ICAO Journal* and in the monthly *Supplement to the Catalogue of ICAO Publications and Audio-visual Training Aids*, which holders of this publication should consult. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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FOREWORD

The safety of civil aviation is the major objective of the International Civil Aviation Organization (ICAO). Considerable progress has been made in increasing safety, but additional improvements are needed and can be achieved. It has long been known that the majority of aviation accidents and incidents result from less than optimum human performance, indicating that any advance in this field can be expected to have a significant impact on the improvement of aviation safety.

This was recognized by the ICAO Assembly, which in 1986 adopted Resolution A26-9 on Flight Safety and Human Factors. As a follow-up to the Assembly Resolution, the Air Navigation Commission formulated the following objective for the task:

"To improve safety in aviation by making States more aware and responsive to the importance of Human Factors in civil aviation operations through the provision of practical Human Factors materials and measures, developed on the basis of experience in States, and by developing and recommending appropriate amendments to existing material in Annexes and other documents with regard to the role of Human Factors in the present and future operational environments. Special emphasis will be directed to the Human Factors issues that may influence the design, transition and in-service use of the future ICAO CNS/ATM systems."

One of the methods chosen to implement Assembly Resolution A26-9 is the publication of guidance materials, including manuals and a series of digests, that address various aspects of Human Factors and its impact on aviation safety. These documents are intended primarily for use by States to increase the awareness of their personnel of the influence of human performance on safety.

The target audience of Human Factors manuals and digests are the managers of both civil aviation administrations and the airline industry, including airline safety, training and operational managers. The target audience also includes regulatory bodies, safety and investigation agencies and training establishments, as well as senior and middle non-operational airline management.

This manual is an introduction to the latest information available to the international civil aviation community on the control of human error and the development of countermeasures to error in operational environments. Its target audience includes senior safety, training and operational personnel in industry and regulatory bodies.

This manual is intended as a living document and will be kept up to date by periodic amendments. Subsequent editions will be published as new research results in increased knowledge on Human Factors strategies and more experience is gained regarding the control and management of human error in operational environments.

ACRONYMS AND ABBREVIATIONS

ADS	Automatic Dependent Surveillance
ATC	Air Traffic Control
CFIT	Controlled Flight Into Terrain
CNS/ATM	Communications, Navigation and Surveillance/Air Traffic Management
CPDLC	Controller-Pilot Data Link Communications
CRM	Crew Resource Management
DFDR	Digital Flight Data Recorder
ETOPS	Extended Range Operations by Twin-engined Aeroplanes
FAA	Federal Aviation Administration
FDA	Flight Data Analysis
FMS	Flight Management System
FOQA	Flight Operations Quality Assurance
ICAO	International Civil Aviation Organization
LOSA	Line Operations Safety Audit
MCP	Mode Control Panel
QAR	Quick Access Recorder
RTO	Rejected Take-Off
SCP	Safety Change Process
SOPs	Standard Operating Procedures
TEM	Threat and Error Management
UTTEM	University of Texas Threat and Error Management

INTRODUCTION

1. This manual describes a programme for the management of human error in aviation operations known as Line Operations Safety Audit (LOSA). LOSA is proposed as a critical organizational strategy aimed at developing countermeasures to operational errors. It is an organizational tool used to identify threats to aviation safety, minimize the risks such threats may generate and implement measures to manage human error in operational contexts. LOSA enables operators to assess their level of resilience to systemic threats, operational risks and front-line personnel errors, thus providing a principled, data-driven approach to prioritize and implement actions to enhance safety.

2. LOSA uses expert and highly trained observers to collect data about flight crew behaviour and situational factors on "normal" flights. The audits are conducted under strict no-jeopardy conditions; therefore, flight crews are not held accountable for their actions and errors that are observed. During flights that are being audited, observers record and code potential threats to safety; how the threats are addressed; the errors such threats generate; how flight crews manage these errors; and specific behaviours that have been known to be associated with accidents and incidents.

3. LOSA is closely linked with Crew Resource Management (CRM) training. Since CRM is essentially error management training for operational personnel, data from LOSA form the basis for contemporary CRM training refocus and/or design known as Threat and Error Management (TEM) training. Data from LOSA also provide a real-time picture of system operations that can guide organizational strategies in regard to safety, training and operations. A particular strength of LOSA is that it identifies examples of superior performance that can be reinforced and used as models for training. In this way, training interventions can be reshaped and reinforced based on successful performance, that is to say, positive feedback. This is indeed a first in aviation, since the industry has traditionally collected information on failed human performance, such as in accidents and incidents. Data collected through LOSA are proactive and can be immediately used to prevent adverse events.

4. LOSA is a mature concept, yet a young one. LOSA was first operationally deployed following the First LOSA Week, which was hosted by Cathay Pacific Airways in Cathay City, Hong Kong, from 12 to 14 March 2001. Although initially developed for the flight deck sector, there is no reason why the methodology could not be applied to other aviation operational sectors, including air traffic control, maintenance, cabin crew and dispatch.

5. The initial research and project definition was a joint endeavour between The University of Texas at Austin Human Factors Research Project and Continental Airlines, with funding provided by the Federal Aviation Administration (FAA). In 1999, ICAO endorsed LOSA as the primary tool to develop countermeasures to human error in aviation operations, developed an operational partnership with The University of Texas at Austin and Continental Airlines, and made LOSA the central focus of its Flight Safety and Human Factors Programme for the period 2000 to 2004.

6. As of February 2002, the LOSA archives contained observations from over 2 000 flights. These observations were conducted within the United States and internationally and involved four United States and four non-United States operators. The number of operators joining LOSA has constantly increased since March 2001 and includes major international operators from different parts of the world and diverse cultures.

7. ICAO acts as an enabling partner in the LOSA programme. ICAO's role includes promoting the importance of LOSA to the international civil aviation community; facilitating research in order to collect necessary data; acting as a cultural mediator in the unavoidably sensitive aspects of data collection; and contributing multicultural observations to the LOSA archives. In line with these objectives, the publication of this manual is a first step at providing information and, therefore, at increasing awareness within the international civil aviation community about LOSA.

8. This manual is an introduction to the concept, methodology and tools of LOSA and to the potential remedial actions to be undertaken based on the data collected under LOSA. A very important caveat must be introduced at this point: this manual is not intended to convert readers into instant expert observers and/or LOSA auditors. In fact, it is strongly recommended that LOSA not be attempted without a formal introduction to it for the

following reasons. First, the forms presented in Appendix A are for illustration purposes exclusively, since they are periodically amended on the basis of experience gained and feedback obtained from continuing audits. Second, formal training in the methodology, in the use of LOSA tools and, most important, in the handling of the highly sensitive data collected by the audits is absolutely essential. Third, the proper structuring of the data obtained from the audits is of paramount importance.

9. Therefore, until extensive airline experience is accumulated, it is highly desirable that LOSA training be coordinated through ICAO or the founding partners of the LOSA project. As the methodology evolves and reaches full maturity and broader industry partnerships are developed, LOSA will be available without restrictions to the international civil aviation community.

10. This manual is designed as follows:

- Chapter 1 includes an overview on safety, and human error and its management in aviation operations. It provides the necessary background information to understand the rationale for LOSA.
- Chapter 2 discusses the LOSA methodology and provides a guide to the implementation of LOSA within an airline. It also introduces a model of crew error management and proposes the error classification utilized by LOSA, which is essentially operational and practical.
- Chapter 3 discusses the safety change process that should take place following the implementation of LOSA.
- Chapter 4 introduces the example of one operator's experience in starting a LOSA.
- Appendix A provides examples of the various forms utilized by LOSA.
- Appendix B provides an example of an introductory letter by an airline to its flight crews.
- Appendix C provides a list of recommended reading and reference material.

11. This manual is a companion document to the *Human Factors Training Manual* (Doc 9683). The cooperation of the following organizations in the production of this manual is acknowledged: The University of Texas at Austin Human Factors Research Project, Continental Airlines, US Airways and ALPA, International. Special recognition is given to Professor Robert L. Helmreich, James Klinect and John Wilhelm of The University of Texas at Austin Human Factors Research Project; Captains Bruce Tesmer and Donald Gunther of Continental Airlines; Captains Ron Thomas and Corkey Romeo of US Airways; and Captain Robert L. Sumwalt III of US Airways and of ALPA, International.

Chapter 1

BASIC ERROR MANAGEMENT CONCEPTS

1.1 INTRODUCTION

1.1.1 Historically, the way the aviation industry has investigated the impact of human performance on aviation safety has been through the retrospective analyses of those actions by operational personnel which led to rare and drastic failures. The conventional investigative approach is for investigators to trace back an event under consideration to a point where they discover particular actions or decisions by operational personnel that did not produce the intended results and, at such point, conclude human error as the cause. The weakness in this approach is that the conclusion is generally formulated with a focus on the outcome, with limited consideration of the processes that led up to it. When analysing accidents and incidents, investigators already know that the actions or decisions by operational personnel were "bad" or "inappropriate", because the "bad" outcomes are a matter of record. In other words, investigators examining human performance in safety occurrences enjoy the benefit of hindsight. This is, however, a benefit that operational personnel involved in accidents and incidents did not have when they selected what they thought of as "good" or "appropriate" actions or decisions that would lead to "good" outcomes.

1.1.2 It is inherent to traditional approaches to safety to consider that, in aviation, safety comes first. In line with this, decision making in aviation operations is considered to be 100 per cent safety-oriented. While highly desirable, this is hardly realistic. Human decision making in operational contexts is a compromise between production and safety goals (see Figure 1-1). The optimum decisions to achieve the actual production demands of the operational task at hand may not always be fully compatible with the optimum

Figure 1-1. Operational Behaviours — Accomplishing the system's goals

decisions to achieve theoretical safety demands. All production systems — and aviation is no exception — generate a migration of behaviours: due to the need for economy and efficiency, people are forced to operate at the limits of the system's safety space. Human decision making in operational contexts lies at the intersection of production and safety and is therefore a compromise. In fact, it might be argued that the trademark of experts is not years of experience and exposure to aviation operations, but rather how effectively they have mastered the necessary skills to manage the compromise between production and safety. Operational errors are not inherent in a person, although this is what conventional safety knowledge would have the aviation industry believe. Operational errors occur as a result of mismanaging or incorrectly assessing task and/or situational factors in a specific context and thus cause a failed compromise between production and safety goals.

1.1.3 The compromise between production and safety is a complex and delicate balance. Humans are generally very effective in applying the right mechanisms to successfully achieve this balance, hence the extraordinary safety record of aviation. Humans do, however, occasionally mismanage or incorrectly assess task and/or situational factors and fail in balancing the compromise, thus contributing to safety breakdowns. Successful compromises far outnumber failed ones; therefore, in order to understand human performance in context, the industry needs to systematically capture the mechanisms underlying successful compromises when operating at the limits of the system, rather than those that failed. It is suggested that understanding the human contribution to successes and failures in aviation can be better achieved by monitoring normal operations, rather than accidents and incidents. The Line Operations Safety Audit (LOSA) is the vehicle endorsed by ICAO to monitor normal operations.

1.2 BACKGROUND

Reactive strategies

Accident investigation

1.2.1 The tool most often used in aviation to document and understand human performance and define remedial strategies is the investigation of accidents. However, in terms of human performance, accidents yield data that are mostly about actions and decisions that failed to achieve the successful compromise between production and safety discussed earlier in this chapter.

1.2.2 There are limitations to the lessons learned from accidents that might be applied to remedial strategies vis-à-vis human performance. For example, it might be possible to identify generic accident-inducing scenarios such as Controlled Flight Into Terrain (CFIT), Rejected Take-Off (RTO), runway incursions and approach-and-landing accidents. Also, it might be possible to identify the type and frequency of external manifestations of errors in these generic accident-inducing scenarios or discover specific training deficiencies that are particularly related to identified errors. This, however, provides only a tip-of-the-iceberg perspective. Accident investigation, by definition, concentrates on failures, and in following the rationale advocated by LOSA, it is necessary to better understand the success stories to see if they can be incorporated as part of remedial strategies.

1.2.3 This is not to say that there is no clear role for accident investigation within the safety process. Accident investigation remains the vehicle to uncover unanticipated failures in technology or bizarre events, rare as they may be. Accident investigation also provides a framework: if only normal operations were monitored, defining unsafe behaviours would be a task without a frame of reference. Therefore, properly focused accident investigation can reveal how specific behaviours can combine with specific circumstances to generate unstable and likely catastrophic scenarios. This requires a contemporary approach to the investigation: should accident investigation be restricted to the retrospective analyses discussed earlier, its contribution in terms of human error would be to increase existing industry databases, but its usefulness in regard to safety would be dubious. In addition, the information could possibly provide the foundations for legal action and the allocation of blame and punishment.

Combined reactive/proactive strategies

Incident investigation

1.2.4 A tool that the aviation industry has increasingly used to obtain information on operational human performance is incident reporting. Incidents tell a more complete story about system safety than accidents do because they signal weaknesses within the overall system **before** the system breaks down. In addition, it is accepted that incidents are precursors of accidents and that *N*-number of incidents of one kind take place before an accident of the same kind eventually occurs. The basis for this can be traced back almost 30 years to research on accidents from different industries, and there is ample practical evidence that supports this research. There are, nevertheless, limitations on the value of the information on operational human performance obtained from incident reporting.

1.2.5 First, reports of incidents are submitted in the jargon of aviation and, therefore, capture only the external manifestations of errors (for example, "misunderstood a frequency", "busted an altitude", and "misinterpreted a clearance"). Furthermore, incidents are reported by the individuals involved, and because of biases, the reported processes or mechanisms underlying errors may or may not reflect reality. This means that incident-reporting systems take human error at face value, and, therefore, analysts are left with two tasks. First, they must examine the reported processes or mechanisms leading up to the errors and establish whether such processes or mechanisms did indeed underlie the manifested errors. Then, based on this relatively weak basis, they must evaluate whether the error management techniques reportedly used by operational personnel did indeed prevent the escalation of errors into a system breakdown.

1.2.6 Second, and most important, incident reporting is vulnerable to what has been called "normalization of deviance". Over time, operational personnel develop informal and spontaneous group practices and shortcuts to circumvent deficiencies in equipment design, clumsy procedures or policies that are incompatible with the realities of daily operations, all of which complicate operational tasks. These informal practices are the product of the collective know-how and hands-on expertise of a group, and they eventually become normal practices. This does not, however, negate the fact that they are deviations from procedures that are established and sanctioned by the organization, hence the term "normalization of deviance". In most cases normalized deviance is effective, at least temporarily. However, it runs counter to the practices upon which system operation is predicated. In this sense, like any shortcut to standard procedures, normalized deviance carries the potential for unanticipated "downsides" that might unexpectedly trigger unsafe situations. However, since they are "normal", it stands to reason that neither these practices nor their downsides will be recorded in incident reports.

1.2.7 Normalized deviance is further compounded by the fact that even the most willing reporters may not be able to fully appreciate what are indeed reportable events. If operational personnel are continuously exposed to substandard managerial practices, poor working conditions and/or flawed equipment, how could they recognize such factors as reportable problems?

1.2.8 Thus, incident reporting cannot completely reveal the human contribution to successes or failures in aviation and how remedial strategies can be improved to enhance human performance. Incident reporting systems are certainly better than accident investigations in understanding system performance, but the real challenge lies in taking the next step — understanding the processes underlying human error rather than taking errors at face value. It is essential to move beyond the visible manifestations of error when designing remedial strategies. If the aviation industry is to be successful in modifying system and individual performance, errors must be considered as symptoms that suggest where to look further. In order to understand the mechanisms underlying errors in operational environments, flaws in system performance captured through incident reporting should be considered as symptoms of mismatches at deeper layers of the system. These mismatches might be deficiencies in training systems, flawed person/technology interfaces, poorly designed procedures, corporate pressures, poor safety culture, etc. The value of the data generated by incident reporting systems lies in the early warning about areas of concern, but such data do not capture the concerns themselves.

Training

1.2.9 The observation of training behaviours (during flight crew simulator training, for example) is another tool that is highly valued by the aviation industry to understand operational human performance. However, the "production" component of operational decision making does not exist under training conditions. While operational behaviours during line operations are a compromise between production and safety objectives, training behaviours are absolutely biased towards safety. In simpler terms, the compromise between production and safety is not a factor in decision making during training (see Figure 1-2). Training behaviours are "by the book".

1.2.10 Therefore, behaviours under monitored conditions, such as during training or line checks, may provide an approximation to the way operational personnel behave when unmonitored. These observations may contribute to flesh out major operational questions such as significant procedural problems. However, it would be incorrect and perhaps risky to assume that observing personnel during training would provide the key to understanding human error and decision making in unmonitored operational contexts.

Surveys

1.2.11 Surveys completed by operational personnel can also provide important diagnostic information about daily operations and, therefore, human error. Surveys

Figure 1-2. Training Behaviours — Accomplishing training goals

provide an inexpensive mechanism to obtain significant information regarding many aspects of the organization, including the perceptions and opinions of operational personnel; the relevance of training to line operations; the level of teamwork and cooperation among various employee groups; problem areas or bottlenecks in daily operations; and eventual areas of dissatisfaction. Surveys can also probe the safety culture; for example, do personnel know the proper channels for reporting safety concerns and are they confident that the organization will act on expressed concerns? Finally, surveys can identify areas of dissent or confusion, for example, diversity in beliefs among particular groups from the same organization regarding the appropriate use of procedures or tools. On the minus side, surveys largely reflect perceptions. Surveys can be likened to incident reporting and are therefore subject to the shortcomings inherent to reporting systems in terms of understanding operational human performance and error.

Flight data recording

1.2.12 Digital Flight Data Recorder (DFDR) and Quick Access Recorder (QAR) information from normal flights is also a valuable diagnostic tool. There are, however, some limitations about the data acquired through these systems. DFDR/QAR readouts provide information on the frequency of exceedences and the locations where they occur, but the readouts do not provide information on the human behaviours that were precursors of the events. While DFDR/QAR data track potential systemic problems, pilot reports are still necessary to provide the context within which the problems can be fully diagnosed.

1.2.13 Nevertheless, DFDR/QAR data hold high cost/efficiency ratio potential. Although probably under-utilized because of cost considerations as well as cultural and legal reasons, DFDR/QAR data can assist in identifying operational contexts within which migration of behaviours towards the limits of the system takes place.

Proactive strategies

Normal line operations monitoring

1.2.14 The approach proposed in this manual to identify the successful human performance mechanisms that contribute to aviation safety and, therefore, to the design of countermeasures against human error focuses on the monitoring of normal line operations.

1.2.15 Any typical routine flight — a normal process — involves inevitable, yet mostly inconsequential errors (selecting wrong frequencies, dialling wrong altitudes, acknowledging incorrect read-backs, mishandling switches and levers, etc.) Some errors are due to flaws in human performance while others are fostered by systemic shortcomings; most are a combination of both. The majority of these errors have no negative consequences because operational personnel employ successful coping strategies and system defences act as a containment net. In order to design remedial strategies, the aviation industry must learn about these successful strategies and defences, rather than continue to focus on failures, as it has historically done.

1.2.16 A medical analogy may be helpful in illustrating the rationale behind LOSA. Human error could be compared to a fever: an indication of an illness but not its cause. It marks the beginning rather than the end of the diagnostic process. Periodic monitoring of routine flights is therefore like an annual physical: proactively checking health status in an attempt to avoid getting sick. Periodic monitoring of routine flights indirectly involves measurement of all aspects of the system, allowing identification of areas of strength and areas of potential risk. On the other hand, incident investigation is like going to the doctor to fix symptoms of problems; possibly serious, possibly not. For example, a broken bone sends a person to the doctor; the doctor sets the bone but may not consider the root cause(s) — weak bones, poor diet, high-risk lifestyle, etc. Therefore, setting the bone is no guarantee that the person will not turn up again the following month with another symptom of the same root cause. Lastly, accident investigation is like a post-mortem: the examination made after death to determine its cause. The autopsy reveals the nature of a particular pathology but does not provide an indication of the prevalence of the precipitating circumstances. Unfortunately, many accident investigations also look for a primary cause, most often "pilot error", and fail to examine organizational and system factors that set the stage for the breakdown. Accident investigations are autopsies of the system, conducted after the point of no return of the system's health has been passed.

1.2.17 There is emerging consensus within the aviation industry about the need to adopt a positive stance and **anticipate,** rather than regret, the negative consequences of human error in system safety. This is a sensible objective. The way to achieve it is by pursuing innovative approaches rather than updating or optimizing methods from the past. After more than 50 years of investigating failures and monitoring accident statistics, the relentless prevalence of human error in aviation safety would seem to indicate a somewhat misplaced emphasis in regard to safety, human performance and human error, unless it is believed that the human condition is beyond hope.

1.3 A CONTEMPORARY APPROACH TO OPERATIONAL HUMAN PERFORMANCE AND ERROR

1.3.1 The implementation of normal operations monitoring requires an adjustment on prevailing views of human error. In the past, safety analyses in aviation have viewed human error as an undesirable and wrongful manifestation of human behaviour. More recently, a considerable amount of operationally oriented research, based on cognitive psychology, has provided a very different perspective on operational errors. This research has proven, in practical terms, a fundamental concept of cognitive psychology: error is a normal component of human behaviour. Regardless of the quantity and quality of regulations the industry might promulgate, the technology it might design, or the training people might receive, error will continue to be a factor in operational environments because it simply is the downside of human cognition. Error is the inevitable downside of human intelligence; it is the price human beings pay for being able to "think on our feet". Practically speaking, making errors is a conservation mechanism afforded by human cognition to allow humans the flexibility to operate under demanding conditions for prolonged periods without draining their mental "batteries".

1.3.2 There is nothing inherently wrong or troublesome with error itself as a manifestation of human behaviour. The trouble with error in aviation is the fact that **negative consequences** may be generated in operational contexts. This is a fundamental point in aviation: if the negative consequences of an error are caught before they produce damage, then the error is inconsequential. In operational contexts, errors that are caught in time do not produce negative consequences and therefore, for practical purposes, do not exist. Countermeasures to error, including training interventions, should not be restricted to avoiding errors, but rather to making them visible and trapping them before they produce negative consequences. This is the essence of error management: human error is unavoidable but manageable.

1.3.3 Error management is at the heart of LOSA and reflects the previous argument. Under LOSA, flaws in human performance and the ubiquity of error are taken for granted, and rather than attempting to improve human performance, the objective becomes to improve the context within which humans perform. LOSA ultimately aims — through changes in design, certification, training, procedures, management and investigation — at defining operational contexts, including buffer zones or time delays between the commission of errors and the point in which error consequences become a threat to safety (see Figure 1-3). The buffer zone or time delay allows for recovery from the consequences of errors. The more resistant the buffer or the longer the time delay, the stronger the intrinsic resistance and tolerance of the operational context to the negative consequences of human error. Operational contexts should be designed in such a way that allows front-line operators second chances to recover from the consequences of errors.

1.3.4 In making an analogy with flight instruments, human performance can be considered as falling into three bands: a "green band", a "yellow band" and a "red band". Within the "green band", the operational context demands are low. Task and situational factors are compatible with cognitive resources, operational personnel make the fewest errors and, as indicated by the high recovery rate, the operational personnel have ample cognitive resources in reserve to recover from the negative consequences of errors. Task and situational factors put human performance into the "yellow band" when the operational context demands increase and become more complex and, consequently, errors increase in number and the recovery rate decreases. As operational context demands continue to increase and eventually peak, task and situational factors force human performance into the "red band". In this band, the number of errors sharply jumps and the recovery rate dips to a point at which cognitive control is lost. At this point, cognitive resources are no longer available to cope with the situation at hand; the mental "batteries" are totally depleted.

1.3.5 This classification of human performance into bands is beneficial to organizations to apply the LOSA data. As an example, the term "coffin corner" is used to describe the point in the operational envelope of an aircraft at which the (low) stall speed and the (high) buffet speed are the same and the aircraft exhibits bizarre behaviour and eventually goes out of control. Weight-versus-altitude-and-speed capability charts and other tools provide flight crews with the necessary information to avoid operating aircraft in this condition and, therefore, to stay within a safe operating envelope. LOSA generates the information necessary for organizations to define the "green band" of safe operations in the human performance envelope, thus avoiding taking operational human performance into the "coffin corner" of cognition (see Figure 1-4).

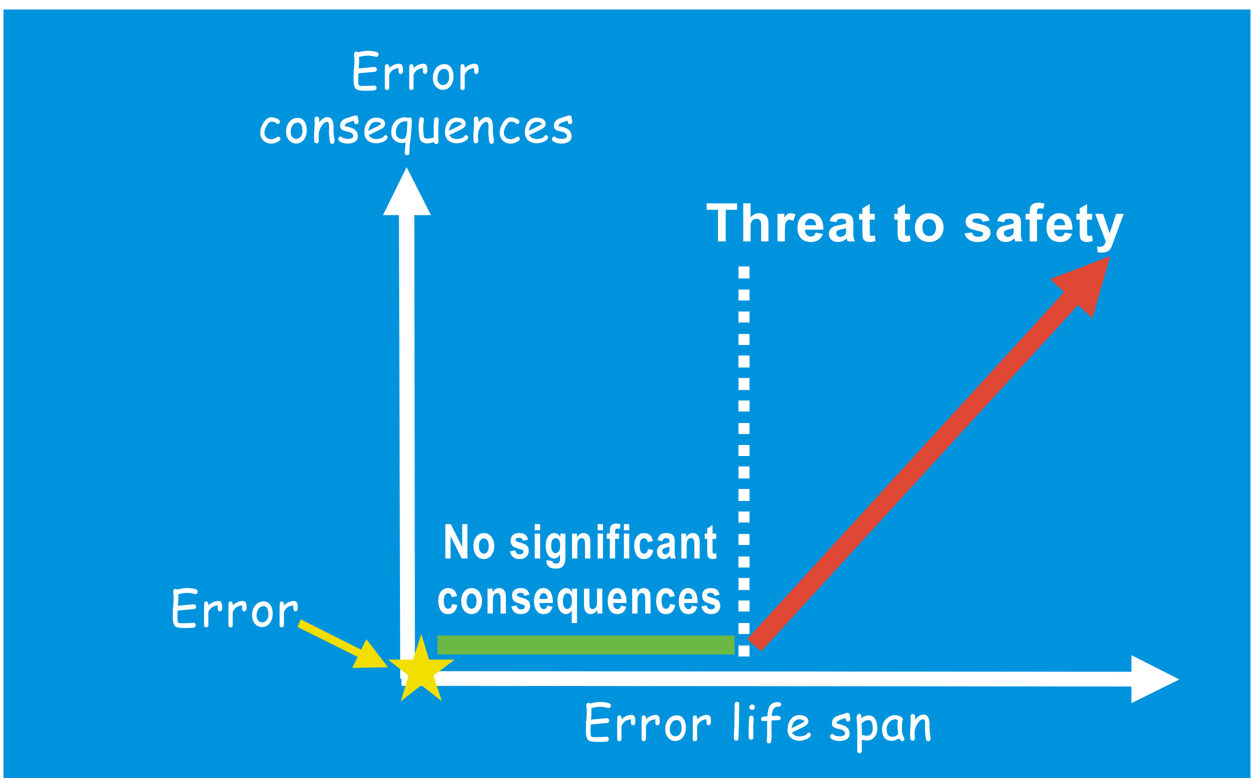


Figure 1-3. Understanding operational errors

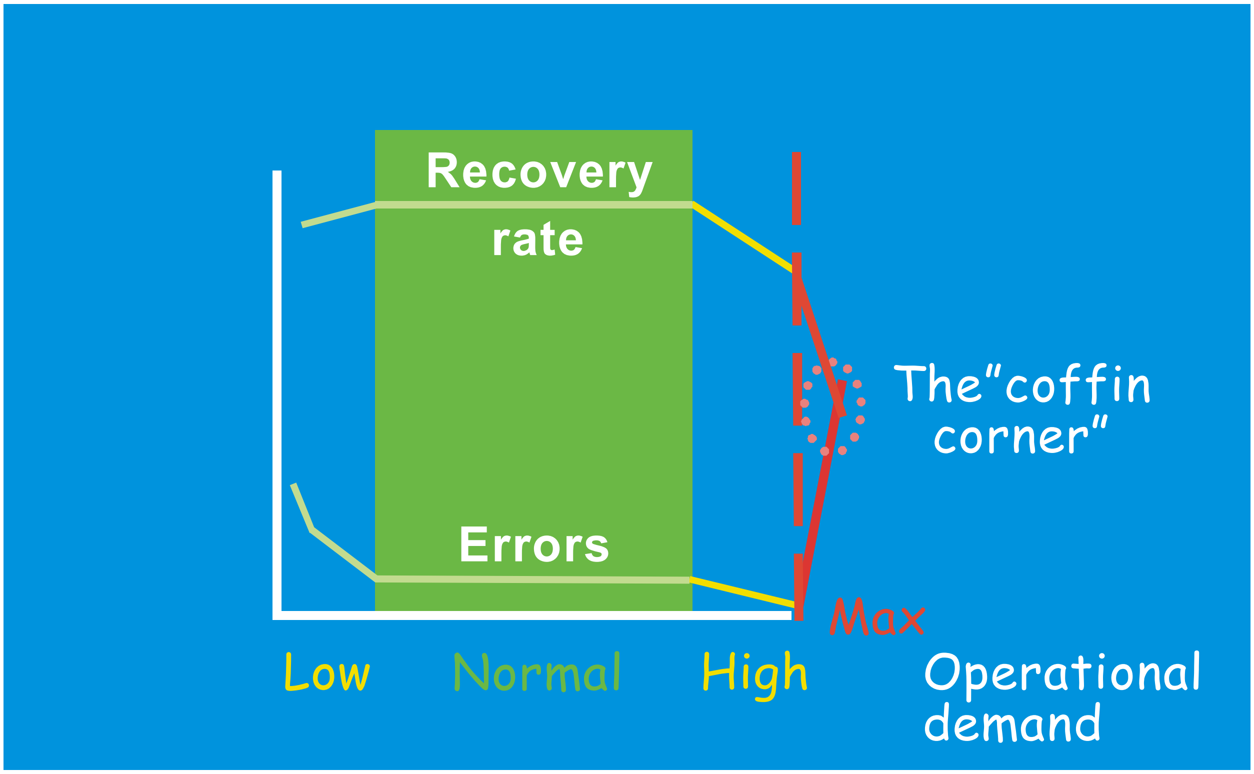


Figure 1-4. Defining the envelope

1.4 THE ROLE OF THE ORGANIZATIONAL CULTURE

1.4.1 In order to understand how an organization can effectively implement approaches to error management, it is essential to examine the organization's daily processes, the kind of corporate culture such processes generate, and the organization's attitudes toward error and punishment. This will make it possible to assess the effectiveness of the controls that the organization has in place to ensure that its processes foster the "green band" of operational human performance. It is good to remember the following points: humans do not live in a vacuum so their behaviours are affected by many external factors; corporate culture is an organizational mandate that conditions operational personnel decision making; and humans exhibit the kinds of behaviours an organization fosters and which they therefore assume the organization expects from them.

1.4.2 In closing this section, it is important to clearly point out the distinction between errors — which are products of human limitations, and violations — which have a motivational component. While error should be considered as the inevitable downside of human intelligence and flexibility and the aviation industry must learn to live with it, violations should be considered from a different perspective. Violations are an emerging topic of research, and in due time, the aviation industry might need to change prevailing attitudes towards them. However, for the purposes of this manual, violations should not be condoned.

1.5 CONCLUSION

1.5.1 There is no denying that monitoring normal operations on a routine basis and worldwide scale poses major challenges. Significant progress has been achieved in tackling some of these challenges. For example, from a methodological point of view, some early problems in defining, classifying and standardizing the data obtained have been solved; and consensus has been reached regarding what data should be collected. From an organizational perspective, there is a need to consider using and integrating multiple data collection tools, including line observations, surveys, self-reports and more refined incident reporting and Flight Data Analysis (FDA) systems. This in turn poses a challenge to the research community to assist airlines by developing analytic methods to integrate multiple and diverse data sources. However, most importantly, the real challenge for the large-scale implementation of LOSA will be overcoming the obstacles, presented by a blame-oriented industry, that will demand continued effort over time before normal operations monitoring is fully accepted by the operational personnel, whose support is essential.

1.5.2 Despite the challenges and barriers, the aviation system has more to gain by moving forward to system-wide implementation of LOSA than by denying progress because that is not the way business has been done in the past or by decrying the difficulties involved. The following chapters present an overview of how to tackle these challenges and barriers.

Chapter 2

IMPLEMENTING LOSA

2.1 HISTORY OF LOSA

2.1.1 In 1991, The University of Texas at Austin Human Factors Research Project, with funding from the FAA (Human Factors Division, AAR-100), developed LOSA to monitor normal line operations. In its early form, LOSA mostly focused on CRM performance. The reason for this was that researchers and airlines alike wanted to know more about the actual practice of CRM rather than just formulating conclusions about its effectiveness from data collected within the training environment, as was the established practice. After LOSA audits were conducted at more than ten airlines in the early 1990s, it was clear that the actual practice of CRM was quite different than the one depicted within the typical training department. Most important, the unique insights gathered from this methodological approach of monitoring normal operations not only advanced the concepts of CRM, but also encouraged new ways of thinking about crew performance.

2.1.2 After several years of development and refinement, LOSA has turned into a strategy of systematic line observations to provide safety data on the way an airline's flight operations system is functioning. The data generated from LOSA observations provide diagnostic indicators of organizational strengths and weaknesses in flight operations as well as an overall assessment of crew performance, both in the technical and human performance areas. LOSA is a data-driven approach to the development of countermeasures to operational threats and errors.

2.2 THE THREAT AND ERROR MANAGEMENT MODEL

2.2.1 LOSA is premised on The University of Texas Threat and Error Management (UTTEM) Model (see Figure 2-1). Essentially, the model posits that threats and errors are integral parts of daily flight operations and must be managed. Therefore, observing the management or mismanagement of threats and errors can build the desired systemic snapshot of performance. Pilots quickly grasp the concepts of external threats once they are explained, and the idea of managing the threats has great relevance to them, more so than error management, which still retains negative connotations despite attempts to acknowledge its ubiquity and necessity in human intelligence and information processing. Crew countermeasures are then seen as the tools that pilots develop to handle these daily threats and errors. The UTTEM Model has been successfully incorporated into training programmes and in some cases has replaced existing CRM training.*

2.2.2 The UTTEM Model provides a quantifiable framework to collect and categorize data. Some questions that can be addressed using this framework include the following:

- What type of threats do flight crews most frequently encounter? When and where do they occur, and what types are the most difficult to manage?
- What are the most frequently committed crew errors, and which ones are the most difficult to manage?
- What outcomes are associated with mismanaged errors? How many result in an Undesired Aircraft State?
- Are there significant differences between airports, fleets, routes or phases of flight vis-à-vis threats and errors?

2.2.3 The following paragraphs introduce a brief overview of the most important building blocks of the UTTEM Model.

Threats and errors defined

Threats

2.2.4 Threats are external situations that must be managed by the cockpit crew during normal, everyday flights. Such events increase the operational complexity of

* Guidance on Threat and Error Management (TEM) training can be found in the *Human Factors Training Manual* (Doc 9683).

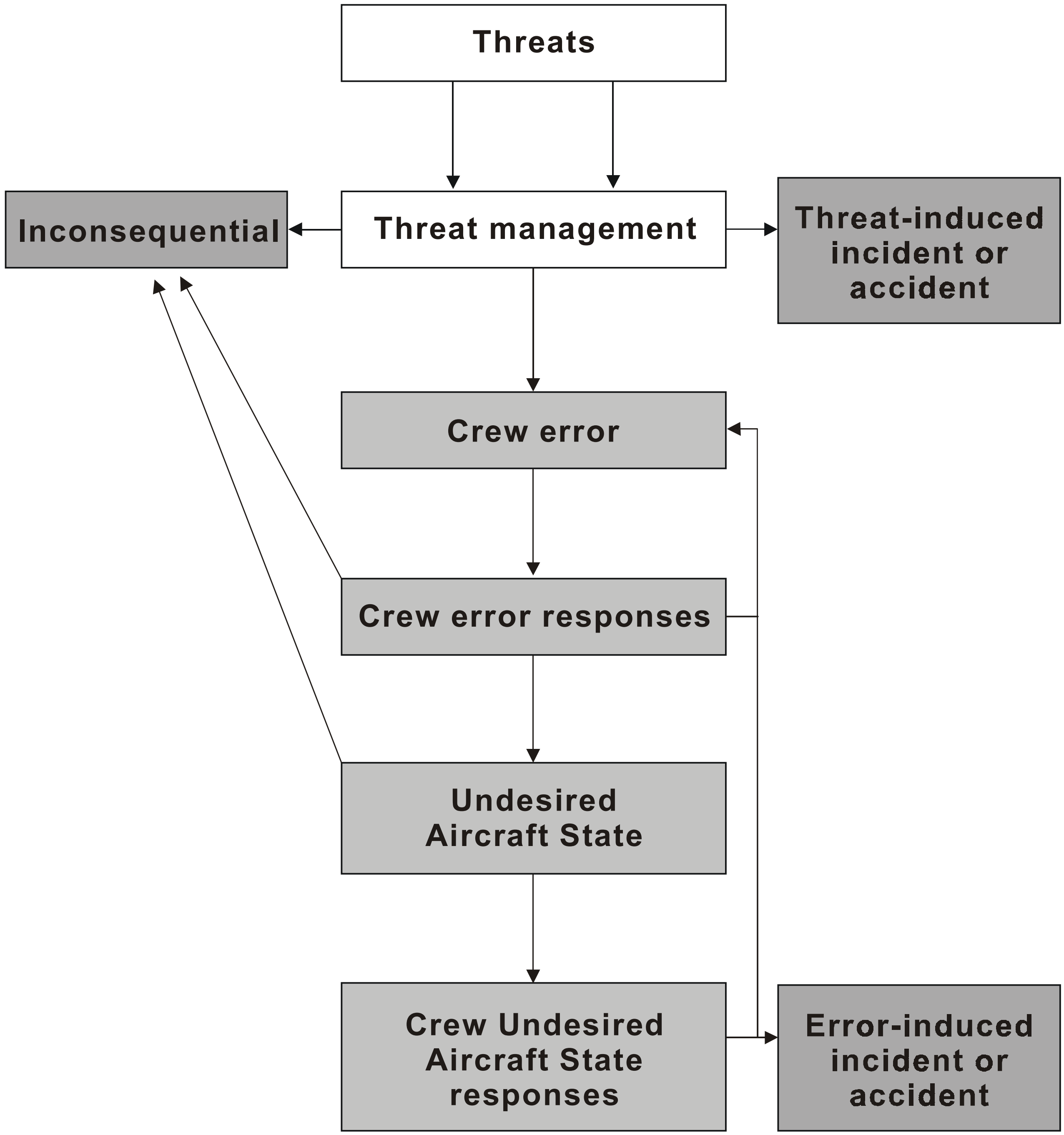


Figure 2-1. The Threat and Error Management Model

the flight and pose a safety risk to the flight at some level. Threats may be expected or anticipated and, therefore, the crew may brief in advance. Threats may also be unexpected. As they occur suddenly and without any warning, there is no possibility for the crew to brief in advance. External threats may be relatively minor or major. Observers should record **all** external threats that are on the code sheet or any others that may be considered significant.

2.2.5 Errors originated by non-cockpit personnel are considered external threats. For example, if the cockpit crew detects a fuel loading error made by ground staff, it would be entered as an external threat, not an error. The crew was not the source of the error (although they must **manage** it, as they would any other external threat). Other examples of non-cockpit crew errors that would be entered as external threats are errors in Air Traffic Control (ATC) clearances discovered by the crew, dispatch paperwork errors and discrepancies in passenger boarding counts by cabin attendants.

Errors

2.2.6 Cockpit crew error is defined as an action or inaction by the crew that leads to deviations from organizational or flight crew intentions or expectations. Errors in the operational context tend to reduce the margin of safety and increase the probability of accidents or incidents. Errors may be defined in terms of non-compliance with regulations, Standard Operating Procedures (SOPs) and policies, or unexpected deviation from crew, company or ATC expectations. Errors observed may be minor (selecting the wrong altitude into the mode control panel (MCP), but correcting it quickly) or major (forgetting to do an essential checklist). Observers should record **all** cockpit crew errors that they detect.

2.2.7 Operators set up SOPs and checklists as the standards for the proper and safe way to conduct flights. Instructors observing deviations from SOPs or checklists would define this as an error, and so does LOSA. If a crew member does not know how to execute a procedure properly or cannot control the aircraft in the expected manner, an instructor would also consider this an error, and so does LOSA. Deviations from expectations of ATC are also classified as crew errors; these would, for example, include altitude deviations or significant deviations around thunderstorms without ATC notification. There are rules in SOPs and/or operator manuals that, for example, specify how much deviation crews may make around thunderstorms before notifying ATC, and observers must be familiar with and apply these company rules when conducting observations. Operators also have **policies** that are less proscriptive than **procedures,** where preferred modes of operation are described. Pilots may violate policies without violating SOPs or increasing risk, and under LOSA, this is not defined as an error. However, if the observer feels that violating a policy unnecessarily increases risk to flight safety, it would be defined as an error. There are also many decision points on a normal flight that are not defined by SOPs or procedures. However, any time the crew makes a decision that unnecessarily increases risk to flight safety, it is defined as a crew error.

2.2.8 Crew errors may not have any consequences, but they still need to be recorded by the observer. For example, a violation to the sterile cockpit rule may not have any negative consequence to the flight, but it is a violation of regulations and thus must be entered as an error. In addition, errors may be intentional or unintentional. As implied in the definition, when a crew action is appropriate or prescribed in SOPs, the lack of action may also be defined as an error.

2.2.9 Is poor crew behaviour that is not a violation of regulations or SOPs (and did not result in an increased risk to flight safety) deemed an error? For example, should observers enter an error if a crew performed the pre-departure briefing in such a way that it was felt to deserve a "minimal proficiency"? The answer is "No". If the minimally proficient or poor pre-departure briefing (or any other less than optimum behaviour) was not associated with an error of some kind, then it is not an error in its own right and should not be entered in the observation form.

2.2.10 LOSA is predicated upon the following five categories of crew errors:

1. *Intentional non-compliance error:* Wilful deviation from regulations and/or operator procedures;

2. *Procedural error:* Deviation in the execution of regulations and/or operator procedures. The intention is correct but the execution is flawed. This category also includes errors where a crew forgot to do something;

3. *Communication error:* Miscommunication, misinterpretation, or failure to communicate pertinent information among the flight crew or between the flight crew and an external agent (for example, ATC or ground operations personnel);

4. *Proficiency error:* Lack of knowledge or psychomotor ("stick and rudder") skills; and

5. *Operational decision error:* Decision-making error that is not standardized by regulations or operator

procedures and that unnecessarily compromises safety. In order to be categorized as an operational decision error, at least one of three conditions must have existed:

- The crew must have had more conservative options within operational reason and decided not to take them;
- The decision was not verbalized and, therefore, was not shared among crew members; or
- The crew must have had time but did not use it effectively to evaluate the decision.

If any of these conditions were observed, then it is considered that an operational decision error was made in the LOSA framework. An example would include the crew's decision to fly through known wind shear on an approach instead of going around.

Definitions of crew error response

2.2.11 LOSA considers three possible responses by crews to errors:

1. *Trap:* An active flight crew response in which an error is detected and managed to an inconsequential outcome;
2. *Exacerbate:* A flight crew response in which an error is detected but the crew action or inaction allows it to induce an additional error, Undesired Aircraft State, incident or accident; and
3. *Fail to respond:* The lack of a flight crew response to an error because it was either ignored or undetected.

Definitions of error outcomes

2.2.12 The outcome of the error is dependent upon the flight crew response. LOSA considers three possible outcomes of errors depending upon crew response:

1. *Inconsequential:* An outcome that indicates the alleviation of risk that was previously caused by an error;
2. *Undesired Aircraft State:* An outcome in which the aircraft is unnecessarily placed in a compromising situation that poses an increased risk to safety; and
3. *Additional Error:* An outcome that was the result of or is closely linked to a previous error.

Undesired Aircraft States

2.2.13 An "Undesired Aircraft State" occurs when the flight crew places the aircraft in a situation of unnecessary risk. For instance, an altitude deviation is an Undesired Aircraft State that presents unnecessary risk. An Undesired Aircraft State may occur in response to a crew action or inaction (error). It is important to distinguish between errors and the Undesired Aircraft State that can result. If an Undesired Aircraft State is observed, there should always be a crew error that is responsible for this undesired state. Such errors may be miscommunications, lack of proficiency, poor decision making or wilful violation of regulations.

2.2.14 Undesired Aircraft States can also occur as a result of equipment malfunction or external party errors, for example, a malfunctioning altimeter or flight management system (FMS), or an ATC command error. These are not associated with crew error and would be classified as external events.

Crew response to Undesired Aircraft States

2.2.15 LOSA considers three possible crew responses to Undesired Aircraft States:

1. *Mitigate:* An active flight crew response to an Undesired Aircraft State that results in the alleviation of risk by returning from the Undesired Aircraft State to safe flight;
2. *Exacerbate:* A flight crew response in which an Undesired Aircraft State is detected, but the flight crew action or inaction allows it to induce an additional error, incident or accident; and
3. *Fail to respond:* The lack of an active flight crew response to an Undesired Aircraft State because it was ignored or undetected.

Definitions of outcomes of Undesired Aircraft States

2.2.16 LOSA considers three possible outcomes to Undesired Aircraft States:

1. *Recovery:* An outcome that indicates the alleviation of risk that was previously caused by an Undesired Aircraft State;

2. *End State/Incident/Accident:* Any undesired ending that completes the activity sequence with a negative, terminal outcome. These outcomes may be of little consequence, for example, a long landing or a landing too far to the left or right of the centre line, or may result in a reportable incident or in an accident; and

3. *Additional error:* The flight crew action or inaction that results in or is closely linked to another cockpit crew error.

2.3 LOSA OPERATING CHARACTERISTICS

2.3.1 LOSA is a proactive safety data collection programme. The data generated provide a diagnostic snapshot of organizational strengths and weaknesses, as well as an overall assessment of flight crew performance in normal flight operations. Therefore, the intent of LOSA is to aid airlines in developing data-driven solutions to improve overall systemic safety. The classic business principle of measure, implement change and measure again is pertinent here, with LOSA providing the metric of implementation effectiveness. Experience has proven that expert external oversight, especially on a first LOSA, is essential for success.

2.3.2 LOSA is defined by the following ten operating characteristics that act to ensure the integrity of the LOSA methodology and its data. Without these characteristics, it is not a LOSA. These characteristics are:

1. *Jump-seat observations during normal flight operations:* LOSA observations are limited to regularly scheduled flights. Line checks, initial line indoctrination or other training flights are off-limits due to the extra level of stress put upon the pilots during these types of situations. Having another observer on board only adds to an already high stress level, thus providing an unrealistic picture of performance. In order for the data to be representative of normal operations, LOSA observations must be collected on regular and routine flights.

2. *Joint management / pilot sponsorship:* In order for LOSA to succeed as a viable safety programme, it is essential that both management and pilots (through their professional association, if it exists) support the project. The joint sponsorship provides a "check and balance" for the project to ensure that change, as necessary, will be made as a result of LOSA data. When considering whether to conduct a LOSA audit, the first question to be asked by airline management is whether the pilots endorse the project. If the answer is "No", the project should not be initiated until endorsement is obtained. This issue is so critical in alleviating pilot suspicion that the existing LOSA philosophy is to deny airline assistance if a signed agreement is not in place before commencing a LOSA. A LOSA steering committee is formed with representatives from both groups and is responsible for planning, scheduling, observer support and, later, data verification (see Point 8).

3. *Voluntary crew participation:* Maintaining the integrity of LOSA within an airline and the industry as a whole is extremely important for long-term success. One way to accomplish this goal is to collect all observations with voluntary crew participation. Before conducting LOSA observations, an observer must first obtain the flight crew's permission to be observed. The crew has the option to decline, with no questions asked. The observer simply approaches another flight crew on another flight and asks for their permission to be observed. If an airline conducts a LOSA and has an unreasonably high number of refusals by crews to be observed, then it should serve as an indicator to the airline that there are critical "trust" issues to be dealt with first.

4. *De-identified, confidential and safety-minded data collection:* LOSA observers are asked not to record names, flight numbers, dates or any other information that can identify a crew. This allows for a level of protection against disciplinary actions. The purpose of LOSA is to collect safety data, not to punish pilots. Airlines cannot allow themselves to squander a unique opportunity to gain insight into their operations by having pilots fearful that a LOSA observation could be used against them for disciplinary reasons. If a LOSA observation is ever used for disciplinary reasons, the acceptance of LOSA within the airline will most probably be lost forever. Over 6 000 LOSA observations have been conducted by The University of Texas at Austin Human Factors Research Project and not one has ever been used to discipline a pilot.

5. *Targeted observation instrument:* The current data collection tool to conduct a LOSA is the LOSA Observation Form. It is not critical that an airline use this form, but whatever data collection instrument is used needs to target issues that affect flight crew performance in normal operations. An example of

the LOSA Observation Form is shown in Appendix A. The form is based upon the UTTEM Model and generates data for a variety of topics, including the following:

- Flight and crew demographics such as city pairs, aircraft type, flight time, years of experience within the airline, years of experience within position, and crew familiarity;
- Written narratives describing what the crew did well, what they did poorly and how they managed threats or errors for each phase of the flight;
- CRM performance ratings using research-developed behavioural markers;
- Technical worksheet for the descent/approach/land phases that highlights the type of approach flown, landing runway and whether the crew met airline stabilized approach parameters;
- Threat management worksheet that details each threat and how it was handled;
- Error management worksheet that lists each error observed, how each error was handled and the final outcome; and
- Crew interview conducted during low workload periods of the flight, such as cruise, that asks pilots for their suggestions to improve safety, training, and flight operations.

6. *Trusted, trained and calibrated observers:* Primarily, pilots conduct LOSAs. Observation teams will typically include line pilots, instructor pilots, safety pilots, management pilots, members of Human Factors groups and representatives of the safety committee of the pilots organization. Another part of the team can include external observers who are not affiliated with the airline. If they have no affiliation with the airline, external observers are objective and can serve as an anchor point for the rest of the observers. Trained, expert external observers add tremendous value, especially if they have participated in LOSA projects at other airlines. It is critical to select observers that are respected and trusted within the airline to ensure the line's acceptance of LOSA. Selecting good observers is the lifeline of LOSA. If you have unmotivated or untrustworthy observers, LOSA will fail. The size of the observation team depends on the airline's size, the number of flights to be observed and the length of time needed to conduct the observations. After observers are selected, everyone is trained and calibrated in the LOSA methodology, including the use of the LOSA rating forms and, particularly, the concepts of threat and error management. Training of observers in the concepts and methodology of LOSA will ensure that observations will be conducted in the most standardized manner. After completing training, observers spend a period of time (between one and two months) observing regularly scheduled line flights. The objective is to observe the largest number of crews and segments possible in the time frame, given the flight schedules, logistics and types of operation sampled.

7. *Trusted data collection site:* In order to maintain confidentiality, airlines must have a trusted data collection site. At the present time, all observations are sent off-site directly to The University of Texas at Austin Human Factors Research Project, which manages the LOSA archives. This ensures that no individual observations will be misplaced or improperly disseminated through the airline.

8. *Data verification roundtables:* Data-driven programmes like LOSA require quality data management procedures and consistency checks. For LOSA, these checks are done at data verification roundtables. A roundtable consists of three or four department and pilots association representatives who scan the raw data for inaccuracies. For example, an observer might log a procedural error for failure to make an approach callout for which there are actually no written procedures in the airline's flight operations manual. Therefore, it would be the job of the roundtable to detect and delete this particular "error" from the database. The end product is a database that is validated for consistency and accuracy according to the airline's standards and manuals, before any statistical analysis is performed.

9. *Data-derived targets for enhancement:* The final product of a LOSA is the data-derived LOSA **targets for enhancement**. As the data are collected and analysed, patterns emerge. Certain errors occur more frequently than others, certain airports or events emerge as more problematic than others, certain SOPs are routinely ignored or modified and certain manoeuvres pose greater difficulty in adherence than others. These patterns are identified for the airline as LOSA targets for enhancement. It is then up to the airline to develop an action plan based on these targets, using experts from within the airline

to analyse the targets and implement appropriate change strategies. After two or three years, the airline can conduct another LOSA to see if their implementations to the targets show performance improvements.

10. *Feedback of results to the line pilots:* After a LOSA is completed, the airline's management team and pilots association have an obligation to communicate LOSA results to the line pilots. Pilots will want to see not only the results but also management's plan for improvement. If results are fed back in an appropriate fashion, experience has shown that future LOSA implementations are welcomed by pilots and thus more successful.

2.3.3 Over the years of implementation, the ten operating characteristics listed above have come to define LOSA. Whether an airline uses third party facilitation or attempts to do a LOSA by itself, it is highly recommended that all ten characteristics are present in the process. Over the past five years, the most valuable lesson learned was that the success of LOSA goes much beyond the data collection forms. It depends upon how the project is executed and perceived by the line pilots. If LOSA does not have the trust from the pilot group, it will probably be a wasted exercise for the airline.

Observer assignment

2.3.4 Members of the observation teams are typically required to observe flights on different aircraft types. This is an important element of the line audit process for several reasons. For one, this has the advantage of allowing both line pilots and instructor pilots of particular fleets to "break out of the box" (their own fleet) and compare operations of fleets other than their own. Eventually, this helps the team as a whole to focus on Human Factors issues and common systemic problems, rather than on specific, within-fleet problems. Furthermore, the results are more robust if observers observe across many fleets instead of observing only one type.

Flight crew participation

2.3.5 Normally the line audit is announced to crew members by means of a letter from the highest level of management within flight operations, with the endorsement of other relevant personnel such as chief pilots and pilots association representatives. This letter specifies the purpose of the audit and the fact that all observations are of a no-jeopardy nature and all data are to be kept strictly confidential. The letter of announcement should precede the line audit by at least two weeks, and line observers are given copies of the letter to show crew members in case questions should arise. Data are kept anonymous and crews are given assurance that they are not in disciplinary jeopardy. Furthermore, crews should have the option to refuse admission of the observer to perform an observation on their flight.

2.4 HOW TO DETERMINE THE SCOPE OF A LOSA

2.4.1 Only smaller airlines with limited numbers of fleets would find it reasonable to attempt to audit their entire flight operation, that is, all types of operations and all fleets. Most airlines will find it cost effective to conduct a LOSA on only parts of their operation. Evidence from LOSA suggests that flight crew practices vary naturally by fleet. The type of operation, such as domestic, international, short-haul or long-haul, is also relevant. Usually, auditing any combination of types of operations is a good way to break down an entire operation into useful comparison groups.

2.4.2 Ideally, every flight crew should be audited, but more often than not, this will be impossible or impractical in material terms. At a major airline and in large fleets, around 50 randomly selected flight crews will provide statistically valid data. For smaller fleets, around 30 randomly selected flight crews will provide statistically valid data, although the risk of arriving at conclusions that might not reflect reality increases as the number of flight crews audited drops. If less than 25 flight crews are audited, the data collected should be considered as "case studies" rather than representing the group as a whole.

2.4.3 The number of observers needed depends, as already discussed, on the intended scope of the audit. For example, an airline might want to audit 50 flight crews in each of 2 domestic fleets, for a total of 100 segments. A conservative rule of thumb to scope this audit would be 2 domestic observations per day per observer. The goal is thus expressed in terms of flight crews observed, rather than segments. Should an airline want to audit an international fleet, the first step is to determine how many international observations can be made in a day, and this depends on the length of the segments. For a domestic LOSA, a workable rule of thumb suggests the need for 50 person/days of work for the actual audit phase of the LOSA. Using line pilots for a month of observations, each might be requested to spend 10 days conducting observations, plus 4 days training/travelling. This requires 14 days per observer. Thus, there would be a need for 4 observers for this hypothetical audit, and this should easily meet the audit's goals. It is important to be conservative in the estimates since sometimes it will be necessary to observe a crew for more than one segment. This counts as one crew, not two.

2.5 ONCE THE DATA IS COLLECTED

The data acquired through the observations must be "verified" and prepared for analysis, and the time involved in this process should not be underestimated. Once the various LOSA forms have been collected, the airline is ready to begin a lengthy process. It typically takes longer to prepare the LOSA data for analysis and ulterior action than it does to collect it. The steps that must be followed in this process include data entry, data quality/consistency checks and final aggregation.

2.6 WRITING THE REPORT

2.6.1 The last stage of LOSA is a written report that presents the overall findings of the project. With a large database like the one generated from a LOSA, it is easy to fall into the trap of trying to present too much information. The author needs to be concise and present only the most significant trends from the data. If the report does not provide a clear diagnosis of the weaknesses within the system for management to act upon, the objective of the LOSA will be unfulfilled.

2.6.2 Writing the report is where "data smarts" enters into the process. Although certain types of comparisons will seem obvious, many analyses will be based upon the "hunches" or "theories" of the writer. The usefulness of the result has to be the guiding principle of this effort. If the writer knows how fleets and operations are managed, comparisons that reflect this structure can be made. If the author knows the kinds of information that might be useful to training, safety or domestic/international flight operations, results can be tailored to these particular aspects of the operation. Feedback from various airline stakeholders is critical during this stage of writing the report. Authors should not hesitate to distribute early drafts to key people familiar with LOSA to verify the results. This not only helps validate derived trends, but it gives other airline personnel, besides the author, ownership of the report.

2.6.3 General findings from the survey, interview and observational data should serve as the foundation in organizing the final report. A suggested outline for the report follows:

Introduction — Define LOSA and the reasons why it was conducted.

Executive Summary — Include a text summary of the major LOSA findings (no longer than two pages).

Section Summaries – Present the key findings from each section of the report including:

- I — Demographics
- II — Safety Interview Results
- III — External Threats and Threat Management Results
- IV — Flight Crew Errors and Error Management Results
- V — Threat and Error Countermeasure Results

Appendix — Include a listing of every external threat and flight crew error observed with the proper coding and an observer narrative of how each one was managed or mismanaged.

Tables, charts and explanations of data should be provided within each section of the report.

2.6.4 It is important to remember that the author's primary job is to present the facts and abstain from outlining recommendations. This keeps the report concise and objective. Recommendations and solutions may be given later in supporting documentation after everyone has had the chance to digest the findings.

2.7 SUCCESS FACTORS FOR LOSA

The best results are achieved when LOSA is conducted in an open environment of trust. Line pilots must believe that there will be no repercussions at the individual level; otherwise, their behaviour will not reflect daily operational reality and LOSA will be little more than an elaborate line check. Experience at different airlines has shown that several strategies are key to ensuring a successful, data-rich LOSA. These strategies include:

- *Using third-party oversight:* One way to build trust in the LOSA process is to seek a credible but neutral third party who is removed from the politics and history of the airline. Data can be sent directly to this third party, who is then responsible for the objective analyses and report preparation. The University of Texas at Austin Human Factors Research Project provides, for the time being, such third party oversight;

- *Promoting LOSA:* Use group presentations, media clippings, experience from other airlines and intra-airline communications to discuss the purpose and logistics of a LOSA audit with management, pilots and any pilots associations. Experience shows that airlines often underestimate the amount of communication required so they must be persistent in their efforts;

- *Stressing that observations cannot be used for discipline purposes:* This is the key issue and must be stated as such in the letter of endorsement;

- *Informing the regulatory authority of the proposed activity:* It is as much a courtesy as it is a way of communicating the presence of LOSA;

- *Choosing a credible observer team:* A line crew always has the prerogative to deny cockpit access to an observer; hence the observer team is most effective when composed of credible and well-accepted pilots from a mix of fleets and departments (for example, training and safety). This was achieved at one airline by asking for a list of potential observers from the management and the pilots association; those pilots whose names appeared on both lists were then selected as acceptable to everyone;

- *Using "a fly on the wall" approach:* The best observers learn to be unobtrusive and non-threatening; they use a pocket notebook while in the cockpit, recording minimal detail to elaborate upon later. At the same time, they know when it is appropriate to speak up if they have a concern, without sounding authoritarian;

- *Communicating the results:* Do not wait too long before announcing the results to the line or else pilots will believe nothing is being done. A summary of the audit, excerpts from the report and relevant statistics will all be of interest to the line; and

- *Using the data:* The LOSA audit generates targets for enhancement, but it is the airline that creates an action plan. One airline did this by creating a committee for each of the central concerns, and they were then responsible for reviewing procedures, checklists, etc., and implementing change, where appropriate.

Chapter 3

LOSA AND THE SAFETY CHANGE PROCESS (SCP)

3.1 INTRODUCTION

3.1.1 When an airline commits to LOSA, it must also commit to acting upon the results of the audit. LOSA is but a data collection tool. LOSA data, when analysed, are used to support changes aimed at improving safety. These may be changes to procedures, policies or operational philosophy. The changes may affect multiple sectors of the organization that support flight operations. It is essential that the organization has a defined process to effectively use the analysed data and to manage the changes the data suggest.

3.1.2 LOSA data should be presented to management in at least the areas of operations, training, standards and safety, with a clear analysis describing the problems related to each, as captured by LOSA. The LOSA report should clearly describe the problems the analysed data suggest but should not attempt to provide solutions. These will be better provided through the expertise in each of the areas in question.

3.1.3 LOSA directs organizational attention to the most important safety issues in daily operations and it suggests what questions should be asked; however, LOSA does not provide the solutions. The solutions lie in organizational strategies. The organization must evaluate the data obtained through LOSA, extract the appropriate information and then carry out the necessary interventions to address the problems thus identified. LOSA will only realize its full potential if the organizational willingness and commitment exist to act upon the data collected and the information such data support. Without this necessary step, LOSA data will join the vast amounts of untapped data already existing throughout the international civil aviation community.

3.1.4 The following would be some of the typical expected actions, in no particular order, by an airline following a LOSA:

- Modifying existing procedures or implementing new ones;
- Redefining operational philosophies and guidelines;
- Arranging specific training in error management and crew countermeasures;
- Reviewing checklists to ensure relevance of the content and then issuing clear guidelines for their initiation and execution; and
- Defining tolerances for stabilized approaches, as opposed to the "perfect approach" parameters promoted by existing SOPs.

3.2 A CONSTANTLY CHANGING SCENE

3.2.1 Airlines are continually involved in changes that, at some point or other, have an effect upon safety. Factors underlying this continuous change process include, among others, regulatory changes (airworthiness directives, advisory circulars, etc.); changes in national or international airspace systems (automatic dependent surveillance (ADS), data link/controller-pilot data link communications (CPDLC), reduced vertical separation, extended range operations by twin-engined aeroplanes (ETOPS), etc.); changes to improve operational efficiencies (reduction of costs, improvement of on-time performance, etc.); operational events (diversions, rejected take-offs, etc.); and progress (route expansion, fleet modernization, new technologies, etc.)

3.2.2 Virtually everyone in an airline is somehow involved in these changes. For example, Chief Executive Officers and their staff decide to buy new equipment; marketing opens up new routes; engineering must install new components; flight operations faces new staffing requirements and adjustments to line procedures; flight standards must define new policies and procedures; and flight training faces acquisition of new simulators.

3.2.3 These changes are achieved and monitored both through established formal and informal mechanisms underlying change processes. Formal mechanisms include meetings (daily, weekly, monthly and quarterly), reports and reviews at all levels of the organization. Informal mechanisms include crosstalk, spontaneous information transfer, and sharing in general by everyone in the organization. Both mechanisms work toward actively maintaining focus on the changes affecting safety.

3.2.4 Therefore, when in spite of these formal and informal mechanisms an airline experiences an accident or an incident, the immediate question arises: What is happening "out there"? The fact is that system changes and organizational responses to these changes generate active and latent threats to daily line operations. Active and latent threats themselves constantly change in a manner proportional to system changes. Active and latent threats become the breeding grounds of crew errors. Many organizations are not aware of these active and latent threats for a number of reasons, including the following:

- The "big picture" of flight operations is constantly changing because of the constantly changing scene;
- Crews may not report threats, fearing punishment;
- Crews may not report threats because they do not receive any feedback on their reports;
- Crews operate unsupervised most of the time;
- Line Checks (supervised performance) are poor indicators of normal operations; and
- Management may have difficulty screening out valid reported crew concerns from over-reported crew complaints.

3.2.5 Active and latent threats are the precursors to accidents and incidents. Threats cannot be identified through the investigation of accidents and incidents until it is too late. Most threats, however, can be proactively identified through LOSA (and other safety data collection programmes such as flight data analysis) and considered as **targets for enhancement**. For example, following a LOSA, an airline might identify the following targets for enhancement:

- Stabilized approaches
- Checklists
- Procedural errors
- Automation errors
- ATC communications
- International flight operations guide
- Captain leadership (intentional non-compliance errors)

3.2.6 To sustain safety in a constantly changing environment, data must be collected and analysed on a routine basis to identify the targets for enhancement and then a formal **safety change process (SCP)** must occur in order to bring about improvement. The basic steps of the SCP include the following and are also shown in Figure 3-1.

- Measurement (with LOSA) to obtain the targets
- Detailed analysis of targeted issues
- Listing of potential changes for improvement
- Risk analysis and prioritization of changes
- Selection and funding of changes
- Implementation of changes
- Time allocation for changes to stabilize
- Re-measurement

3.2.7 Airlines need a defined SCP to keep the organization working together to achieve the same safety objectives. A well-defined SCP keeps the organization from getting into "turf" issues, by clearly specifying who and what impacts flight operations. An SCP also contributes to improving the safety culture by maximizing the capabilities of current and future safety programmes. Last, but not least, an SCP provides a principled approach to target limited resources.

3.2.8 In the past, SCPs were based on accident and incident investigations, experience and intuition. Today, SCPs must be based on the "data wave", the "data warehouse" and the "drill-down" analysis. Measurement is fundamental, because until an organization measures, it can only guess. In the past, SCPs dealt with accidents. Today, SCPs must deal with the precursors of accidents.

3.3 ONE OPERATOR'S EXAMPLE OF AN SCP

3.3.1 This section briefly presents some of the very positive results obtained by one airline that pioneered LOSA in international civil aviation. The examples represent a two-year period, between 1996 and 1998, and include

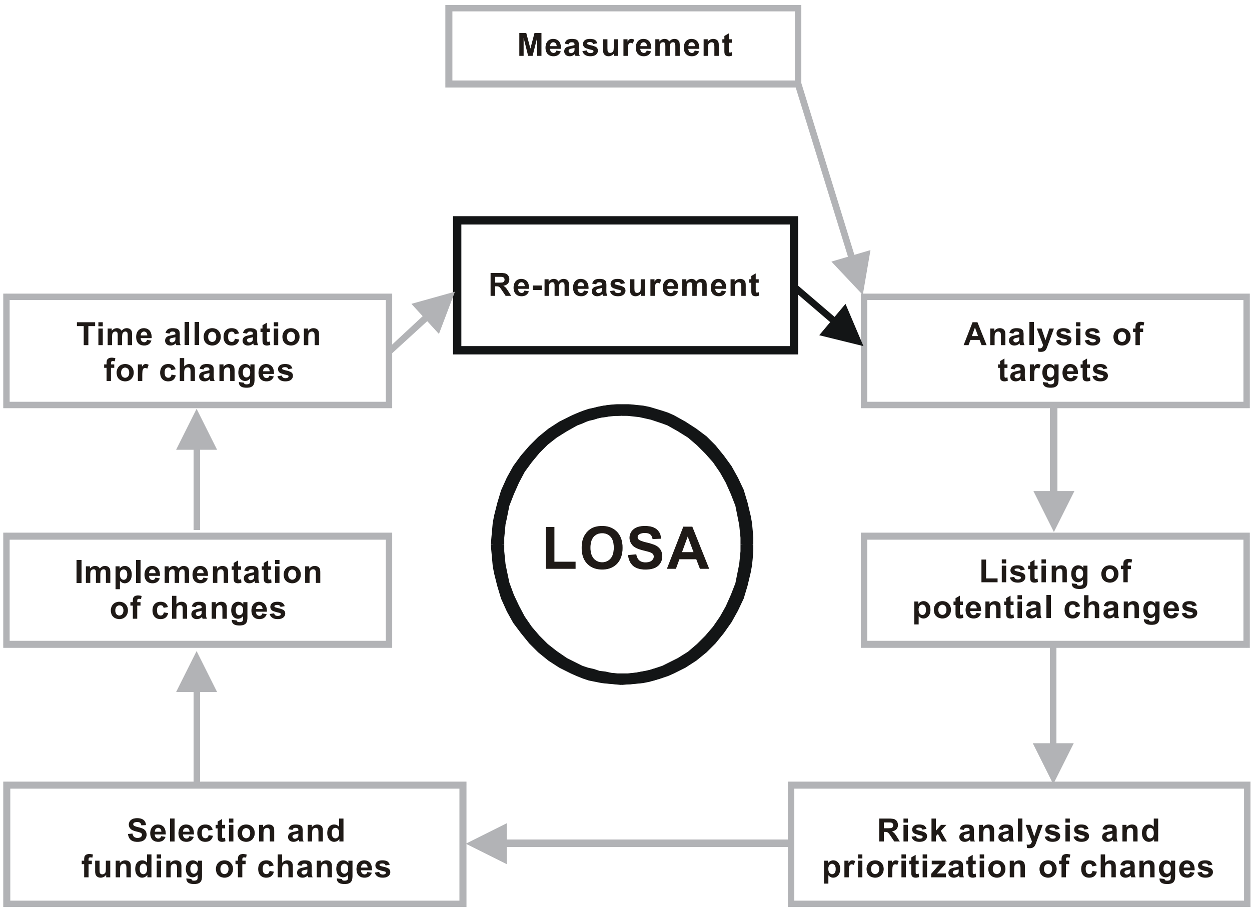


Figure 3-1. Basic steps of the safety change process

aggregate data collected during 100 flight segments. During this two-year period, 85 per cent of the crews observed made at least one error during one or more segments, and 15 per cent of the crews observed made between two and five errors. Errors were recorded in 74 per cent of the segments observed, with an average of two errors per segment (see Chapter 2 for a description of the error categories in LOSA). These data, asserted as typical of airline operations, substantiated the pervasiveness of human error in aviation operations, while challenged beyond question the illusion of error-free operational human performance.

3.3.2 LOSA observations indicated that 85 per cent of errors committed were inconsequential, which led to two conclusions. First, the aviation system possesses very strong and effective defences, and LOSA data allow a principled and data-driven judgement of which defences work and which do not, and how well defences fulfil their role. Second, it became obvious that pilots intuitively develop *ad hoc* error management skills, and it is therefore essential to discover what pilots do well so as to promote safety through organizational interventions, such as improved training, procedures or design, based on this “positive” data.

3.3.3 When the airline started conducting base-line observations in 1996, the crew error-trapping rate was 15 per cent; that is, flight crews detected and trapped only 15 per cent of the errors they committed. After two years, following implementation of organizational strategies aimed at error management based on LOSA data, the crew error-trapping rate increased to 55 per cent (see Figure 3-2).

3.3.4 Base-line observations in 1996 suggested problems in the area checklist performance. Following remedial interventions — including review of standard operating procedures, checklist design and training — checklist performance errors decreased from 25 per cent to 15 per cent, which is a 40 per cent reduction in checklist errors (see Figure 3-3).

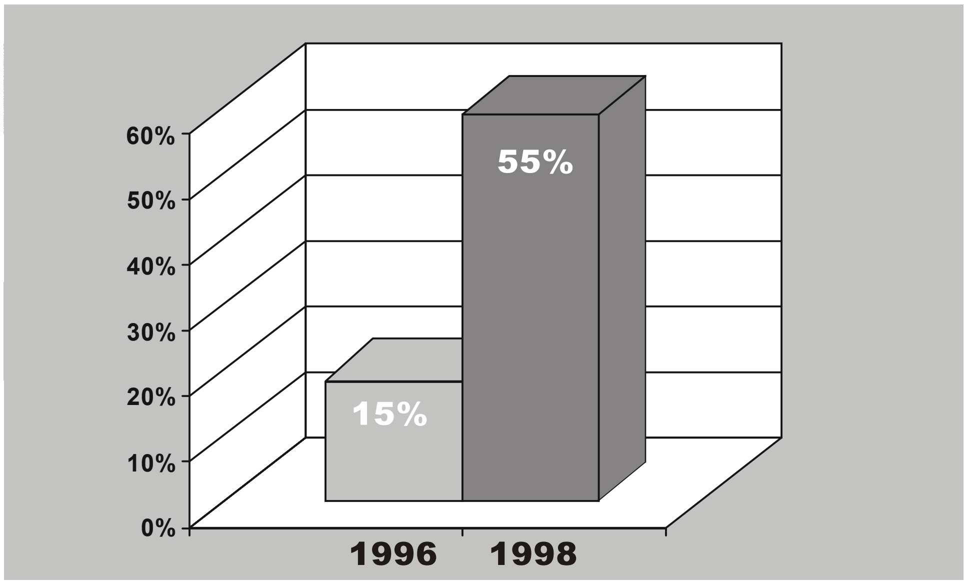


Figure 3-2. Crew error-trapping rate

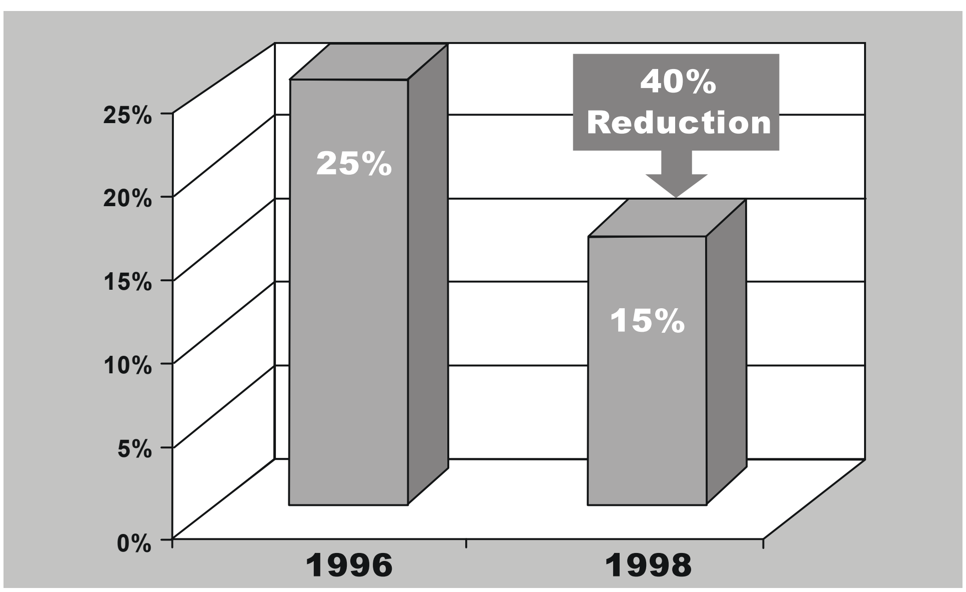


Figure 3-3. Checklist errors

3.3.5 Lastly, base-line observations in 1996 suggested that 34.2 per cent of approaches did not meet all requirements of the audit's stabilized approach criteria, as specified in the operator's SOPs. Unstabilized approaches (using more stringent criteria than during the 1996 audit) decreased to 13.1 per cent (a 62 per cent reduction) in 1998, following remedial action through organizational interventions. The data accessed through the operator's flight operations quality assurance (FOQA) programme is consistent with LOSA data and shows a similar decline for 1998.

3.3.6 How does such change take place? By adopting a defined SCP. Following data acquisition and analysis, the airline decided to form specific committees including a checklist committee and an unstabilized approaches committee. Each committee considered the problems identified by the analysis of the LOSA data and then proposed organizational interventions to address them. Such interventions included modification of existing procedures, implementation of new ones, specific training, and redefinition of operational philosophies, among others. For example, checklists were reviewed to ensure relevance of contents, and clear guidelines for their initiation and execution were promulgated. Gates and tolerances for stabilized approaches were defined, as opposed to the "perfect approach" parameters promulgated by the SOPs existing at that time. Proper training and checking guidelines were established, taking into account an error management approach to crew coordination.

3.3.7 The improved error management performance by flight crews, successful reduction in checklist performance errors and reduction in unstabilized approaches discussed earlier reflect the success of a properly managed SCP, based upon data collected by observing line operations. They are also examples of how analysis of LOSA data provides an opportunity to enhance safety and operational human performance.

Chapter 4

HOW TO SET UP A LOSA — US AIRWAYS EXPERIENCE

"Honest and critical self-assessment is one of the most powerful tools that management can employ to measure flight safety margins."

Flight Safety Foundation Icarus Committee
May 1999

4.1 GATHERING INFORMATION

In order to decide if conducting a LOSA would be beneficial, it is important to understand the LOSA process. The first contact should be ICAO or The University of Texas at Austin Human Factors Research Project. Both are able to provide all the information needed and can discuss benefits that have been derived from past LOSAs. They will also be aware of other airlines currently planning or conducting a LOSA, and it may be possible to attend those airlines' training classes. It is also a good idea to talk with and/or visit other airlines that have already completed a LOSA to learn from their experiences.

4.2 INTERDEPARTMENTAL SUPPORT

4.2.1 When first exploring whether or not to conduct a LOSA, it is advisable to gather representatives from all departments that may be potentially involved. This could include the flight operations, training and safety departments, as well as representatives from the pilots union. If LOSA is not supported by all concerned, the effectiveness of LOSA will be compromised.

4.2.2 As an example, a few years ago a large airline decided to audit its line flights on a somewhat random basis. The audit was not a LOSA but did have similarities in that it used trained observers to ride in the airline's cockpits. The airline's safety department administered the line audit, and the data that they collected were valid and important. However, the problem was that the flight operations and training departments of this airline felt somewhat threatened by the safety department telling them what "was wrong" with the airline, and therefore they were not very receptive to the findings of this particular line audit.

4.2.3 A few years later, this same airline conducted a very successful LOSA. This time, the airline emphasized that the audit was not "owned" by the safety department, but rather, was a product of the flight operations, training and safety departments, along with the pilots union. Each of these departments and organizations became members of the "LOSA steering committee." This airline's LOSA was successful for many reasons, but primarily because right from the start, all relevant departments were involved with the development and direction that the LOSA took. In short, the programme had interdepartmental "buy-in".

4.3 LOSA STEERING COMMITTEE

4.3.1 This buy-in and support of other departments are crucial; therefore, consideration should be given to forming a "LOSA steering committee." Determining which departments should be members varies with each organization but, at a minimum, should include the safety, flight operations and flight training departments and the pilots union. The role of each of these is described below.

Safety department

4.3.2 Ideally, the safety department should be the department to administer the LOSA. There are several reasons for this. For one, conducting audits is typically a job function of the safety department. Another important reason is that the safety department often holds the trust of the line pilots regarding confidential information. It is the safety department that typically administers confidential incident reporting systems and the FOQA Programme or digital flight data recorder monitoring programmes.

Flight operations and training departments

4.3.3 The flight operations and training departments must be integrally involved with implementing a LOSA for several reasons. First, they are at the centre of the operation and have first-hand information about what is and is not working well. These departments often know of specific areas on which they would like the LOSA to concentrate. Additionally, these departments can provide valuable input and suggestions for the smooth conduct of the LOSA. They will also be able to help provide the much needed personnel. Possibly the most important reason for their involvement is that ultimately many of the problem areas and the potential benefits that are identified during a LOSA must be "corrected" or implemented by these departments. As with the example of the airline above, if these departments do not support the LOSA, then there could be possible resistance to the findings from the LOSA. However, if these departments take an active part in the process, implementation of LOSA enhancements becomes much more probable.

Pilots union

4.3.4 The importance of having the pilots union involved with and support the LOSA must not be overlooked. If the line pilots believe that their union supports this endeavour, they will more readily accept observation flights. Additionally, if pilots believe this is a process that they can support, they will be more forthcoming and candid with their views and safety concerns. On the other hand, if the pilots view LOSA as a management tool to spy on them, then the results will not be as productive. The pilots union can also help disseminate the results of the LOSA and inform the pilots of any company decisions as a result of the LOSA. Hopefully, the union will agree with the enhancements and endorse them.

4.4 THE KEY STEPS OF A LOSA

4.4.1 To help provide focus for the LOSA, the LOSA steering committee should first look at problems that have been identified in the past by all involved departments. With this information in hand, the committee can then decide what they expect to gain from the LOSA and use that to form goals and an action plan. It must be kept in mind that the goals and action plan may have to be modified depending on the LOSA findings.

Goals

4.4.2 The LOSA steering committee should meet to determine what they would like to achieve from the LOSA. This will vary among airlines, but the following are some goals established by one airline:

- To heighten the safety awareness of the line pilot
- To obtain hard data on how crews manage threats and errors
- To measure and document what is happening "on the line"
  - — What works well
  - — What does not work well
- To provide feedback to the system so that enhancements can be made
- To inform end users WHY enhancements are being made, especially if the enhancements are a result of end user feedback
- To monitor results of LOSA enhancements

4.4.3 One airline stated up front that they wanted their line pilots to be the "customer" of the LOSA, meaning that whatever problems were identified, they would work to correct them to make the system safer and more efficient for their pilots.

Action plan

4.4.4 Figure 4-1 shows a flow chart of the key steps to LOSA. Steps 1 to 6 are covered below. Notice that the actual LOSA observations are not the end of the project but, in fact, are only a part of an entire process to help improve system safety at an airline. Steps 7 to 9 have already been covered earlier in this manual.

Step 1: Form initial development team

This team may be the same as the LOSA steering committee or just a few core individuals who can bring the committee up to date.

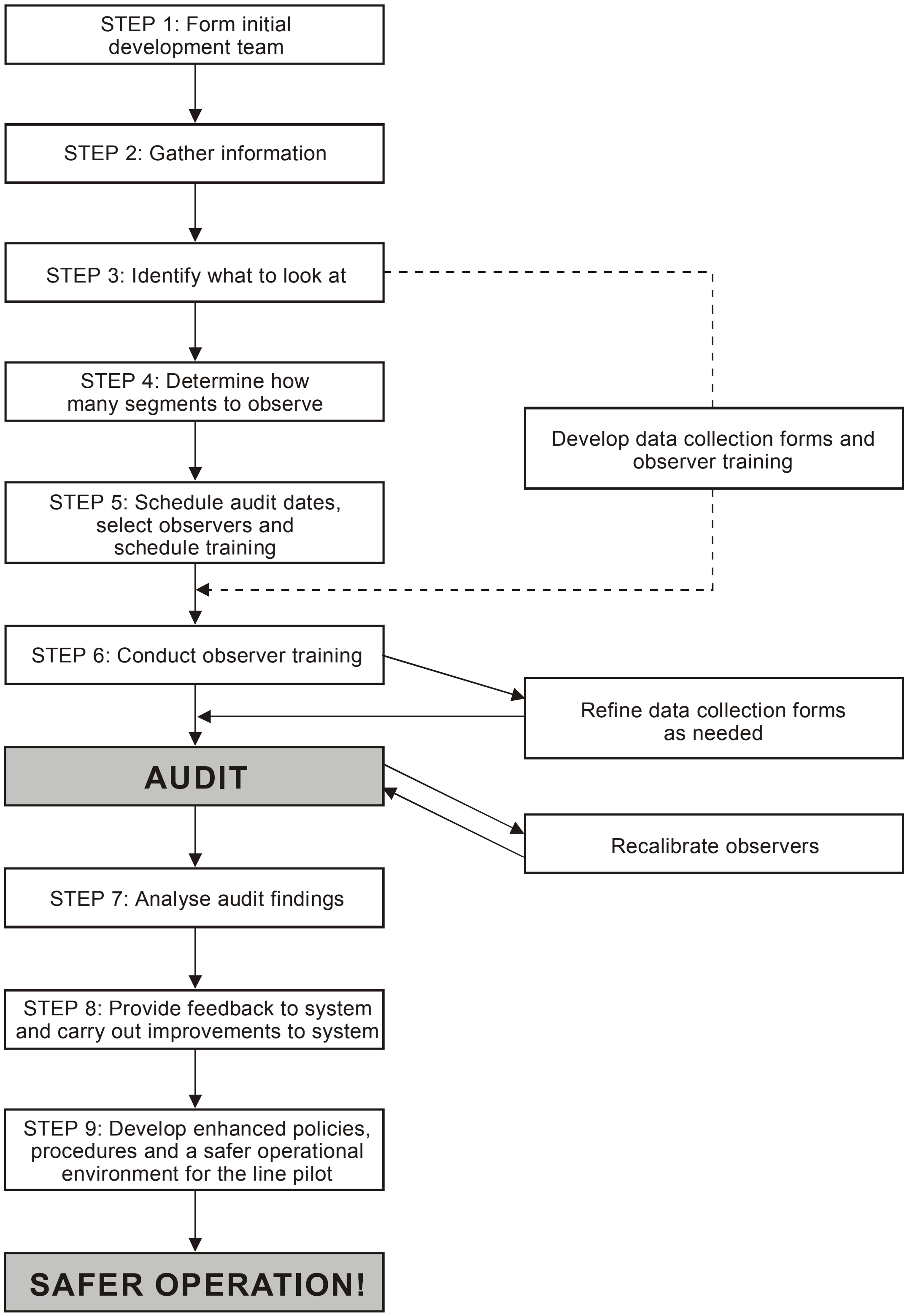


Figure 4-1. The key steps to LOSA

Step 2: Gather information

In order to conduct a LOSA, the initial development team must understand how LOSAs have been carried out in the past and they should be aware of the benefits that have been derived. They should, therefore, gather information on the LOSA process.

Step 3: Identify what to look at

To conduct the most efficient LOSA, it is best to focus on specific aspects. One common mistake is to try to tackle too much at one time. When doing this, the effort can be enormous and the data findings can be overwhelming.

A more manageable approach may be to narrowly focus on or target specific things to be observed. Are there certain airports that have more hazards or threats compared to other airports? Do certain aircraft fleets have more instances of tail strikes? Are unstabilized approaches something your operation is struggling with?

The decisions about what to observe should be based on data and not just instincts. For example, if an airline utilized an FOQA Programme or a confidential incident reporting system, these sources would be excellent places to help pinpoint areas on which efforts should be focused.

It should be remembered that LOSA is not designed to look at the entire operation, but really just provide a representative sampling or "slice" of the operations. One large international carrier decided to focus their first LOSA on their domestic operations, but had plans to later conduct a LOSA that focused on their international operations.

Step 4: Determine how many segments to observe

The number of flights that will be observed is a function of the number of people who will act as LOSA observers. Also to be considered is the need to collect enough data to provide a statistically valid sample of the operation. For example, statisticians at The University of Texas at Austin Human Factors Research Project have determined that if an airline wanted to evaluate a specific airport, then that airline should observe at least ten flights into and out of that airport. For a specific operation or fleet, the LOSA should observe at least 50 flights on that operation or fleet.

Step 5: Schedule audit dates, select observers and schedule training dates

Depending on the size of an airline's operations, a LOSA may last anywhere from approximately three to eight weeks. The LOSA observations should not be spread out over an extremely long time period. The objective is to gather the data needed to examine a specific area of operations. If the observations take place over a long time, it is likely that the effort will become diluted.

The quality of data collected depends entirely on who is collecting that data, so selecting LOSA observers is something that should be carefully considered. A good LOSA observer is one who is familiar with the airline's procedures and operations. Observers should be able to occupy the cockpit jump-seat and capture data but should not be obtrusive and overbearing.

Step 6: Conduct observer training

LOSA observer training will typically take two days. During this time, LOSA observers should have the opportunity to complete LOSA rating forms using training examples. Also, once the line audit has begun, it is a good idea to periodically provide feedback to LOSA observers to reinforce the things that they do well and to coach them in the areas that require improvement.

4.5 THE KEYS TO AN EFFECTIVE LOSA

4.5.1 If a LOSA is properly conducted, an airline will be able to obtain a multitude of information about threats and errors that flight crews face in daily operations. In US Airways experience, there are two key elements that will determine the quality of data obtained: the airline's views on confidentiality and no-jeopardy, and the observers themselves.

Confidentiality and no-jeopardy

4.5.2 It is human nature for people to behave somewhat differently when they know they are being evaluated, and airlines have a lot of information on how flight crews perform in the simulator and line checks. The idea of a LOSA is to capture data about the flight operations that could not be obtained otherwise.

4.5.3 To facilitate being able to observe the natural behaviour of crews, airlines must promote LOSA as no-jeopardy. The notion is that data from LOSA observations will not be used to discipline a pilot. For example, if a LOSA observer sees a crew unintentionally deviate from their assigned altitude, the observer will not use that information in a manner that could be punitive to that crew.

4.5.4 Some airlines are not as comfortable with the notion of no-jeopardy. At a minimum, in order to do a LOSA, an airline should agree that LOSA flight data are confidential and de-identified. The LOSA forms must not contain information that could be traced to a specific flight or crew.

4.5.5 This is not to say that the overall results from an airline's LOSA programme should not be publicized. In fact, once the entire LOSA programme is completed, the airline is encouraged to share the findings with their pilots. However, under no circumstances should the results from a particular flight be divulged or a crew disciplined for mistakes that occur on a LOSA flight.

The role of the observer

4.5.6 As cited above, the LOSA observer plays a key role in the effectiveness of a LOSA. If observers are seen as threats to the career of the pilots being observed, then the pilots may act differently than if the observers were perceived as simply being there to collect data to help improve the airline.

4.5.7 Some airlines use the analogy that the LOSA observer should be like a "fly on the wall", meaning that the observer will not interfere with the crew's performance. Observers should create an environment where the crews hardly realize that they are being observed. It is imperative that crews do not feel as if they are being given a check-ride. If an airline uses check airmen and instructors as LOSA observers, those observers must make a conscious effort to step out of their typical roles as evaluators. The LOSA observers must clearly understand that their role is limited to collecting data, not to disciplining or critiquing crews.

4.6 PROMOTING LOSA FOR FLIGHT CREWS

Before an airline begins a LOSA, it is highly recommended that the LOSA be widely publicized. Articles in the company's safety publication can go a long way towards improving line pilot acceptance of a LOSA. There is one way of publicizing a LOSA that must not be overlooked and that is a letter that is jointly signed by the company management and union officials. See Appendix B for an example.

Appendix A

EXAMPLES OF THE VARIOUS FORMS UTILIZED BY LOSA

LOSA Observation Form — EXAMPLE

Observer Information

Observer ID (Employee number)	3059
Observation Number	#1

Crew Observation Number (e.g., "1 of 2" indicates segment one for a crew that you observed across two segments)	1	**Of**	1

Flight Demographics

City Pairs (e.g., PIT-CLT)	PIT - LAX			
A/C Type (e.g., 737-300)	B-757			
Pilot flying (Check one)	**CA**		**FO**	X

Time from Pushback to Gate Arrival (Hours:Minutes)		4:55	
Late Departure? (Yes or No)	Yes	**How late?** (Hours:Minutes)	

Crew Demographics

	CA	FO	SO/FE	Relief 1	Relief 2
Base	PIT	PIT			
Years experience for all airlines	35	5			
Years in position for this A/C	7	1 month			
Years in automated A/C (FMC with VNAV and LNAV)	12	1 month			

Crew Familiarity (Check one)	**First LEG the crew has EVER flown together**	
	First DAY the crew has EVER flown together	
	Crew has flown together before	X

Predeparture / Taxi-Out

Narrative	Your narrative should provide a context. What did the crew do well? What did the crew do poorly? How did the crew perform when confronted with threats, crew errors, and significant events? Also, be sure to justify your behavioral ratings.

The CA established a great team climate – positive with open communication. However, he seemed to be in a rush and not very detail oriented. The FO, who was relatively new to the A/C, tried to keep up but fell behind at times. The CA did not help the cause by interrupting the FO with casual conversation ("marginal" workload management).

All checklists were rushed and poorly executed. The CA was also lax verifying paperwork. This sub-par behavior contributed to an undetected error - the FO failed to set his airspeed bugs for T/O ("poor" monitor/cross-check). The Before Takeoff Checklist should have caught the error, but the crew unintentionally skipped over that item. During the takeoff roll, the FO noticed the error and said, "Missed that one."

The Captain's brief was interactive but not very thorough ("marginal" SOP briefing). He failed to note the closure of the final 2000' of their departing runway (28R) due to construction. Taxiways B7 and B8 at the end of the runway were also out. The crew was marked "poor" in contingency management because there were no plans in place on how to deal with this threat in the case of a rejected takeoff. Lucky it was a long runway.

1	2	3	4
Poor Observed performance had safety implications	**Marginal** Observed performance was barely adequate	**Good** Observed performance was effective	**Outstanding** Observed performance was truly noteworthy

Planning Behavioral Markers			Rating
SOP BRIEFING	The required briefing was interactive and operationally thorough	— *Concise, not rushed, and met SOP requirements* — *Bottom lines were established*	*2*
PLANS STATED	Operational plans and decisions were communicated and acknowledged	— *Shared understanding about plans — "Everybody on the same page"*	*3*
WORKLOAD ASSIGNMENT	Roles and responsibilities were defined for normal and non-normal situations	— *Workload assignments were communicated and acknowledged*	*3*
CONTINGENCY MANAGEMENT	Crew members developed effective strategies to manage threats to safety	— *Threats and their consequences were anticipated* — *Used all available resources to manage threats*	*1*

Execution Behavioral Markers			**Rating**
MONITOR / CROSS-CHECK	Crew members actively monitored and cross-checked systems and other crew members	— *Aircraft position, settings, and crew actions were verified*	1
WORKLOAD MANAGEMENT	Operational tasks were prioritized and properly managed to handle primary flight duties	— *Avoided task fixation* — *Did not allow work overload*	2
VIGILANCE	Crew members remained alert of the environment and position of the aircraft	— *Crew members maintained situational awareness*	3
AUTOMATION MANAGEMENT	Automation was properly managed to balance situational and/or workload requirements	— *Automation setup was briefed to other members* — *Effective recovery techniques from automation anomalies*	

Review / Modify Behavioral Markers			**Rating**
EVALUATION OF PLANS	Existing plans were reviewed and modified when necessary	— *Crew decisions and actions were openly analyzed to make sure the existing plan was the best plan*	
INQUIRY	Crew members asked questions to investigate and/or clarify current plans of action	— *Crew members not afraid to express a lack of knowledge - "Nothing taken for granted" attitude*	3
ASSERTIVENESS	Crew members stated critical information and/or solutions with appropriate persistence	— *Crew members spoke up without hesitation*	

Takeoff / Climb

Narrative	Your narrative should provide a context. What did the crew do well? What did the crew do poorly? How did the crew perform when confronted with threats, crew errors, and significant events? Also, be sure to justify your behavioral ratings.

Normal takeoff besides one error. As the crew started to clean up the aircraft, the FO called "flaps up" before the flap retraction speed. The CA trapped the error and did not retract the flaps until the proper speed.

After passing 10000' all the way up to the TOC, the CA and FO failed to cross-verify multiple altitude changes. There was no intention on part of the CA to verify. In addition, since it happened multiple times, the observer coded it as an intentional noncompliance.

1	2	3	4
Poor Observed performance had safety implications	**Marginal** Observed performance was barely adequate	**Good** Observed performance was effective	**Outstanding** Observed performance was truly noteworthy

Execution Behavioral Markers			**Rating**
MONITOR /CROSS-CHECK	Crew members actively monitored and cross-checked systems and other crew members	— *Aircraft position, settings, and crew actions were verified*	*1*
WORKLOAD MANAGEMENT	Operational tasks were prioritized and properly managed to handle primary flight duties	— *Avoided task fixation* — *Did not allow work overload*	*3*
VIGILANCE	Crew members remained alert of the environment and position of the aircraft	— *Crew members maintained situational awareness*	*2*
AUTOMATION MANAGEMENT	Automation was properly managed to balance situational and/or workload requirements	— *Automation setup was briefed to other members* — *Effective recovery techniques from automation anomalies*	

Review / Modify Behavioral Markers			**Rating**
EVALUATION OF PLANS	Existing plans were reviewed and modified when necessary	— *Crew decisions and actions were openly analyzed to make sure the existing plan was the best plan*	
INQUIRY	Crew members asked questions to investigate and/or clarify current plans of action	— *Crew members not afraid to express a lack of knowledge — "Nothing taken for granted" attitude*	
ASSERTIVENESS	Crew members stated critical information and/or solutions with appropriate persistence	— *Crew members spoke up without hesitation*	

Cruise

Narrative	Your narrative should provide a context. What did the crew do well? What did the crew do poorly? How did the crew perform when confronted with threats, crew errors, and significant events? Also, be sure to justify your behavioral ratings.

Routine – no comments

Descent / Approach / Land Technical Worksheet

Descent (Above 10,000 ft.)

1	**Was the approach briefed before the TOD?** (Yes / No)	*Yes*

2	**Did the crew begin the descent before or at the FMS TOD?** (Yes / No)	*Yes*

3	**Did the aircraft get significantly above/below the FMS or standard path?** (Yes / No)	*No*
		If "Yes", explain in the narrative the cause and whether the crew tried to regain the path.

Approach and Land (Below 10,000 ft.)

4	**Approach flown?** (Check one)	**Visual**	X	**Instrument backup on visual approach?** (Check One)	**Yes**	X
					No	
		Precision		**Type of precision approach**		
		Nonprecision		**Type of nonprecision approach**		

5	**Approach: Hand flown or Automation flown?**	*Hand-flown*

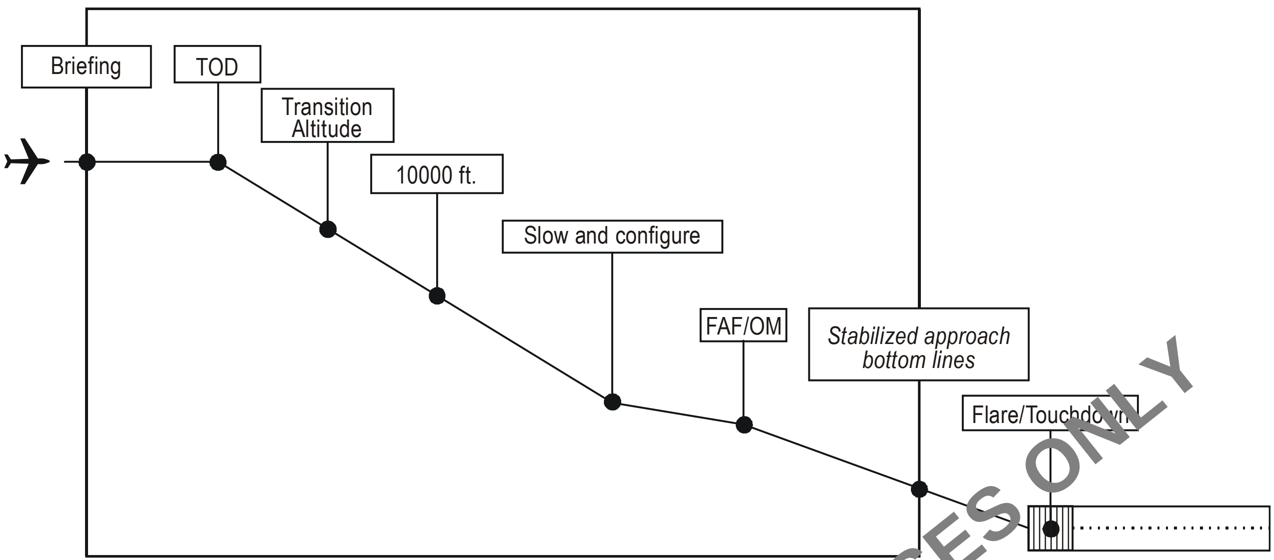
6	**Did the aircraft get significantly above/below a desirable descent path?** (Yes / No)	*Yes*
		If "Yes", explain in the narrative the cause and whether the crew tried to regain the path.

7	**During flap extension, flaps were "generally" extended:** (Check one)	**Close to or at minimum maneuvering speed**	
		Close to or at the maximum flap extension speed	X
		Above maximum flap extension speed (If this happens, be sure to describe in the narrative)	

8	**Weather** (Check One)	**VMC**	X	**IMC**	

	Stabilized Approach Parameters	1500 AFE	1000 AFE	500 AFE
9	Target airspeed between –5 and +15	Yes	Yes	Yes
	Vertical speed ≤ 1000 fpm	Yes	Yes	Yes
	Engines spooled	Yes	Yes	Yes
	Landing configuration (Final flaps / gear down)	Yes	Yes	Yes
	On proper flight path (G/S and localizer)	Yes	Yes	Yes

Descent / Approach / Land – The Blue Box



Narrative	Think "blue box." Describe significant events from the TOD to landing using the picture above to define landmarks. Talk about how the crew performed when confronted with threats and crew errors. Also, be sure to justify your behavioral ratings.

<u>Briefing to TOD</u> – The CA and FO did a nice job with the approach brief, which was completed by the TOD. Much better than their takeoff brief. They expected runway 25L from the Civet Arrival for a straight-in visual approach. Jepp charts were out, contingencies talked about, and everything was by the book. The FO asked a lot of questions and the CA was patient and helpful. Nicely done!

<u>10000' to slowing and configuring</u> – ATC cleared the crew to 25L, but at 8000', ATC changed us to the Mitts Arrival for runway 24R due to a slow moving A/C on 25L. The CA changed the arrival and approach in the FMC and tuned the radios. As soon as everything was clean, ATC called back and told the crew they could either land on 25L or 24R at their discretion. Since time was a factor, the crew discussed and decided to stick with the approach into 24R. The crew was flexible and the CA did a nice job assigning workload. He directed the FO fly the plane while he checked everything over one more time.

The crew was also better monitors and cross checkers. However, their execution of checklists was still a little sloppy – late and rushed.

The crew did a nice job staying vigilant with heavy traffic in the area – used ATC and TCAS effectively.

<u>Bottom lines to Flare / Touchdown</u> – The approach was stable, but the FO let the airplane slip left, which resulted in landing left of centerline. Since the FO was new to this aircraft (1 month flying time), the observer chalked it up to a lack of stick and rudder proficiency.

<u>Taxi-in</u> – The crew did a great job navigating taxiways and crossing the active 24L runway. Good vigilance and teamwork.

Descent / Approach / Land

1	2	3	4
Poor Observed performance had safety implications	**Marginal** Observed performance was barely adequate	**Good** Observed performance was effective	**Outstanding** Observed performance was truly noteworthy

Planning Behavioral Markers			Rating
SOP BRIEFING	The required briefing was interactive and operationally thorough	— *Concise, not rushed, and met SOP requirements* — *Bottom lines were established*	4
PLANS STATED	Operational plans and decisions were communicated and acknowledged	— *Shared understanding about plans — "Everybody on the same page"*	4
WORKLOAD ASSIGNMENT	Roles and responsibilities were defined for normal and non-normal situations	— *Workload assignments were communicated and acknowledged*	4
CONTINGENCY MANAGEMENT	Crew members developed effective strategies to manage threats to safety	— *Threats and their consequences were anticipated* — *Used all available resources to manage threats*	3

Execution Behavioral Markers			Rating
MONITOR / CROSS-CHECK	Crew members actively monitored and cross-checked systems and other crew members	— *Aircraft position, settings, and crew actions were verified*	2
WORKLOAD MANAGEMENT	Operational tasks were prioritized and properly managed to handle primary flight duties	— *Avoided task fixation* — *Did not allow work overload*	3
VIGILANCE	Crew members remained alert of the environment and position of the aircraft	— *Crew members maintained situational awareness*	3
AUTOMATION MANAGEMENT	Automation was properly managed to balance situational and/or workload requirements	— *Automation setup was briefed to other members* — *Effective recovery techniques from automation anomalies*	3

Review / Modify Behavioral Markers			Rating
EVALUATION OF PLANS	Existing plans were reviewed and modified when necessary	— *Crew decisions and actions were openly analyzed to make sure the existing plan was the best plan*	4
INQUIRY	Crew members asked questions to investigate and/or clarify current plans of action	— *Crew members not afraid to express a lack of knowledge — "Nothing taken for granted" attitude*	3
ASSERTIVENESS	Crew members stated critical information and/or solutions with appropriate persistence	— *Crew members spoke up without hesitation*	

Overall Flight

Narrative	This narrative should include your overall impressions of the crew.

Overall, the crew did a marginal job with planning and review/modify plans during predeparture. However, during the descent/approach/land phase, it was excellent. Their execution behaviors were marginal to good for the entire flight.

While the takeoff brief was marginal, the CA made an outstanding approach brief. Open communication was not a problem. Good flow of information when the flight's complexity increased with the late runway change. They really stepped it up.

The big knock against this crew involved checklists, cross verifications, and all monitoring in general. They were a little too complacent during low workload periods (e.g., No altitude verifications during climb). The CA set a poor example in this regard.

During predeparture, the CA introduced an unnecessary element of being rushed, which compromised workload management. However, his decisiveness and coordination in the descent/approach/land phase kept his leadership from being marked "marginal."

1	2	3	4
Poor Observed performance had safety implications	**Marginal** Observed performance was barely adequate	**Good** Observed performance was effective	**Outstanding** Observed performance was truly noteworthy

Overall Behavioral Markers			Rating
COMMUNICATION ENVIRONMENT	Environment for open communication was established and maintained	*- Good cross talk – flow of information was fluid, clear, and direct*	*4*
LEADERSHIP	Captain showed leadership and coordinated flight deck activities	*- In command, decisive, and encouraged crew participation*	*3*

Did you observe a flight attendant briefing on the first leg of the pairing? (Check one)	**Yes**		**Rating**	
	No			
	No opportunity to observe	*X*		

	CA	FO
Contribution to Crew Effectiveness	*2*	*3*

Overall Crew Effectiveness	Rating
	3

Threat Management Worksheet

Threats — Events or errors that originate outside the influence of the flightcrew but require active crew management to maintain safety

Threat ID	*Threat Description*			*Threat Management*	
	Describe the threat	**Threat Code**	**Phase of flight** 1 Predepart/Taxi 2 Takeoff/Climb 3 Cruise 4 Des/App/Land 5 Taxi-in	**Effectively managed?** (Yes / No)	**How did the crew manage or mismanage the threat?**
T 1	*Runway and taxiway construction on their departing runway (final 2000')*	*4*	*1*	*No*	*Threat mismanaged — CA failed to talk about the construction and closures in his brief. No plans in place in the event of a RTO.*
T 2	*Late ATC runway change — changed runway to 24R from 25L due to a slow moving aircraft on 25L*	*50*	*4*	*Yes*	*Threat managed — CA reprogrammed the FMC, handled the radios, and placed emphasis on the FO to fly the aircraft.*
T 3	*ATC called back and told the crew that it was at their discretion to land on 24R or 25L*	*50*	*4*	*Yes*	*Threat managed — CA asked for the FO's preference. They mutually decided to continue the approach into 24R because it was already in the box.*
T 4	*Heavy congestion going into LAX*	*3*	*4*	*Yes*	*Threat managed — The crew closely monitored the traffic with the help of ATC and TCAS.*
T __					

Threat Codes

Departure / Arrival Threats
1 Adverse weather / turbulence / IMC
2 Terrain
3 Traffic — Air or ground congestion, TCAS warnings
4 Airport — construction, signage, ground conditions
5 TCAS RA/TA

Aircraft Threats
20 Aircraft malfunction
21 Automation event or anomaly
22 Communication event — radios, ATIS, ACARS

Operational Threats
30 Operational time pressure — delays, OTP, late arriving pilot or aircraft
31 Missed approach
32 Flight diversion
33 Unfamiliar airport
34 Other non-normal operation events — max gross wt. T/O, rejected T/O

Cabin Threats
40 Cabin event / distraction / interruption
41 Flight attendant error

ATC Threats
50 ATC command — challenging clearances, late changes
51 ATC error
52 ATC language difficulty
53 ATC non-standard phraseology
54 ATC radio congestion
55 Similar call signs

Crew Support Threats
80 MX event
81 MX error
82 Ground handling event
83 Ground crew error
84 Dispatch/ paperwork event
85 Dispatch / paperwork error
86 Crew scheduling event
87 Manuals / charts incomplete / incorrect

99 Other Threats

Error Management Worksheet

Error ID	Error Description					Error Response / Outcome		
	Describe the crew error and associated undesired aircraft states	**Phase of flight** 1 Predepart/Taxi 2 Takeoff/Climb 3 Cruise 4 Des/App/Land 5 Taxi-in	**Error Type** 1 Intentional Noncompliance 2 Procedural 3 Communication 4 Proficiency 5 Decision	**Error Code** Use Code Book	**Who committed the error?**	**Who detected the error?**	**Crew Error Response** 1 Trap 2 Exacerbate 3 Fail to Respond	**Error Outcome** 1 Inconsequential 2 Undesired state 3 Additional error
E 1	*FO failed to set his airspeed bugs.*	*1*	*2*	*211*	*2*	*1*	*3*	*3*

Error ID	Error Management		Undesired Aircraft State			
	Associated with a threat? (If Yes, enter Threat ID)	**How did the crew manage or mismanage the error?**	**Undesired Aircraft State Code**	**Who detected the state?**	**Crew Undesired State Response** 1 Mitigate 2 Exacerbate 3 Fail to Respond	**Undesired Aircraft State Outcome** 1 Inconsequential 2 Additional error
E 1	*No*	*Error chain to E2*				

Who Committed / Detected Codes

Flightcrew
1 CA
2 FO
3 SO / FE
4 Relief Officer
5 Jumpseat Rider
6 All crew members
7 Nobody

Other people
8 ATC
9 Flight attendant
10 Dispatch
11 Ground
12 MX

Aircraft
20 Aircraft systems

99 Other

Undesired Aircraft State Codes

Configuration States
1 Incorrect A/C configuration - flight controls, brakes, thrust reversers, landing gear
2 Incorrect A/C configuration — systems (fuel, electrical, hydraulics, pneumatics, air-conditioning, pressurization, instrumentation)
3 Incorrect A/C configuration — automation
4 Incorrect A/C configuration — engines

Ground States
20 Proceeding towards wrong runway
21 Runway incursion
22 Proceeding towards wrong taxiway / ramp
23 Taxiway / ramp incursion
24 Wrong gate

Aircraft Handling States — All Phases
40 Vertical deviation
41 Lateral deviation

42 Unnecessary WX penetration
43 Unauthorized airspace penetration

44 Speed too high
45 Speed too low

46 Abrupt aircraft control (attitude)
47 Excessive banking
48 Operation outside A/C limitations

Approach / Landing States
80 Deviation above G/S or FMS path
81 Deviation below G/S or FMS path

82 Unstable approach
83 Continued landing - unstable approach

84 Firm landing
85 Floated landing
86 Landing off C/L
87 Long landing outside TDZ

99 Other Undesired States

Error Management Worksheet

Error ID	Error Description					Error Response / Outcome		
	Describe the crew error and associated undesired aircraft states	**Phase of flight** 1 Predepart/Taxi 2 Takeoff/Climb 3 Cruise 4 Des/App/Land 5 Taxi	**Error Type** 1 Intentional Noncompliance 2 Procedural 3 Communication 4 Proficiency 5 Decision	**Error Code** Use Code Book	**Who committed the error?**	**Who detected the error?**	**Crew Error Response** 1 Trap 2 Exacerbate 3 Fail to Respond	**Error Outcome** 1 Inconsequential 2 Undesired state 3 Additional error
E 2	In running the Before Takeoff Checklist, the FO skipped the takeoff data item.	1	2	200	2	7	3	1
E 3	FO called "flaps up" prior to the flap retraction speed.	2	2	299	2	1	1	1

Error ID	Error Management		Undesired Aircraft State			
	Associated with a threat? (If Yes, enter Threat ID)	**How did the crew manage or mismanage the error?**	**Undesired Aircraft State Code**	**Who detected the state?**	**Crew Undesired State Response** 1 Mitigate 2 Exacerbate 3 Fail to Respond	**Undesired Aircraft State Outcome** 1 Inconsequential 2 Additional error
E 2	No	Errors mismanaged — The bug error should have been caught with the Before Takeoff Checklist, but the FO unintentionally skipped that item. All checklists during this phase were poorly executed. The FO caught the error during the takeoff roll.				
E 3	No	Error managed — CA saw that the aircraft was not at the proper speed and waited to retract the flaps. Good monitoring in this case.				

Error Management Worksheet

Error ID	***Error Description***					***Error Response / Outcome***		
	Describe the crew error and associated undesired aircraft states	**Phase of flight** 1 Predepart/Taxi 2 Takeoff/Climb 3 Cruise 4 Des/App/Land 5 Taxi	**Error Type** 1 Intentional Noncompliance 2 Procedural 3 Communication 4 Proficiency 5 Decision	**Error Code** Use Code Book	**Who committed the error?**	**Who detected the error?**	**Crew Error Response** 1 Trap 2 Exacerbate 3 Fail to Respond	**Error Outcome** 1 Inconsequential 2 Undesired state 3 Additional error
E 4	*CA and FO failed to verify multiple altitude changes.*	*2*	*1*	*140*	*1*	*6*	*3*	*1*
E 5	*FO, who was new to the aircraft, let it slip a little to the left during the final approach. Resulted in landing left of the centerline.*	*4*	*4*	*402*	*2*	*6*	*1*	*2*

Error ID	***Error Management***		***Undesired Aircraft State***			
	Associated with a threat? (If Yes, enter Threat ID)	**How did the crew manage or mismanage the error?**	**Undesired Aircraft State Code**	**Who detected the state?**	**Crew Undesired State Response** 1 Mitigate 2 Exacerbate 3 Fail to Respond	**Undesired Aircraft State Outcome** 1 Inconsequential 2 Additional error
E 4	*No*	*No error management — intentional error*				
E 5	*No*	*Error mismanaged — FO tried to correct but still landed left of the centerline. Approach was stable and they made the first high-speed taxiway. The CA did not verbalize the deviation during the approach.*	*86*	*6*	*1*	*1*

Intentional Noncompliance Error Codes

Sterile Cockpit Errors
100 Sterile cockpit violation

Callout Errors
104 Omitted takeoff callouts (i.e., V-speeds)
105 Omitted climb or descent callouts
106 Omitted approach callouts

Crew to ATC Errors
109 Altitude deviation without ATC clearance
110 Course or heading deviation without ATC clearance (deviation more than 20 degrees)
111 Use of nonstandard ATC phraseology
112 Omitted position report to ATC
113 Omitted non-radar environment report to ATC
114 Omitted call signs to ATC

Checklist Errors
120 Checklist performed from memory
121 Completed checklist not called "complete"
122 Checklist not performed to completion
123 Use of nonstandard checklist protocol (i.e., use of nonstandard responses)
124 Omitted checklist
125 Self-performed checklist — no challenge or response
126 Omitted abnormal checklist
127 Self initiated checklist — not called for by PF
128 Self initiated checklist — not called for by CA
129 Checklist performed late or at wrong time

Cross-Verification Errors
140 Failure to cross-verify MCP / altitude alerter changes

141 Failure to cross-verify FMC/CDU changes before execution
142 Failure to cross-verify altimeter settings

Hard Warning Errors
160 Failure to respond to GPWS warnings
161 Failure to respond to TCAS warnings
162 Failure to respond to overspeed warning

Briefing Errors
170 Omitted takeoff briefing
171 Omitted approach briefing
172 Omitted flight attendant briefing (only for the first flight of a trip or crew change)
173 Omitted engine-out briefing

179 Intentional failure to arm spoilers

Approach Errors
180 Failure to execute a go-around *after* passing procedural bottom lines of an unstable approach
181 Speed deviation without ATC clearance
183 Intentionally flying below the G/S
184 PF makes own flight control settings

Automation and Instrument Setting Errors
185 PF makes own MCP changes
186 PF makes own FMC changes
187 Failure to set altitude alerter
189 Setting altimeters before the transition altitude
190 Using equipment placarded inoperative

Other Noncompliance Errors
195 Taxi-in or out without a wing walker
196 A/C operation with unresolved MEL item
199 Other noncompliance errors not listed in the code book

Procedural Error Codes

Checklist Errors
200 Missed checklist item
201 Wrong checklist performed
202 Checklist performed late or at the wrong time
203 Forgot to call for checklist
206 Wrong response to a challenge on a checklist (i.e., item not checked that was responded to as “checked”)
207 Completed checklist not called "complete"
209 Omitted checklist
233 Omitted abnormal checklist

Primary Instrument or Panel Errors
210 Wrong altimeter settings
211 Wrong bug settings (i.e., airspeed or altimeter)
212 Failure to set altitude alerter
213 Failure to cross-verify altimeter settings
214 Failure to cross-verify altitude alerter

Lever and Switch Errors
215 Failure to extend the flaps on schedule
216 Failure to retract the flaps on schedule
217 Wrong display switch setting
218 Failure to leave thrust reversers extended
219 Failure to lower the landing gear on schedule
220 Failure to bring up the landing gear on schedule
221 Failure to extend the speed brakes on landing
222 Failure to retract the speed brakes
223 Failure to engage thrust reversers on landing
224 Failure to retract thrust reversers after landing
225 Failure to turn on the landing lights
226 Wrong fuel switch setting
227 Failure to turn on TCAS
228 Failure to turn on the fasten seat belt sign
229 Failure to arm spoilers
230 Failure to turn on the A/C packs (no pressurization)
231 Wrong panel setup for an engine start
278 Wrong power settings for T/O
279 Wrong autobrake setting
232 Other incorrect switch or lever settings

Mode Control Panel Errors
234 Failure to cross-verify MCP / altitude alerter changes
235 Wrong MCP altitude setting dialed
236 Wrong MCP vertical speed setting dialed
237 Wrong MCP speed setting dialed
238 Wrong MCP course setting dialed
239 Wrong MCP heading setting dialed
240 Wrong setting on the MCP autopilot or FD switch
241 Wrong MCP mode executed
242 Wrong MCP mode left engaged
243 Manual control while a MCP mode is engaged
244 Failure to execute a MCP mode when needed
245 Wrong MCP navigation select setting (NAV/GPS/ILS/VOR switch)
246 PF makes own MCP changes
247 Wrong MCP setting on the auto-throttle switch

Flight Management Computer / Control Display Unit Errors
249 Failure to cross-verify FMC/CDU changes / position
250 Wrong waypoint / route settings entered into the FMC
251 Failure to execute a FMC mode when needed
252 Wrong mode executed in the FMC
253 Wrong mode left engaged in the FMC
254 Wrong present position entered into the FMC
255 Wrong weights / balance calcs entered into the FMC
256 Wrong speed setting entered into the FMC
257 PF makes own FMC changes
258 Wrong FMC format for input
205 Wrong approach selected in the FMC
204 Other wrong CDU entries / settings

259 Wrong nav radio frequency

Radio Errors
260 Wrong ATIS frequency dialed
261 Wrong ATC frequency dialed
262 Wrong squawk

Documentation Errors
263 Wrong ATIS information recorded
264 Wrong runway information recorded
265 Wrong V-speeds recorded
266 Wrong weights and balance information recorded
267 Wrong fuel information recorded
268 Missed items on the documentation (flight plan, NOTAMS, or dispatch release)
269 Misinterpreted items on the documentation (flight plan, NOTAMS, or dispatch release)
270 Wrong time calculated in the flight plan
271 Wrong clearance recorded

Callout Errors
275 Omitted takeoff callouts (i.e., V-speeds)
276 Omitted climb or descent callouts
277 Omitted approach callouts

Job Sequence Errors
280 Executing the correct job procedures out of sequence

Handling Errors
281 Unintentional lateral deviation
282 Unintentional vertical deviation
286 Unintentional speed deviation

Ground Navigation Errors
283 Attempting or actually turning down the wrong runway
284 Attempting or actually turning down the wrong ramp / taxiway / gate
287 Attempting or actually lining up for the incorrect runway
288 Attempting or actually lining up off C/L
289 Failure to execute a go-around *after* passing procedural bottom lines of an unstable approach
290 Missed runway
291 Missed taxiway
292 Missed gate

Hard Warning Errors
293 Failure to respond to GPWS warnings
294 Failure to respond to TCAS warnings

Briefing Errors
272 Incomplete flight attendant briefing
273 Incomplete cruise briefing
274 Incomplete approach briefing
295 Omitted takeoff briefing
296 Omitted approach briefing
297 Omitted flight attendant briefing
298 Omitted engine-out briefing

Other Procedural Errors
299 Other procedural errors not listed in the code book

Communication Error Codes

Crew to ATC Errors
300 Wrong readbacks or callbacks to ATC
301 Missed ATC calls
302 Omitted call signs to ATC
303 Failure to give readbacks or callbacks to ATC
305 Omitted position report to ATC
306 Omitted non-radar environment report to ATC
307 Misinterpretation of ATC instructions
309 Crew omitted ATC call
310 Missed instruction to hold short

Crew to Crew Errors
319 Wrong airport communicated
320 Wrong taxiway communicated
321 Wrong runway communicated
322 Wrong takeoff callouts communicated
323 Wrong climb and descent callouts communicated
324 Wrong approach callouts communicated
325 Wrong gate assignment communicated
335 Crew miscommunication that lead to a misinterpretation
336 Wrong engine out procedures stated

Other Communication Errors
350 Misinterpretation of ATIS
399 Other communication errors not listed in the code book

Proficiency Error Codes

400 Lack of systems knowledge
401 Lack of automation knowledge
402 Lack of stick and rudder proficiency
403 Lack of knowledge to properly contact ATC
404 Lack of procedural knowledge
405 Lack of weather knowledge
406 Lack of knowledge of standard ATC phraseology
407 Lack of knowledge to contact company (i.e., gate assignments)

499 Other knowledge or proficiency based errors not listed in the code book

Operational Decision Error Codes

Descent and Approach Errors
500 Failure to execute a go-around *before* reaching procedural bottom-lines
501 Unnecessary low maneuver on approach
502 Approach deviation (lateral or vertical) by choice
503 Decision to start the descent late
520 Operating at the edge of the performance envelope (no buffer for error)

Navigation Errors
510 Navigation through known bad weather that unnecessarily increased risk (i.e., thunderstorms or wind shear)
512 Decision to navigate to the wrong assigned altitude
513 Decision to navigate on the incorrect heading or course
514 Decision to navigate without ground clearance

521 Speed too high for operating environment

ATC Errors
530 Accepting instructions from ATC that unnecessarily increased risk
531 Making a request to ATC that unnecessarily increased risk
532 Failure to verify ATC instructions
533 Altitude deviation without ATC notification
534 Course or heading deviation without ATC clearance
535 Accepting a visual in nonvisual conditions

Crew Interaction Errors
540 Non-essential conversation at inappropriate times

Automation Errors
550 FMC over-reliance — used at inappropriate times
551 FMC under-reliance — not used when needed
552 Heads down FMC operation
553 Discretionary omission of FMC data (e.g., winds)

Instrument Errors
560 Lack of weather radar use

Checklist Errors
570 Failure to complete a checklist in a timely manner (i.e., after takeoff checklist)

Paperwork Errors
590 Failure to cross-verify documentation or paperwork

Other Operational Decision Errors
599 Other operational decision errors not listed in the code book

Threat and Error Management Worksheet Codes

Threat Codes

Departure / Arrival Threats
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2 Terrain
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4 Airport — construction, signage, ground conditions
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20 Aircraft malfunction
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40 Cabin event / distraction / interruption
41 Flight attendant error

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50 ATC command — challenging clearances, late changes
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54 ATC radio congestion
55 Similar call signs

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80 MX event
81 MX error
82 Ground handling event
83 Ground crew error
84 Dispatch/ paperwork event
85 Dispatch / paperwork error
86 Crew scheduling event
87 Manuals / charts incomplete / incorrect

99 Other Threats

Who Committed / Detected Codes

Flightcrew
1 CA
2 FO
3 SO / FE
4 Relief Officer
5 Jumpseat Rider
6 All crew members
7 Nobody

Other people
8 ATC
9 Flight attendant
10 Dispatch
11 Ground
12 MX

Aircraft
20 Aircraft systems

99 Other

Undesired Aircraft State Codes

Configuration States
1 Incorrect A/C configuration — flight controls, brakes, thrust reversers, landing gear
2 Incorrect A/C configuration — systems (fuel, electrical, hydraulics, pneumatics, air-conditioning, pressurization, instrumentation)
3 Incorrect A/C configuration — automation
4 Incorrect A/C configuration — engines

Ground States
20 Proceeding towards wrong runway
21 Runway incursion
22 Proceeding towards wrong taxiway / ramp
23 Taxiway / ramp incursion
24 Wrong gate

Aircraft Handling States — All Phases
40 Vertical deviation
41 Lateral deviation
42 Unnecessary WX penetration
43 Unauthorized airspace penetration
44 Speed too high
45 Speed too low
46 Abrupt aircraft control (attitude)
47 Excessive banking
48 Operation outside A/C limitations

Approach / Landing States
80 Deviation above G/S or FMS path
81 Deviation below G/S or FMS path
82 Unstable approach
83 Continued landing - unstable approach
84 Firm landing
85 Floated landing
86 Landing off C/L
87 Long landing outside TDZ

99 Other Undesired States

LOSA Crew Interview

1. Training
   a) Is there a difference in how you were trained, and how things really go in line operations?
   b) If so, why?

2. Standardization
   a) How standardized are other crews that you fly with?
   b) If there is a lack of standardization, what do you think is the reason(s) for procedural non-compliance?

3. Automation
   a) What are the biggest automation "gotchas" for this airplane?

4. Overall safety improvements – concerns and suggestions for improvement
   a) Flight Ops
   b) Dispatch
   c) Airports and ATC
   d) SOPs

Appendix B

EXAMPLE OF AN INTRODUCTORY LETTER BY AN AIRLINE TO ITS FLIGHT CREWS

To: All US Airways Pilots

From: Captain Ed Bular
Senior Director, Flight Operations

Captain Ron Schilling
Director, Flight Training and Standards

Captain Pete Eichenlaub
Director, US Airways Flight Safety and Quality Assurance

Captain Terry McVenes
Chairman, ALPA Central Air Safety Committee

Subject: Line Operations Safety Audit (LOSA)

Date: October 1, 2000

Beginning mid-October and continuing for approximately five weeks, US Airways will conduct a Line Operations Safety Audit (LOSA). For this audit, we will use US Airways pilots to conduct cockpit jumpseat observations, along with three observers from the University of Texas Human Factors Research Project (a.k.a. "NASA/UT Aerospace Crew Research Project."

LOSA observations are **no-jeopardy** events, and all data are confidential and de-identified. LOSA data go directly to the UT Human Factors Research Program for data entry and analysis. Be assured that these observations are not checkrides. Although some LOSA observers may be US Airways check airmen, they are not there to critique your performance — their mission is to be an unobtrusive observer and to fill out data collection forms after the flight is completed.

Early on, it was decided that the ultimate customer of the audit should be the US Airways line pilot. By that, the audit should help us identify problem areas so that we can correct them and make your job easier. Did you ever see a procedure that could be done better, but didn't feel like you had a way to feed that idea into the system for possible change? Are some procedures better than others as far as helping avoid, trap and mitigate errors? LOSA should help us identify the strengths and weaknesses of our crew procedures, and with that information, management is committed to making necessary changes to continually improve the way that we do business.

In short, we're doing a LOSA so that we can improve the system to better support you. After the audit is completed, we're committed to telling you how it went, and how we plan to make improvements.

In addition to using US Airways pilots as LOSA observers, we will also use three observers from UT Human Factors Research Program. These gentlemen are very experienced LOSA observers, having worked with the UT program for many years. They are John Bell, Roy Butler and James Klinect, and their credentials can be verified by your requesting that they present a copy of their FAA jumpseat authorization.

Please extend your usual professional courtesies to the LOSA observation team, and thank you for your unfailing cooperation.

Sincerely,

Captain Ed Bular
Senior Director, Flight Operations

Captain Ron Schilling
Director, Flight Training and Standards

Captain Pete Eichenlaub
Director, Flight Safety and Quality Assurance

Captain Terry McVenes
Chairman, ALPA Central Air Safety Committee

Appendix C

LIST OF RECOMMENDED READING AND REFERENCE MATERIAL

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