

**Maintenance and ramp line operations safety assessment (M&R LOSA):  
using a tested approach for risk management and safety enhancement**

Avaliação de segurança nas operações de linha em serviços de rampa e de manutenção  
(M&R LOSA): utilizando uma abordagem testada para gerenciamento de riscos e  
aumento da segurança

**Maggie Jiao MA<sup>1</sup>**

**Brian WOOD<sup>2</sup>**

**ABSTRACT:** *The aviation industry is maturing in its preference for proactive intervention over post-accident remediation in potentially hazardous circumstances. Line Operations Safety Audits (LOSA) adopts a truly proactive and predictive strategy to address aviation safety. As a voluntary safety program, LOSA collects safety data during normal airline operations through peer observations in strict non-jeopardy conditions. Sponsored by the Federal Aviation Administration (FAA), an M&R LOSA project was launched in October 2008 to capitalize on the successes of flight deck LOSA and extend it to aviation maintenance and ramp operations. The project delivered an array of open source tools, including observation data collection forms, procedures, program manuals, scenario-based training, and databases. The M&R LOSA programs are expected to positively leverage peer pressure to enforce behavior change and allow subunits of an organization to build in some flexibility to address their key problems and assure the effectiveness of safety recommendations.*

**KEYWORDS:** *Line operations safety audit (LOSA); safety management system; voluntary safety program.*

**RESUMO:** *A indústria da aviação está amadurecendo no que tange sua preferência pela intervenção proativa sobre a remediação pós-acidente em circunstâncias potencialmente perigosas. O Programa de auditorias de Segurança nas Operações de Linha (LOSA) adota uma estratégia verdadeiramente proativa e preditiva para lidar com a segurança na aviação. Como um programa de segurança de caráter voluntário, o LOSA coleta os dados de segurança durante as operações normais das companhias aéreas através das observações de colegas em condições estritas de não risco. Patrocinado pela Federal Aviation Administration (FAA), um projeto do M&R LOSA foi lançado em outubro de 2008 para capitalizar sobre os sucessos do LOSA na cabine de comando e estendê-lo aos serviços de rampa e de manutenção de aeronaves. O projeto disponibilizou uma gama de ferramentas de código aberto, incluindo formulários de coleta de dados de observação, procedimentos, manuais de programas, treinamento baseado em cenários e bancos de dados. Espera-se que os programas do M&R LOSA alavanquem a pressão dos colegas de maneira positiva,*

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<sup>1</sup> Maintenance Human Factors, Boeing Commercial Aviation Services, [maggie.j.ma@boeing.com](mailto:maggie.j.ma@boeing.com)

<sup>2</sup> Vice President, Operations and Customer Service, Airport Terminal Services, Inc., [bwood@atsstl.com](mailto:bwood@atsstl.com)

*visando a impelir uma mudança de comportamento e permitir que subunidades de uma empresa incorporem alguma flexibilidade para lidar com seus problemas mais importantes e garantir a efetividade das recomendações de segurança.*

***PALAVRAS-CHAVE:*** Programa de Auditorias de Segurança nas Operações de Linha (LOSA); sistema de gerenciamento de segurança; programa de segurança de caráter voluntário.

## **1 Introduction**

Managing risks has become increasingly important in modern organizations. Three sources of information may indicate emerging safety risks: (1) reactive sources highlight issues after an undesired event has taken place, (2) proactive sources look for precursors to undesired events, and (3) predictive sources capture system performance as it happens in real-time, normal operations (Illson, 2006). The aviation industry is maturing in its preference for proactive intervention over post-accident remediation in potentially hazardous circumstances (Jones & Tesmer, 1999). Systems such as the National Aeronautics and Space Administration's Aviation Safety Reporting System (ASRS) and the Aviation Safety Action Program (ASAP) encourage air carrier and repair station employees to voluntarily report unsafe conditions. However, those systems are used proactively following adverse events. Line Operations Safety Audits (LOSA) adopts a truly proactive and predictive strategy to address aviation safety. As a voluntary safety program, LOSA collects safety data during normal airline operations through peer observations in strict non-jeopardy conditions and was originally designed for flight deck operations. Since 2001 flight LOSA has been used to improve safety and enhance performance. The hazards that threaten the safety of flight deck operations are not unique to that environment. Similar problems are present during maintenance and ramp operations.

The Safety Management System (SMS) is becoming a standard throughout the aviation industry worldwide. The essential idea of any SMS is to provide a systematic approach to achieve acceptable levels of safety risk. Serving as the core of a company's variety of safety efforts, SMS provides an organizational framework to support a sound safety culture (FAA, 2006). LOSA data are critical to sustaining a functional SMS. Assisted by safety audits of normal operations, SMS also provides significant business benefits such as better operational process management and consequently, financial benefits. In fact, SMS carries the same level of importance as a financial management system because unexpected events in either system may cause major harm to maintenance and ground operations.

## **2 Reshaping Flight Deck LOSA for Maintenance and Ramp Operations**

There remains substantial opportunity for safety improvement on the ramp and in the hangar. The Flight Safety Foundation (Lacagnina, 2007) estimates the airline industry worldwide is losing US \$5 billion a year worldwide in direct and indirect costs associated with aircraft damage on the ramp. It is further estimated that 243,000 people are injured on the ramp every year. The LOSA process holds promise to reduce the incidents and accidents by providing a means for ramp and maintenance workers to identify and develop methods to address threats and errors before they lead to an incident or accident.

In order to capitalize on the success of flight deck LOSA and reshape it to match the requirements of maintenance and ramp environments, it is essential to compare and contrast the similarities and differences among flight, maintenance, and ramp operations. Based on a literature review and interviews with domain experts, these three areas of aviation were compared in the following aspects: work scope, risks, general process and duration, documentation use, personnel, training/certification, work environment, and challenges (Table 1).

	<b>Flight</b>	<b>Maintenance &amp; Inspection</b>	<b>Ramp</b>
<b>Scope</b>	Four phases: <ul style="list-style-type: none"> <li>- Predeparture/Taxi</li> <li>- Taxi, Take-off &amp; Climb</li> <li>- Cruise</li> <li>- Descent, Approach &amp; Land</li> </ul>	All varieties of maintenance activities on and off the flight line	All operations required to service an aircraft during a normal turnaround between landing and departure, including marshalling, chocking, refueling, servicing water/lavatory, catering, passenger boarding/disembarking, loading/unloading baggage, aircraft towing, and pushback
<b>Risk</b>	<ul style="list-style-type: none"> <li>- A typical airline flight faces three to six threats, on average, from weather, air traffic control, airport conditions, and airline support function</li> <li>- Extremely high mental workload during certain phases of flight</li> </ul>	<ul style="list-style-type: none"> <li>- Dangerous work environment</li> <li>- Exposure to common industrial hazards, hazardous materials, noise, radiation, temperature and humidity extremes, as well as the risks involving the aircraft and moving equipment</li> <li>- The FAA estimates that one airline loses between \$75 and \$100 million each year to</li> </ul>	<ul style="list-style-type: none"> <li>- A dangerous environment where workers are at risk of death, disabling injury, and work-related stress</li> <li>- The Flight Safety Foundation found that nearly 14 out of every 100 ramp workers are injured yearly</li> </ul>

		maintenance related problems	
<b>General Process &amp; Duration</b>	<ul style="list-style-type: none"> <li>- Divided by different phases of flight</li> <li>- Varying differences in length of flight</li> <li>- Maximum work hours are enforced</li> </ul>	<ul style="list-style-type: none"> <li>- Multiple people and shifts may work on one task</li> <li>- Impact can be hidden and long lasting</li> <li>- Shift work and overtime</li> </ul>	<ul style="list-style-type: none"> <li>- Multiple people and shifts may work on one task</li> <li>- Impact can be hidden and long lasting</li> <li>- The cyclical nature of this job and intensive work hours with constrain physical and mental performance</li> </ul>
<b>Documentation Use</b>	<ul style="list-style-type: none"> <li>- Extensive (manual, checklists, diagram &amp; charts, etc.)</li> <li>- A trail of paperwork</li> </ul>	<ul style="list-style-type: none"> <li>- Extensive (manual, work cards, etc.)</li> <li>- A trail of paperwork</li> </ul>	<ul style="list-style-type: none"> <li>- Less paperwork compared to the other two domains</li> </ul>
<b>Personnel</b>	<ul style="list-style-type: none"> <li>- Most with college education</li> <li>- Must meet medical requirements</li> <li>- Mostly unionized</li> </ul>	<ul style="list-style-type: none"> <li>- No medical requirements</li> <li>- Mostly unionized</li> </ul>	<ul style="list-style-type: none"> <li>- No medical requirements</li> <li>- Mostly non-unionized</li> </ul>
<b>Training &amp; Certificates</b>	<ul style="list-style-type: none"> <li>- Aviation schools under Part 61 or Part 141 or military</li> <li>- Highly trained with federal licensure</li> <li>- A full range of certification and ratings</li> </ul>	<ul style="list-style-type: none"> <li>- Aviation Maintenance School program certificated under Part 147 with an FAA-approved and supervised curriculum</li> <li>- Highly trained with Federal licensure and certificates</li> <li>- Aircraft Maintenance Technician certification</li> <li>- Airframe &amp; Powerplant license</li> </ul>	<ul style="list-style-type: none"> <li>- Company training</li> <li>High turnover rate</li> <li>No certification required</li> </ul>
<b>Work Environment</b>	<ul style="list-style-type: none"> <li>- Confined space</li> <li>- Multiple ways to communicate with external world real-time (e.g., radio, data link)</li> </ul>	<ul style="list-style-type: none"> <li>- Harsh environment</li> <li>- Confined space</li> <li>- Depend on a trail of paperwork and brief interpersonal communication to connect with external world</li> </ul>	<ul style="list-style-type: none"> <li>- Frequently work in restricted spaces on a congested apron with other service equipment vehicles, aircraft, and pedestrians</li> <li>- Time pressure, noise, jet blasts, and weather</li> <li>- Some agents are on radios; overall communication is difficult, especially with the required hearing protection</li> </ul>
<b>Challenges</b>	<ul style="list-style-type: none"> <li>- Extremely high responsibilities</li> <li>- Fatigue, time pressure,</li> </ul>	<ul style="list-style-type: none"> <li>- Shift turn-over</li> <li>- Distraction, fatigue, time pressure, harsh</li> </ul>	<ul style="list-style-type: none"> <li>- Shortage of staff</li> <li>- Distraction, fatigue, time pressure, harsh</li> </ul>

	automation, technology, etc.	environmental factors, etc. - Outsourcing - Both physically and mentally challenging	environmental factors - Both physically and mentally challenging
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**Table 1.** *Differences among Flight, Maintenance, and Ramp Operations*

*Note:* (Fiorino, 2004; Hobbs & Williamson, 1995; Kerkloh, 1992; McDonald & Fuller, 1994; NSC, 1975; Orlady, Orlady, & Lauber, 1999; Rankin, Hibit, Allen, & Sargent, 2000; Tumulty, 2002).

### 3 M&R LOSA Project

Sponsored by the Federal Aviation Administration (FAA), under the direction of the Air Transport Associations (ATA)'s Maintenance and Ramp Human Factors Task Force, a M&R LOSA project was launched in October 2008 to capitalize on the successes of flight deck LOSA and extend it to aviation maintenance and ramp operations by reshaping flight deck LOSA to match the requirements of maintenance and ramp environments. To best promote voluntary participation and non-punitive safety culture, the task force has redefined LOSA as "Line Operations Safety Assessment." The goal of the M&R LOSA initiative is to develop a practical, customizable, and scalable methodology and deliver it to the industry along with an open source toolset. A comprehensive literature review and examination of the grassroots LOSA effort in aviation maintenance and ramp operations provided a holistic view of where the industry currently stands in terms of mentality, operational demands, technological preparedness, and resources for M&R LOSAs (Ma et al., 2011). The ATA's task force designed and developed an array of open source tools, including observation data collection forms, procedures, program manuals, scenario-based training, and databases. The databases offer data management capabilities including storage, analysis, and reporting. The task force consulted numerous airline safety representatives who were engaged in ongoing maintenance and ramp LOSA efforts which brought in experience from thousands of LOSA observations from around the world. After initial development, between September 2009 and November 2010, five rounds of beta testing were conducted for ramp, line maintenance, and base maintenance with Part 135 and Part 121 carriers at five different U.S. airports and allowed input from over 100 maintenance technicians and ramp personnel. Both passenger and cargo operations were evaluated. In April 2011, a maintenance and ramp LOSA trial implementation was conducted focusing on identifying (1) any weaknesses in the current LOSA programs, and (2) gaps to a successful implementation.

### 4 Customization

The design and development of observation forms, procedures, and training for the M&R LOSA programs paid particular attention to the difference among maintenance, ramp operations and flight operations. The following are some examples:

Forms and Training: In flight deck LOSA, the duration of the flight and cockpit allow the observers ample time and a relative comfortable environment to take extensive notes. Observers are often allocated several hours after each flight to finish up notes and complete coding. For maintenance and ramp LOSAs, due to the challenging physical environment and quick turn-around, the observation forms were designed to be in a checklist style with some fields for additional notes, which saves the observers from writing extensive notes during the observation and places less demand on their memory, spelling skills, and penmanship. Another advantage of very structured checklist styled observation forms is to assist the observers in collecting extensive information. In contrast to flight data recording, there is no real-time objective data recording which can be utilized for comparison purposes in maintenance and ramp LOSAs.

A flight LOSA observation is carried out for different phases of a flight. For maintenance and ramp LOSA, observation forms were sectioned by different tasks to offer flexibility to observers. For example, the maintenance forms include nine tasks such as planning, troubleshooting, preparing for removal, removal, preparing to install, servicing, and so on. A separate set of forms were specifically designed for quality control inspection tasks. Maintenance training materials are customized for line maintenance, base maintenance, and shops, and quality inspection. The ramp forms consist of eleven different phases and tasks of ramp operations: arrival, downloading, lavatory/potable water, catering, cleaning service, fuel service, uploading, departure, a/c maintenance, de-ice/anti-ice, and pilot walk-around.

Post-Observation Discussion: In flight LOSA, the observers were trained to use “buzz in, observe, buzz out” style due to a main concern of “being neutral and non-punitive.” At the end of an observation, pilots might ask the observer to “debrief” their performance. In these circumstances, flight LOSA observers were trained to politely decline the invitation. This emphasizes the concept that the observer is not there to evaluate the frontline employees, merely to record events (FAA, 2006). In flight LOSA, the observer is up and close, riding with the crew for an extended period of time. So it is very unlikely the observer would miss any details. In maintenance and ramp LOSAs, observers often have to stand farther away due to all the distractions going on and sometimes a short turn-around, so some format of discussion after each observation may be a natural and polite way to end the observation. Particularly, experience at some organizations has shown the benefits of a post-observation discussion with the technicians or ramp agents. The sole purpose of this discussion is to gather additional demographic information and offer a two-way communication opportunity to clarify questions either observers or the employees being observed may have. As this discussion is voluntary, technicians or ramp agents can refuse to answer any questions they do not feel comfortable to address. Immediately following each observation is the best time to catch the frontline

employees. The observers need to be trained and calibrated to carry out the post-observation discussion using pre-scripted protocols. They should ask the questions in a diplomatic way (e.g., “Why do people often skip knee pads at this station?” instead of “Why didn’t you put on knee pads?”) An organization can decide if it wants to adopt the post-observation discussion based on its safety culture, communication style, and labor/management dynamics.

Technology Use: Paper/pencil format works the best for flight LOSA, because, compared to tapping and typing sounds, it is less disturbing to the pilots who are being observed in the cockpit. On the other hand, portal electronic devices (e.g., tablet PC, personal digital assistant/PDA, or smart phone) may be an effective alternative for observers in M&R LOSA programs because (1) the maintenance and ramp observation forms are checklist based, which do not require extensive text entry; (2) using PDA/tablet PC is less distracting to the frontline employees in general maintenance and ramp environments.

The Task Force has released the M&R LOSA observation forms, procedures, databases, and training materials for the public ([www.MRLOSA.com](http://www.MRLOSA.com)). The task force is working on a detailed implementation manual for M&R LOSA programs including written protocols for LOSA observers.

## **5 Success Story**

Maintenance LOSA observations have been found to help make deactivation procedures more workable, efficient, and safer. For example, Boeing 767 leading edge device deactivation and reactivation procedures used to take three hours to properly tag out without individual sign-offs, because some systems being deactivated were not necessary. Lockout and tag out leading edge device in the Maintenance Manual (MM) is 37-pages long. Some steps refer to other sections of the MM. In mid 2007, a maintenance LOSA auditor at the former Continental Airline identified this inefficiency, which was then addressed by Tech Publications by rewriting their deactivation/reactivation procedures. Now, with sign-offs, this modified process takes between thirty and forty-five minutes to complete. The new procedures also help to standardize the process to avoid problems caused by shift changes (deactivation and reactivation are often carried out by different shifts) and interruptions. This improved procedure has been implemented in the entire fleet. As a result of the changes implemented by maintenance LOSA, the threats have been reduced tremendously and there has been no damage to the aircraft since.

## **6 Example**

After some pilot tests, Airport Terminal Services (ATS) launched its LOSA program for all ramp and passenger service operations in November 2010. As a leading indicator in ATS’ SMS, the LOSA program is a non-punitive peer lead observation program. Trained observers complete an

online report based on their observations. This online report feeds the results into a database where the data are cleansed and then sent back out to the field formatted as good usable information. The data from the LOSA program are then distributed and used in, for instance, crew briefings, lead supervisor meetings, safety meetings. The LOSA data are used corporately to help assess the effectiveness of ATS' training programs and to help ATS be more proactive in identifying trends that need to be addressed. LOSA offers an excellent separate stream of data that ATS can compare to its audit trends. With nearly 20,000 observations conducted, LOSA is a key link in the favorable safety results at ATS. ATS is a firm believer that the ramp LOSA can be adaptable for even small operations and the trained observers can be part of the working crew – not necessarily in addition or above the work line compliment.

To summarize, the M&R LOSA programs are expected to positively leverage peer pressure to enforce behavior change and allow subunits of an organization to build in some flexibility to address their key problems and conquer them one at a time. The periodic assessment can help ensure that specific problems identified have been resolved, as well as assure the effectiveness of safety recommendations.

## **7 Acknowledgements**

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