



SYSTEM SAFETY SOCIETY

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Professionals Dedicated to the Safety of Systems, Products & Services

Safety Management System (SMS)

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Topics/Agenda

- System Safety Engineering Management history basic philosophy, and definitions.
- Under what authority is SMS required?
- The SMS defined and its elements (The basic structure of the ICAO, FAA, and JPDO SMS program).
- SMS Implementation.
- Potential issues/challenges
- References for additional information



History - System Safety Engineering Management

- System Safety Engineering had its origin in the 1950s and early 1960 in the U.S. Air Force Ballistic Missile Division, where safety is especially critical.
- This new pro-active systematic concept of System Safety was to identify the safety problems ahead of experiencing catastrophic events and thus able to minimize and manage those risks in the design process.
- One of the key points was that everything operates as a “system” and that all failures (parts, humans, management, and the environment) affect the final outcome of the “system.”
- The System Safety approach is a pro-active and systematic approach to identify potential initiating failure conditions and their worst likely effects on the “system.”



History - System Safety Engineering Management

- MIL–S–38130 was first published in 1963.
- Bell’s System Safety effort was initiated on a USAF military helicopter contract in 1969 to MIL-S-38130A of 1966.
- In July of 1969, MIL-STD-882 became the System Safety Engineering standard, with continuing revisions up to present Revision E, just released.
- U.S. military services (DoD) require System Safety efforts on military aircraft and engines.



System Safety Engineering Management

- From, “**DoD - Standard Practice for System Safety**” MIL-STD 882E
- **System.** An integrated composite of people, products, and processes that provide a capability to satisfy a stated need or objective.
- **System safety.** *The application of engineering and management principles, criteria, and techniques to achieve acceptable mishap risk, within the constraints of operational effectiveness and suitability, time, and cost, throughout all phases of the system life-cycle.*
- **System safety engineering.** An engineering discipline that employs specialized professional knowledge and skills in applying scientific and engineering principles, criteria, and techniques to *identify and eliminate hazards*, in order to *reduce* the associated mishap *risk*.
- **System safety management.** *All plans and actions taken to identify, assess, mitigate, and continuously track, control, and document environmental, safety, and health (ESH) mishap risks encountered in the development, test, acquisition, use, and disposal of DoD weapon systems, subsystems, equipment, and facilities.*



System Safety Engineering Management

- From, “FAA Oder 8000.369, System Safety Management Guidance” (09/30/2008)
- **System.** An integrated set of constituent pieces combined in an operational or support environment to accomplish a defined objective. *These pieces include people, equipment, information, procedures, facilities, services, and other support services, which interact.*
- **System engineering.** A discipline that concentrates on the design and application of the *whole (system)* as distinct from the parts. It involves looking at a problem in its entirety, taking into account *all the facets and all the variables*, and relating the social to the technical aspect. The translation of *operational requirements* into *design, development*, and *implementation* concepts and requirements in the *lifecycle of a system*.
- **System safety.** The application of engineering and management principles, criteria, and techniques to optimize *all aspects of safety* within the constraints of operational effectiveness, time, and cost throughout *all phases of the system lifecycle*.
- **System safety engineering.** An engineering discipline requiring specialized professional knowledge and skills in applying scientific and engineering principles, criteria and techniques to identify and *eliminate hazards, in order to reduce the associated risk*.
- **System safety management.** A management discipline that defines system safety program requirements and ensures the planning, implementation, and accomplishment of system safety tasks and activities are consistent with *the overall program requirement*.



Under What Authority is SMS Required?

- AKA, “Who came up with this great idea?”



Background - ICAO

- International Civil Aviation Organization (ICAO)
- ICAO is a United Nations affiliated organization that is dedicated to increasing the safety and security of international civil aviation.
- The organization addresses fundamental issues ranging from air navigation and capacity to emerging environmental concerns such as engine noise and emissions.
- As a member of ICAO, the U.S. has committed to comply with ICAO safety standards



ICAO Standard

- ICAO issued an SMS standard in 2006.
- Part 1 of ICAO's SMS mandate deals with scheduled commercial transport and charter (non-scheduled commercial) operations, while Part 2 deals with private non-revenue aircraft
- This standard applies to all operations of aircraft by operators authorized to conduct international commercial air transport (Annex 6, Part 1) and to private aircraft with a certified Maximum Takeoff Weight (MTOW) of 12,500 pounds (5,700 kg) and/or private aircraft with one or more turbo jet engines (Annex 6, Part 2, Chapter 3).
- ICAO mandates that member states require, as part of a state safety program, operators to establish an SMS for commercial operations. For GA, an operator conducting international operations over 12,500 pounds (5,700 kg MTOW) is required to establish an SMS (Annex 6, Part 2).



Background - FAA

- The SMS doctrine is derived in part from the statutory authority in Title 49 of the United States Code (49 U.S.C.) and Title 14 of the Code of Federal Regulations (14 CFR).
- Title 49 U.S.C. Chapter 401 of subpart L part A, Section 40101(d), establishes safety considerations in the public interest and states that the Administrator shall consider the following matters, among others, as being in the public interest:
 - (1) Assigning, maintaining, and enhancing safety and security as the highest priorities in air commerce.
 - (2) Regulating air commerce in a way that best promotes safety and fulfills national defense requirements.
 - (3) Encouraging and developing civil aeronautics, including new aviation technology.
 - (4) Controlling the use of the navigable airspace and regulating civil and military operations in that airspace in the interest of the safety and efficiency of both of those operations.
 - (5) Consolidating research and development for air navigation facilities and the installation and operation of those facilities.
 - (6) Developing and operating a common system of air traffic control and navigation for military and civil aircraft.



Background - JPDO

Joint Planning and Development Office (JPDO)

Vision 100 Century of Aviation Reauthorization Act (Public Law 108-176) created the JPDO to **manage the work related to the development of the Next Generation Air Transportation System (NextGen)**, a vision of air transportation in 2025. Basic tenets described in the NextGen Integrated Plan include the following:

- (1) Ensuring the future air transportation system will remain the world's safest form of transportation **requires a new safety approach**.
- (2) Regulatory authorities must change their role from focusing on testing, inspecting, and certifying individual elements to focusing on approvals and audits of the safety management of aviation product/service providers.
- (3) Safety needs to be embedded in all products, policies, or technologies. A **comprehensive safety management doctrine** will create high-level standards and procedures for the safety programs of aviation product/service providers and those that provide the associated safety oversight.
- (4) Standards cannot be put in place without a data analysis capability to identify and resolve accident precursors



Joint Planning Development Office

- Memorandum of Understanding (MOU) signed 9 June 2008 by five (5) government agencies:
 - Department of Transportation (DOT)
 - Department of Defense (DoD)
 - Department of Homeland Security (DHS)
 - Department of Commerce (DOC)
 - National Aeronautics and Space Administration (NASA)
- SMS Standard v. 1.4 was created by the Safety Working Group (SWG) of the JPDO and published 2008
- The JPDO SMS Standard v. 1.4 was developed for use by the government member agencies



Safety Management System

Definition:

- a ``systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies, and procedures."''

International Civil Aviation Organization (*ICAO*), *Safety Management Manual*, at 1.4.2, *ICAO Doc. 9859-AN/460 (1st ed. 2006)*.



Safety Management System

Definition:

- “An SMS is an integrated collection of processes, procedures, and programs that ensures a formalized and proactive approach to system safety through risk management. Risk analysis is required for all activities or process changes to identify safety impacts. The SMS is a closed-loop system ensuring corrective actions or process changes are documented and all problems or issues are tracked to resolution”.

FAA Order 8000.369, System Safety Management Guidance” (09/30/2008)



SMS and System Safety Attributes

- Responsibility and authority for accomplishment of required activities,
- Procedures to provide clear instructions for the members of the organization to follow,
- Controls which provide organizational and supervisory controls on the activities involved in processes to ensure they produce the correct outputs,
- Measures of both the processes and their products,
- Interfaces are a critical aspect of system management; recognizing the important interrelationships between processes and activities within the company as well as with contractors, vendors, customers, and other organizations with which the company does business.
- (The Human Aspect of Organizations). “An organization’s Safety Culture consists of its values, beliefs, legends, rituals, mission goals, performance measures, and sense of responsibility to its employees, customers, and the community



SMS Elements

Referred to as “The Four Pillars of SMS”

- Policy
- Safety Risk Management (SRM)
- Safety Assurance
- Safety Promotion



SMS comparisons (Policy)

JPDO (SMS v. 1.4)	FAA (AC-120-92A)	ICAO
4.0 Policy	1.0 Safety Policy and objectives	1.0 Safety Policy and objectives
4.1 General Requirements	1.1 Safety Policy	1.1 Management commitment and responsibility
4.2 Safety Policy	1.2 Management Commitment and Safety Accountabilities	1.2 Safety Accountabilities
4.3 Quality System	1.3 Key Safety Personnel	1.3 Appointment of Key Safety Personnel
4.4 Safety Planning	1.4 Emergency Preparedness and Response	1.4 Coordination of Emergency Response Planning
4.5 Organizational Structure and Responsibilities	1.5 SMS Documentation and Records	1.5 SMS Documentation
4.6 Compliance with Legal and Other Requirements		
4.7 Operational Procedures and Controls		
4.8 Emergency Preparedness and Response		
4.9 Safety Documentation and Records		



SMS comparisons (SRM)

JPDO (SMS v. 1.4)	FAA (AC-120-92A)	ICAO
5.0 Safety Risk Management	2.0 Safety Risk Management	2.0 Safety Risk Management
5.1 General Requirements	2.1 Hazard Identification and Analysis	2.1 Hazard Identification
5.2 Describe System	2.1.1 System Description and Task Analysis	2.2 Safety Risk Assessment and Mitigation
5.3 Identify Hazards	2.1.2 Identify Hazards	
5.4 Analyze Safety Risk	2.2 Risk Assessment and Control	
5.5 Assess Safety Risk	2.2.1 Analyze Safety Risk	
5.6 Control/Mitigate Safety Risk	2.2.2 Assess Safety Risk	
	2.2.3 Control/Mitigate Safety Risk	

SMS comparisons (Safety Assurance)

JPDO (SMS v. 1.4)	FAA (AC-120-92A)	ICAO
6.0 Safety Assurance	3.0 Safety Assurance	3.0 Safety Assurance
6.1 General Requirements	3.1 Safety Performance Monitoring and Measurement	3.1 Safety Performance Monitoring and Measurement
6.2 Information Acquisition	3.1.1 Continuous Monitoring	3.2 The Management of Change
6.3 Analysis of Data/Information	3.1.2 Internal Audits by Operational Departments	3.3 Continuous Improvement of the SMS
6.4 System Assessment	3.1.3 Internal Evaluation	
6.5 Corrective Action	3.1.4 External Auditing of the SMS	
6.6 Management reviews	3.1.5 Investigation	
	3.1.6 Employee Reporting and Feedback System	
	3.1.7 Analysis of Data	
	3.1.8 System Assessment	
	3.2 Management of Change	
	3.3 Continuous Improvement	
	3.3.1 Preventive/Corrective Action	
	3.3.2 Management Review	



SMS comparisons (Safety Promotion)

JPDO (SMS v. 1.4)	FAA (AC-120-92A)	ICAO (Doc 9859)
7.0 Safety Promotion	4.0 Safety Promotion	4.0 Safety Promotion
7.1 Safety Culture	4.1 Competencies and Training	4.1 Training and Education
7.2 Communication and Awareness	4.1.1 Personnel Expectations (Competence)	4.2 Safety Communication
7.3 Personnel Competency	4.1.2 Training	
7.4 Safety Knowledge Management	4.2 Communication and Awareness	

Note: The JPDO SMS Standard v. 1.4 has an additional ‘Pillar’ entitled, “Interoperability”



SMS Implementation Steps

- Five steps are recommended to phase in SMS
- First step:
 - Gather information
 - Evaluate corporate goals and objectives
 - Determine the viability of committing resources to an SMS implementation effort



SMS Implementation Steps

- Second step:
 - Top management commits to providing the resources necessary for full implementation of SMS through out the organization.
 - Conduct Gap Analysis - An initial step in developing an SMS is to analyze and assess existing programs, systems, processes, and activities with respect to the SMS functional expectations found in the SMS Framework.
 - “Gaps” being those elements required by the SMS Framework that are not already being performed by the service provider.
 - Create an implementation plan. The implementation plan is simply a “road map” describing how the service provider intends to close the existing gaps by meeting the objectives and expectations in the SMS Framework.



SMS Implementation Steps

- Third step:
 - Develop and implement a basic safety risk management (SRM) process and plan
 - Organize and prepare the organization for further SMS development.
 - Information acquisition, processing, and analysis functions are implemented and a tracking system for risk control and corrective actions are established.
 - Known deficiencies in safety management practices and operational processes are corrected
 - An awareness of hazards develops and the appropriate systematic application of preventative or corrective action(s) occurs.
 - This allows for **reaction** to unwanted events and problems as they occur and to develop appropriate remedial action(s)



SMS Implementation Steps

- Fourth step:
 - Safety risk management (SRM) is applied to initial design of systems, processes, organizations, and products, development of operational procedures, and planned changes to operational processes.
 - The activities involved in the SRM process involve careful analysis of systems and tasks involved; identification of potential hazards in these functions, and development of risk controls.
 - The risk management process developed now is used to analyze, document, and track these activities.
 - The processes are used to look ahead however, these *proactive* processes have been implemented but their performance has not yet been proven



SMS Implementation

- Fifth step:
 - This is the final step in SMS implementation.
 - Processes are in place and the performance and effectiveness have been verified.
 - The complete safety assurance (SA) process, including continuous monitoring and the remaining features of the other SRM and SA processes are functioning.
 - A major objective of a successful SMS is to attain and maintain this **continuous improvement** status for the life of the organization



SMS Implementation

- “By 2025 safety design assurance will have been built into all operations under the Next Generation of Air Transportation System (NextGen)”.



SMS Implementation

- For approximately a decade, many of the System Safety concepts have been or are being integrated into the civil aviation world, under the phrase, “Safety Management System (SMS)”.
- Transport Canada Agency and the FAA have been extensively involved in risk management systems, as have the North American civil aircraft manufacturers.
- New aircraft certifications are now requiring Function Hazard Assessments (FHAs) and System Safety Assessments (SSAs), which are part of SMS for initial certification.



SMS Implementation

- SMS also has a place in Continuing Airworthiness of existing aircraft to stay within the certificated configuration.
- The closed loop process used by most Type Certificate (TC) Holders includes hazard or quality deficiency identification, problem analysis, and notification processes, problem correction, and implementing the corrective action(s).
- This is a continuous process that TC Holders have been using to improve their fleets and meet several Federal Aviation Regulations (FARs).



Potential Issues/Challenges

- Common taxonomy (e.g., SRM is used with SMS. Army uses CRM, Air Force uses ORM).
- Analysis of systems and tasks involved. Systems and tasks not being equal between entities. (e.g., 'Flight time', when does it start and end?)
- Identification of potential hazards. How this is accomplished and to what level is not specified. (e.g., Source, mechanism, outcome).
- Are hazards specific enough? (e.g., 'FOD' from runway, or maintenance debris, or lost tools or all of the above?)
- FAA has no formal mechanism/department for certification of SMS. Relying on self certification which may not be accepted globally. Some organizations offer certification (IS-BAO, EASA) but their inspection criteria is not always directly tied to ICAO, or FAA requirements.
- A variety of SMS formats are materializing which could lead to conflicts between standards and confusion or need for developing multiple SMSs (FAA, ICAO, JPDO, etc.)
- Need to review and align DoD regulations, standards, etc. with SMS requirements/taxonomy
- Risk assessment matrixes are not standardized



SMS Implementation References

- **The following references are recommended reading material for the development and implementation of an SMS:**
 - a. Safety Management Implementation (SMS) Guide Rev. 3, FAA.
 - b. Annex 6 to the Convention on International Civil Aviation, Operation of Aircraft
 - c. International Civil Aviation Organization (ICAO) Document 9859, ICAO Safety Management Manual (SMM)
 - d. ICAO Document 9734, Safety Oversight Manual
 - e. FAA Order 8000.369, Safety Management System Guidance
 - f. FAA Order VS 8000.367, Aviation Safety (AVS) Safety Management System Requirements
 - g. FAA Order 8000.368, Flight Standards Service Oversight
 - h. SMS Framework, FAA, AFS SMS Program Office Safety Management System Framework
 - i. SMS Assurance Guide, FAA, AFS SMS Program Office Safety Management System Assurance Guide
 - j. SMS Guidebook for Developing a Safety Management System for Air Operators (Currently in development)
 - k. FAA AC 120-92A, Safety Management Systems for Aviation Service Providers



Conclusion

- Safety Management System (SMS) is essentially System Safety Engineering Management.
- Implementation of SMS for most large aviation corporations and contractors working on U.S. military programs should not be too difficult as they already have most if not all the elements. They may just have to organize and/or name them differently.
- It is organized in a specific framework order and offers specific guidance regarding a “phased in” approach.
- It allows for a tailored approach to an organization’s unique requirements.
- It offers a global framework for system safety (consistency).
- Hazard identification/tracking is vague and leaves it open to the interpretation of the organization.
- Interoperability between organization's data/hazard tracking could be a challenge and should be addressed through agreements on common definitions/parameters.
- Certification could be a challenge and become inconsistent leading to the need for multiple certifications.



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