FAA
Air Traffic Organization

Introduction to Safety Management System

Presented to: ATS Incident Analysis Workshop
By: Rafael D. L. Quezada, International Programs Officer (FAA Air Traffic Organization)
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Overview

- What is Safety Management System?
- Four Components of SMS
- Integrating SMS into Operations

What is Safety Management System?

Questions That SMS Answers

Are there currently unmanaged risks or leading indicators pointing to unsafe conditions?

- What is going to be your next accident?

Did we introduce additional risk through mitigations or system improvements?

- How do you know?

Who will mitigate them? How?

- What are you doing about it?

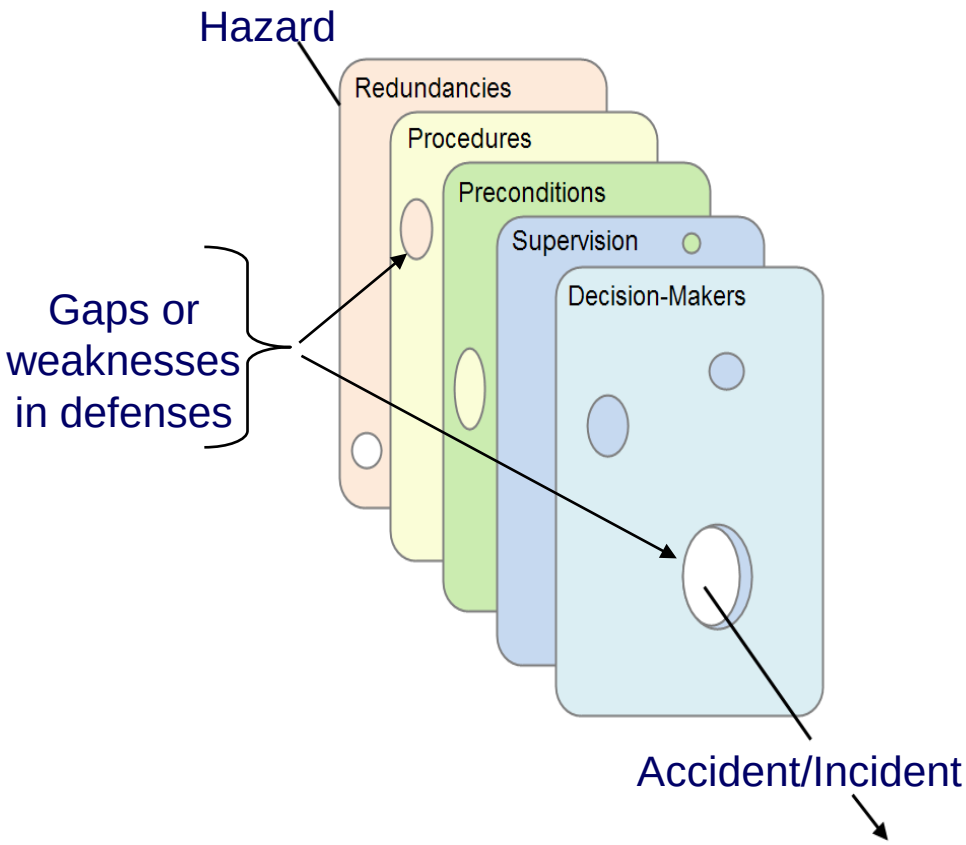
How do you know that you are reaching your safety goals?

- How do you know it's working?

What is Safety Management System?

The Problem: Preventing Gaps

- A safe, error-tolerant system requires multiple defenses, barriers, and safeguards.
- Gaps in a system's defenses are not static; they open and close as changes occur:
  - Operational situation
  - Environment
  - Equipment serviceability state



What is Safety Management System?

How Are Gaps Detected?

- Reactive hazard recognition:
  - Analyze the chain of events that led to an actual accident, incident, or hazardous event
- Proactive hazard recognition:
  - Carefully analyze system data to identify sequences of events where faults, errors, or hazards could lead to an accident or incident

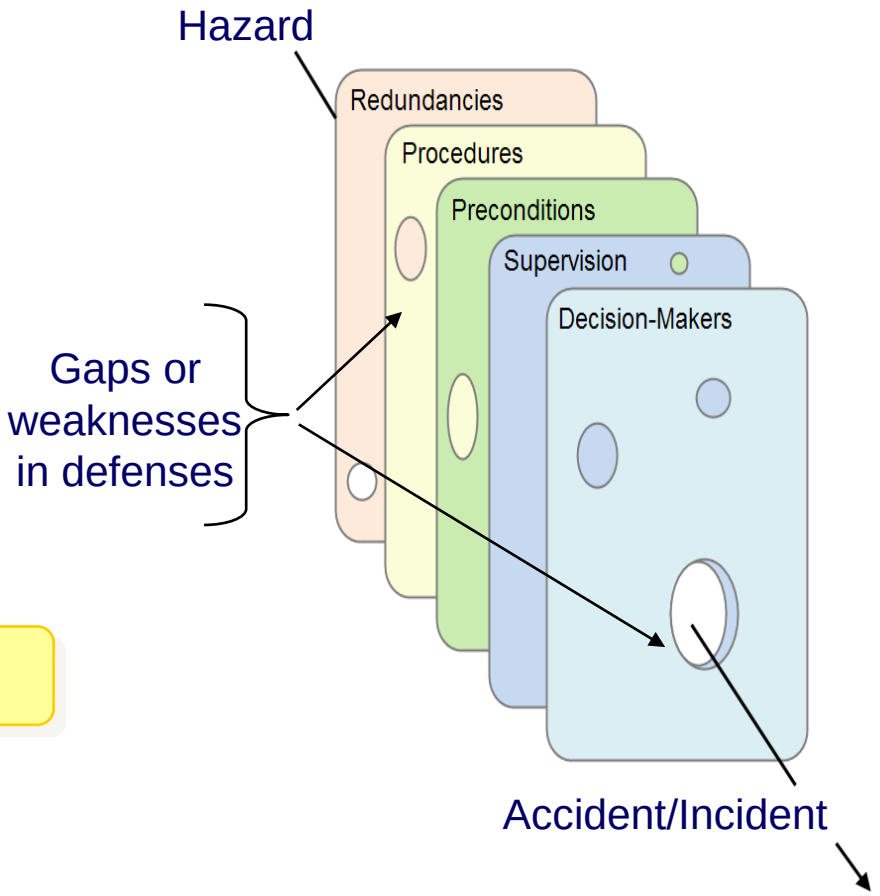
What is Safety Management System?

How Are Gaps Closed?

Equipment

Operating procedures

Organizational factors



What else do we do?

What is Safety Management System?

Why SMS?

- Repetitive, recurrent common cause accidents (low hanging fruit) essentially eliminated
  - Emerging threats are low frequency, hard to detect
  - Need to move from reactive to proactive and prognostic
- Aviation system is changing rapidly
  - New technologies
  - New business models
  - Expanded environmental impact concerns
- Significant increase in system demand
  - The number, types and complexity of airplanes
  - The amount of flights and passengers

What is Safety Management System?

SMS Defined

An integrated collection of processes, policies, procedures, and programs that are used to assess, define, and manage the safety risk in the provision of…

What is Safety Management System?

What is SMS?

- A formal, top-down business-like approach to managing safety risk
- SMS includes systematic procedures, practices, and policies for the management of safety, including:
  - Safety Policy
  - Safety Risk Management (SRM)
  - Safety Assurance
  - Safety Promotion

What is Safety Management System?

What Does SMS Do?

- Systematically looking for the things that can and do go wrong (hazards) in our system or operation
- Finding, describing, and tracking these hazards, their causes, and inherent risk
- Prioritizing the hazards according to risk
- Mitigating the risk
- Verifying that the mitigations work

Overview

- What is Safety Management System?
- Four Components of SMS
- Integrating SMS into Operations

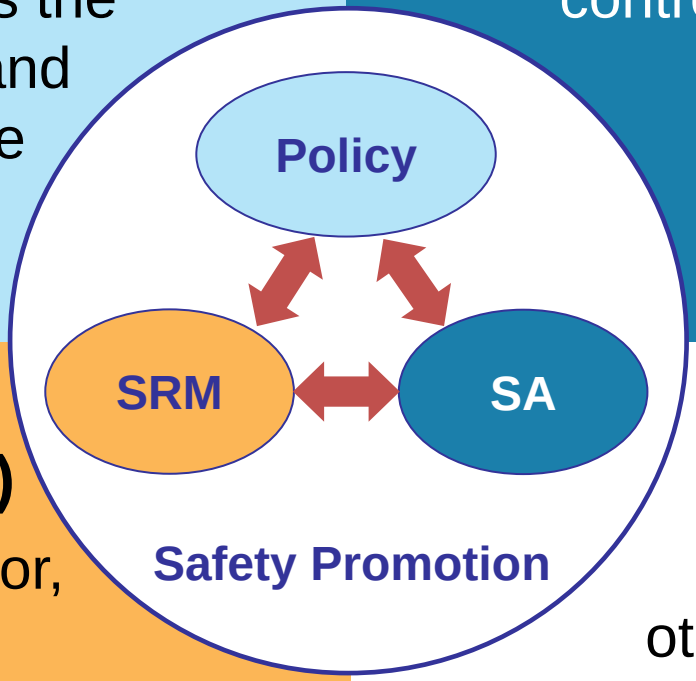
The Four SMS Components

Safety Policy

Establishes senior management's commitment to continually improve safety; defines the methods, processes, and organizational structure to meet safety goals

Safety Assurance (SA)

Evaluates the continued effectiveness of implemented risk control strategies; supports the identification of new hazards



Safety Risk Management (SRM)

Determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk

Safety Promotion

Includes training, communication, and other actions to create a positive safety culture within all levels of the workforce

The Four SMS Components

SMS Integrated Components

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Safety Policy

The Four SMS Components

ICAO Safety Management System Policy

Prior to 2013

- SMS in ICAO Annexes
  - Annex 1, Personnel Licensing
  - Annex 6, Operation of Aircraft
  - Annex 8, Airworthiness of Aircraft
  - Annex 11, Air Traffic Control Services
  - Annex 13, Aircraft Accident and Incident Investigation
  - Annex 14, Aerodromes

- ICAO Document 9859 Safety Management Manual
  - Intended to provide States with guidance to develop the regulatory framework and the supporting guidance material for the implementation of safety management systems (SMS) by service providers.
  - Also provides guidance for the development of a State Safety Program (SSP), in accordance with the International Standards and Recommended Practices (SARPs)

The Four SMS Components

ICAO Safety Management System Policy

- ICAO High-Level Safety Conference 2010 – Recommendation 2/5
  - ICAO should develop, in close collaboration with States, international and national organizations, a new Annex dedicated to safety management responsibilities and processes which would address the safety management responsibilities of States framed under the State Safety Programme (SSP)
  - The new Safety Management Annex should facilitate the provision of State and air carrier safety information to the travelling public, in addition to specifying the high level safety responsibilities of States
- Feb 2012 – ICAO Safety Management Panel published first version of Annex 19 – Safety Management

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Safety Risk Management

The Four SMS Components

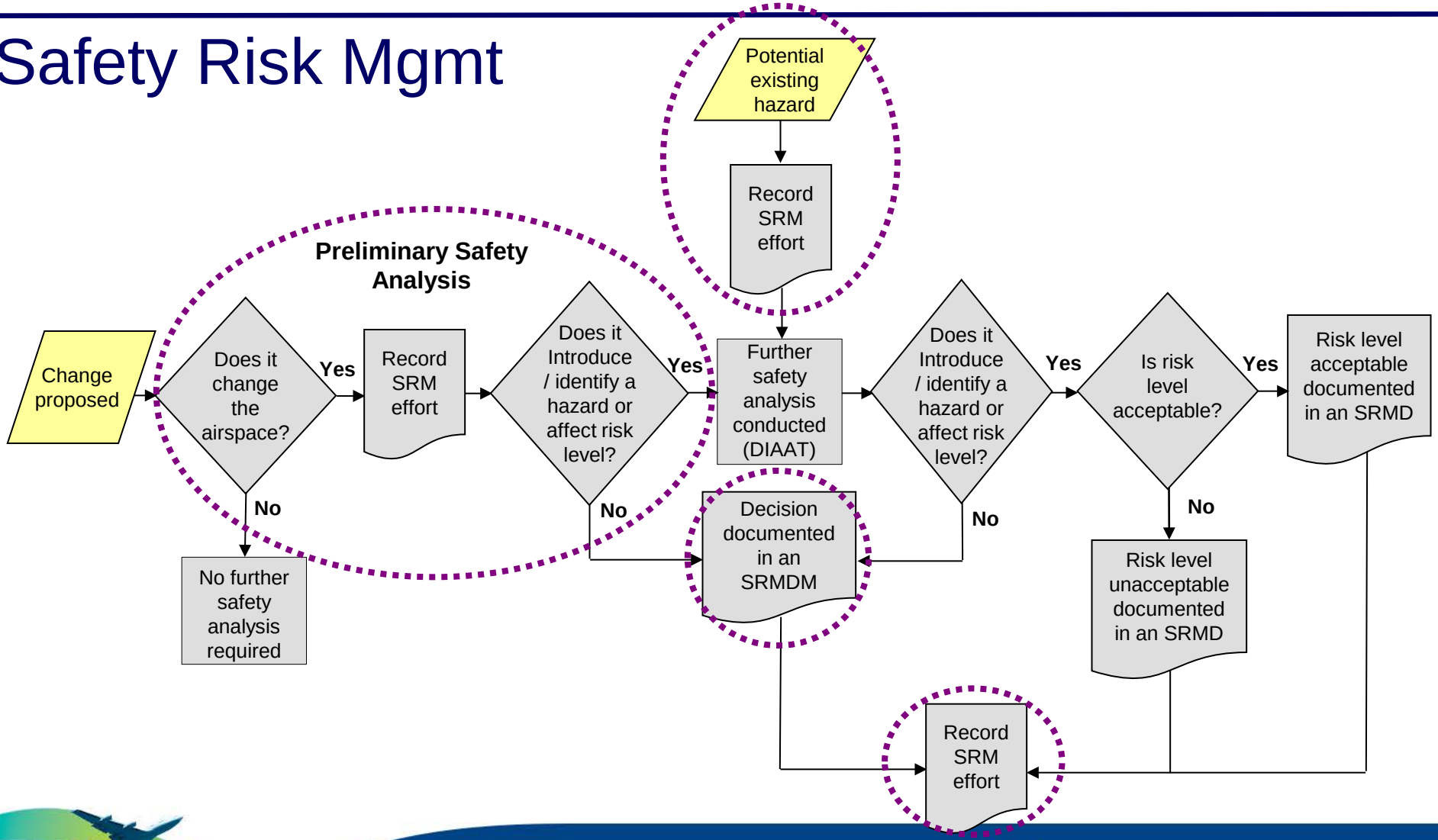
Safety Risk Management (SRM)

- Formalized, proactive approach to ensuring safety
  - Identifies hazards
  - Analyzes and assesses risk
  - Documents SRM analysis
    - Records hazards and their safety performance targets
    - Review and approve documentation
  - Accepts the risk introduced by changes
  - Approves changes for implementation

Safety performance targets are measurable goals used to verify the predicted residual risk of a hazard

The Four SMS Components

Safety Risk Mgmt



The Four SMS Components

Safety Risk Management – DIAAT Process

D — DESCRIBE THE SYSTEM

- Define scope and objectives
- Define stakeholders
- Define system or change
- Identify criteria and plan for risk management efforts

I — IDENTIFY HAZARDS

- Identify hazards
- Be comprehensive and do not dismiss hazards prematurely
- Use a structured approach
- Employ lessons learned and experience supplemented by checklists

A — ANALYZE RISK

- Identify existing controls
- Determine risk based upon the predicted severity and likelihood of the outcome

A — ASSESS RISK

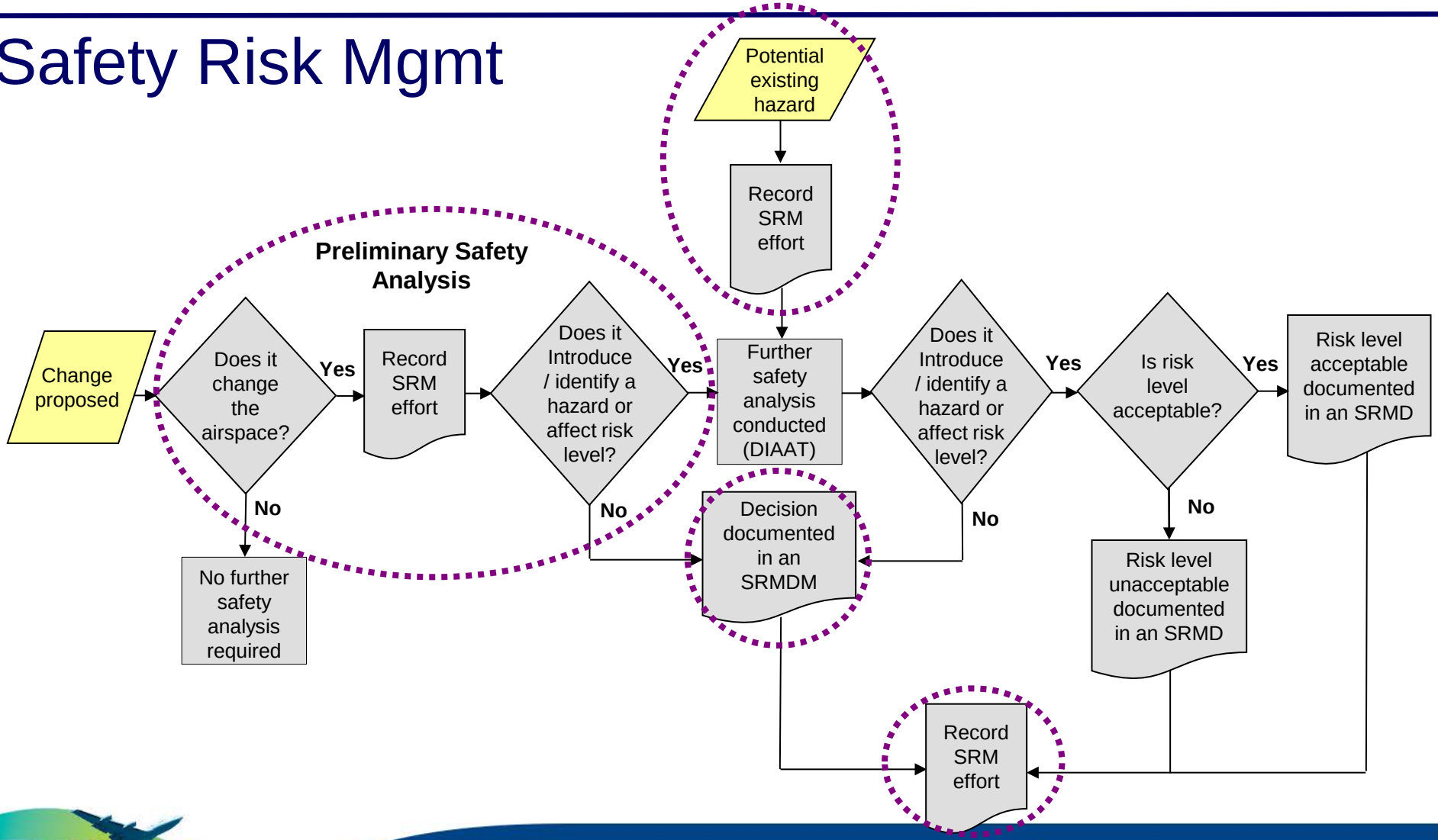
- Prioritize hazards according to the severity and likelihood of the risk

T — TREAT RISK

- Identify mitigation strategies
- Develop safety performance targets
- Develop monitoring plans

The Four SMS Components

Safety Risk Mgmt



The Four SMS Components

Safety Risk Management - Severity and Likelihood

- **Severity** is an assessment of consequences (i.e., effects) that could be caused by all credible effects of a specific hazard.
- Determination of severity is independent of likelihood.

Likelihood is an expression of how often an event is expected to occur.

Consider severity with existing controls when determining likelihood.

Definitions are tailored to domain and service.

Severity + Likelihood = Risk Level

The Four SMS Components

Safety Risk Management

Assess Risk

Likelihood	Severity: Minimal 5	Minor 4	Major 3	Hazardous 2	Catastrophic 1
Frequent A	Low	Medium	High	High	High
Probable B	Low	Medium	High	High	High
Remote C	Low	Low	Medium	High	High
Extremely Remote D	Low	Low	Low	Medium	High
Extremely Improbable E	Low	Low	Low	Low	High / Medium

'High' if there is/are single-point and/or common-cause failures

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Safety Assurance

The Four SMS Components

Safety Assurance

- Ensures compliance with SMS requirements through:
  - Safety assessments
  - Evaluations
  - Audits
- Provides insight and analysis
  - Outputs feed other components of the SMS

Continuous monitoring is fundamental to the success of the safety and performance

The Four SMS Components

Safety Assurance

- Enhances awareness of potentially hazardous situations by:
  - Identifying new or existing hazards generated from operational deviations, errors, or problem reports
  - Determining the severity/likelihood of hazards
  - Identifying new risks
  - Verifying safety performance targets
  - Providing metrics for safety reviews
  - Helping to execute monitoring plans

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Promotion

The Four SMS Components

Safety Promotion

Culture Behaviors for Leadership

- Allocate resources to safety management
- Encourage a questioning attitude regarding safety
- Do not tolerate willful violations of safety policies/rules
- Require open communication regarding potential safety hazards
- Recognize individual and organizational safety accomplishments
- Present safety lessons learned to all employees
- Encourage employees to:
  - Look for and report potential for safety hazards
  - Work to reduce safety hazards within their purview
  - Openly discuss safety hazards and seek support to mitigate the risks associated with the hazards

Overview

- What is Safety Management System?
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Integrating SMS into Operations

How to Continuously Improve SMS

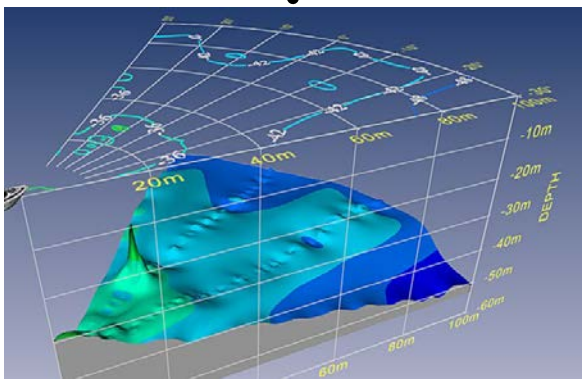
- **Establish SMS requirements**
- **Develop and validate;**
  - SMS policy
  - Auditing processes
  - Evaluation procedures
- **Implement the SMS program**
- **Verify Implementation**
- **Collect and track SMS performance**

Integrating SMS into Operations

Necessary Culture Change

SMS is forensic (backwards looking) and prognostic (forward looking)

Past **Present** **Future**



- Encourage the collection and sharing of safety information
- Use information to identify hazards

- Rigorous Safety Risk Management (SRM)
- Make risk-based decisions

Key Takeaways

SMS answers to the four questions:

- What are the risks?
  Identifies unmanaged risks/leading indicators pointing to unsafe conditions
- What about new risk?
  Integrates risk management into decision making process
- How do we mitigate them?
  Develops a plan to mitigate and control risks and assigns responsibility
- How do you know you're reaching your safety goals?
  Provides a construct for establishing goals and measuring progress

Leadership supports SMS by:

- Promoting its ideals and importance
- Understanding and, when appropriate, accepting the risk associated with changes and existing hazards
- Working to support safety initiatives with associated stakeholders
- Fostering communication about safety and lessons learned
- Facilitating a safety culture – "Just Culture"

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Questions?

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BACK UP Slides

Severity Classifications

Effect On: ↓	Hazard Severity Classification ***Note: Severities related to ground-based effects apply to movement areas only.***				
	Minimal **5**	**Minor** **4**	**Major** **3**	**Hazardous** **2**	**Catastrophic** **1**
	Conditions resulting in any one of the following:				
ATC Services	- A minimal reduction in ATC services - CAT D RI - PE, OD, or Measure of Compliance (MOC) ≥66%	- A slight reduction in ATC services - Low RAE - CAT C RI or OE	- A partial loss of ATC services - Medium RAE - CAT B RI or OE	- Unplanned ATC Zero - High RAE - CAT A RI or OE	- Ground Collision - Mid-Air Collision - CFIT
AT Equipment	NAV, COMM, WX, or SURV equipment malfunction or failure resulting in any one of the following: - A minimal reduction in ATC services - CAT D RI - MOC ≥66%	NAV, COMM, WX, or SURV equipment malfunction or failure resulting in any one of the following: - A slight reduction in ATC services - Low RAE - CAT C RI or OE	NAV, COMM, WX, or SURV equipment malfunction or failure resulting in any one of the following: - A partial loss of ATC services - Medium RAE - CAT B RI or OE	NAV, COMM, WX, or SURV equipment malfunction or failure resulting in any one of the following: - Total Loss of Communication Capability - High RAE - CAT A RI or OE	NAV, COMM, WX, or SURV equipment malfunction or failure resulting in any one of the following: - Ground Collision - Mid-Air Collision - CFIT

Severity Classifications (cont.)

Effect On: ↓	Hazard Severity Classification *Note: Severities related to ground-based effects apply to movement areas only.*				
	Minimal **5**	**Minor** **4**	**Major** **3**	**Hazardous** **2**	**Catastrophic** **1**
	Conditions resulting in any one of the following:				
Flight Crew	- Pilot is aware of traffic (identified by TCAS traffic alert, issued by ATC, or observed by flight crew) in close enough proximity to require focused attention, but no action is required. - Pilot Deviation (PD) where loss of airborne separation falls within the same parameters of a PE or MOC ≥66%	- Aircraft is in close enough proximity to another aircraft (identified by TCAS resolution advisory, issued by ATC, or observed by flight crew) to require specific pilot action to alter or maintain current course/altitude but intentions of other aircraft are known and a potential collision risk does not exist. - PD where loss of airborne separation falls within the same parameters of a Low RAE or Category C OE - Event within operating limitations, emergency procedures used, minor human errors/factors, and minor ground safety issues	- Aircraft is in close enough proximity to another aircraft (identified by TCAS resolution advisory, issued as a safety alert by ATC, or observed by flight crew) on a course that requires corrective action to avoid potential collision. Intentions of other aircraft are not known. - PD where loss of airborne separation falls within the same parameters of a Medium RAE or Category B OE - Reduction in safety margin or functional capability of the aircraft, requiring crew to follow abnormal procedures as per AFM	- Near Mid-Air Collision (NMAC) results due to proximity of less than 500 feet from another aircraft, or a report is filed by pilot or flight crew member that a collision hazard existed between two or more aircraft. - Reduction in safety margin and functional capability of the aircraft requiring crew to follow emergency procedures as per AFM - PD where loss of airborne separation falls within the same parameters of a High RAE or Category A OE.	- Ground Collision - Mid-Air Collision - CFIT - Failure conditions that would prevent continued safe flight and landing

Severity Classifications (cont.)

Effect On:	Hazard Severity Classification *Note: Severities related to ground-based effects apply to movement areas only.*				
	Minimal **5**	**Minor** **4**	**Major** **3**	**Hazardous** **2**	**Catastrophic** **1**
	Conditions resulting in any one of the following:				
↓ Flying Public	- Minimal injury or discomfort to Persons on Board (POB)	- Physical discomfort to passenger(s) (e.g., extreme braking action; clear air turbulence causing unexpected movement of aircraft resulting in injuries to one or two passengers out of their seats) - Minor injury to greater than zero to less or equal to 10% of POB	- Physical distress to passengers (e.g., abrupt evasive action; severe turbulence causing unexpected aircraft movements) - Minor injury to greater than 10% of POB	- Serious injury to POB	- Fatal injuries to POB

Severity Classifications (cont.)

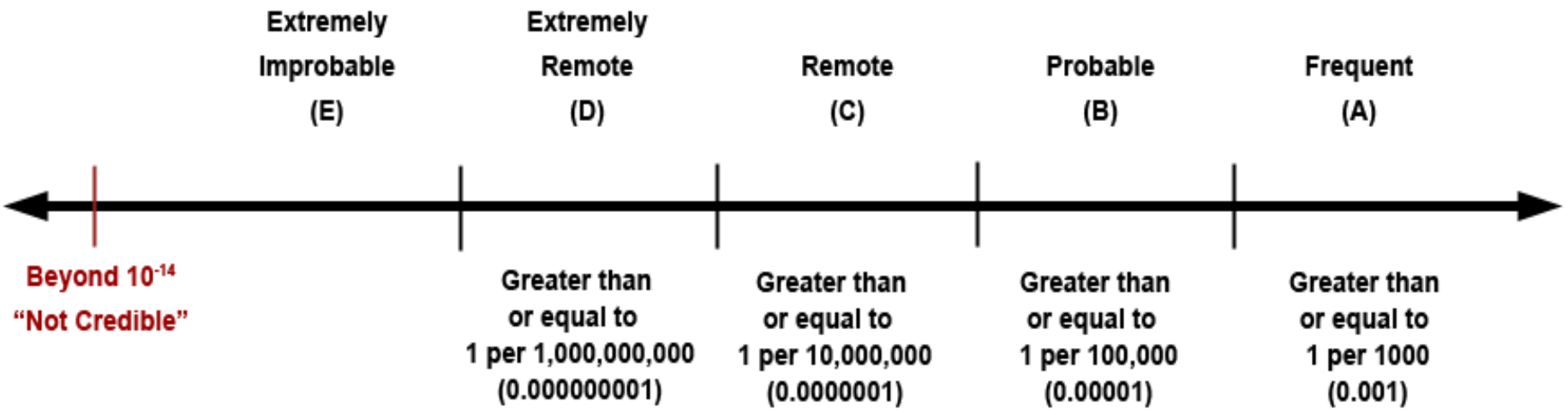
Effect On:	Hazard Severity Classification *Note: Severities related to ground-based effects apply to movement areas only.*				
	Minimal **5**	**Minor** **4**	**Major** **3**	**Hazardous** **2**	**Catastrophic** **1**
	Conditions resulting in any one of the following:				
Unmanned Aircraft Systems ↓	- Discomfort to those on the ground - Loss of separation leading to a MOC ≥66%	- Loss of separation resulting in a CAT C OE or Low RAE - Non-serious injury to 3 or fewer people on the ground	- Non-serious injury to more than 3 people on the ground - Loss of separation resulting in a CAT B OE or Medium RAE - A reduced ability of the crew to cope with adverse operating conditions to the extent that there would be a significant reduction in safety margins - Manned aircraft making an evasive maneuver, but proximity from Unmanned Aircraft (UA) remains greater than 500'	- Loss of separation resulting in a CAT A OE or High RAE - Incapacitation to UAS crew - Proximity of less than 500' to a manned aircraft - Serious injury to persons other than the UAS crew	- A collision with a manned aircraft - Fatality or fatal injury to persons other than the UAS crew

Likelihood Table: Quantitative

	Operations: Expected Occurrence Rate (per operation/flight hour/operational hour*)
	Quantitative (ATC / Flight Procedures / Systems Engineering)
Frequent A	(Probability) ≥ 1 per 1000
Probable B	1 per 1000 > (Probability) ≥ 1 per 100,000
Remote C	1 per 100,000 > (Probability) ≥ 1 per 10,000,000
Extremely Remote D	1 per 10,000,000 > (Probability) ≥ 1 per 1,000,000,000
Extremely Improbable E	1 per 1,000,000,000 > (Probability) ≥ 1 per 10^{14}

*It is important to note that the close correlation between flight hours and operations is entirely coincidental; average flight time is roughly two hours, and each flight has about two Tower and two TRACON operations. The two numbers are not interchangeable.

Likelihood Table: Quantitative



If your calculation of likelihood lands directly on the border between two ratings, it is included in the upper rating. For example, if a likelihood is calculated to be exactly 1 per 1000, it would be rated as Frequent and not Probable.

Likelihood Table: Qualitative

	Operations: Expected Occurrence Rate (Calendar-Based)
	Qualitative (Domain-wide: NAS-wide, Terminal, or En Route)
Frequent A	Equal to or more than once per week
Probable B	Less than once per week and equal to or more than once per 3 months
Remote C	Less than once per 3 months and equal to or more than once per 3 years
Extremely Remote D	Less than once per 3 years and equal to or more than once per 30 years
Extremely Improbable E	Less than once per 30 years

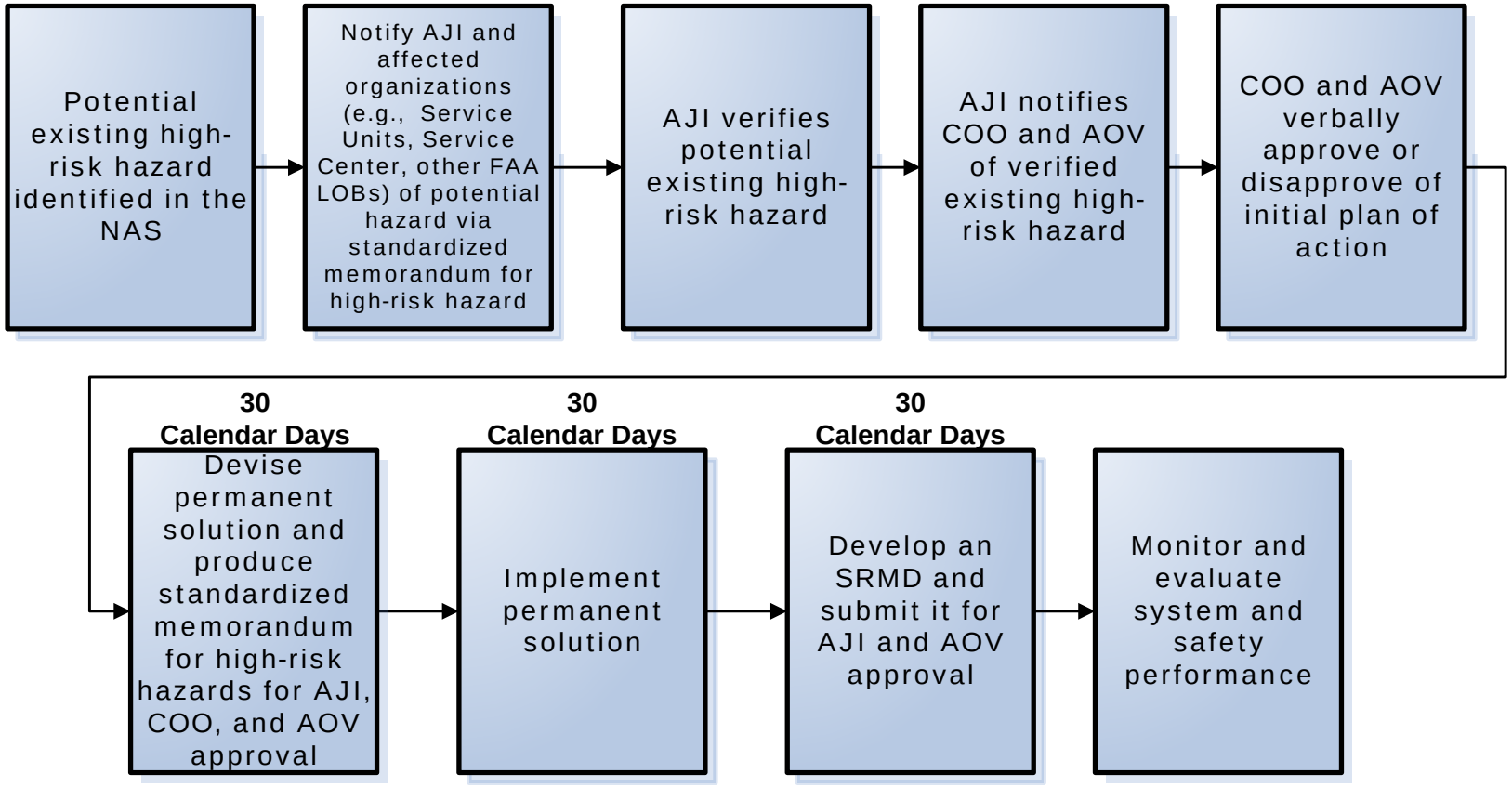
Risk Classification

High

- Unacceptable risk
  - Must be mitigated to a medium or low risk prior to implementation*
  - Must verify predicted residual risk
- Record PHA/HAW and Monitoring Plan in SRMTS
- Hazards with catastrophic effects caused by:
  - Single point or common cause events or failures
  - Combination of undetectable latent events

*When an existing risk in the NAS is high, the COO may permit continuation of the operation or system for up to 30 days (with AOV Approval) while a mitigation strategy is developed by the responsible office and Approved by AOV

Existing High-Risk Hazard Process



SRMTS requirements apply

Risk Classification (cont.)

Medium

Minimum acceptable risk (must be mitigated)
May be implemented
Must verify predicted residual risk
Record PHA/HAW and Monitoring Plan in SRMTS

Low

Acceptable risk (without restriction or limitation)
May be implemented (without safety requirements)
Must verify predicted residual risk
Record PHA/HAW and Monitoring Plan in SRMTS

Monitoring

Identify mitigation strategies to reduce risk to the lowest possible level

Establish monitoring activities to evaluate current risk (post-implementation) against safety performance targets

- Equipment Outages
- Operational Errors
- Number of Go-Arounds

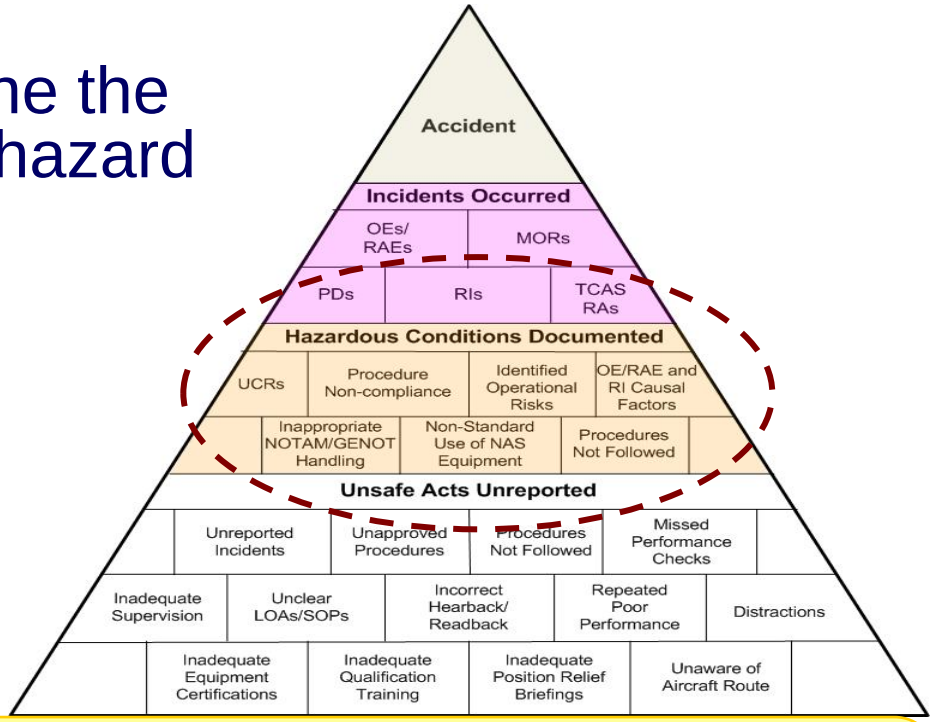
Develop a Monitoring Plan

- Formally identify all hazards
- Implement safety requirements for all risk levels identified in the final PHA/HAW
- Correlate safety requirements to safety order of precedence
- Record monitoring activities.
  - Who is responsible?
  - How will we monitor and how often?
  - How will we track the hazards?
  - What are we measuring against?
  - How will we measure progress?

Document and verify low risk hazards at least once

Safety Performance Targets

- Quantifiable goals that define the predicted residual risk of a hazard
- Measured using safety performance indicators



Mapping a hazard to a specific safety performance target may not be possible in terms of establishing a causal relationship. In such cases, the SRM panel must identify a sound alternate method to verify the predicted residual risk and determine whether existing controls and/or safety requirements were appropriate and are functioning as intended.

Risk Acceptance

- Safety Review
  - Verification that the safety requirements can be implemented
  - Commitment to implement the safety requirements
- Risk Review
  - Analysis accurately reflects the safety risk
  - Underlying assumptions are correct
  - Safety requirements are valid
  - Findings are complete and accurate
  - Monitoring plan is comprehensive
- Accepting the Safety Risk
  - Understands and accepts the safety risk
  - Monitoring plans are appropriately defined

Approval and Acceptance

Item	Service Unit Approval	ATO Safety and Technical Training Approval	AOV Approval*	AOV Acceptance*
SRMDs that identify medium or low safety risk; risk, controls & mitigations stay within the service units	✓ Per service unit guidance			
SRMDs that identify medium or low safety risk; risk, controls, and mitigations span service units	✓ Each affected service unit, per service unit guidance	✓		
SRMDs that identify medium or low safety risk; risk, controls, and mitigations involve LOBs outside of the ATO	✓ Each affected LOB, per LOB guidance	✓		✓
Controls that are defined to mitigate or eliminate initial/current high risk hazards	✓	✓	✓	
Changes or waivers to provisions of handbooks, orders, and documents, including FAA Order 7110.65, *Air Traffic Control*, current edition, which pertains to separation minima	✓	✓	✓	

SRMD Update Requirements

- The SRMD must be updated if monitoring reveals any of the following:
  - Hazards that were not initially identified
  - Risk levels higher than the predicted residual risk
  - The need for different or additional safety requirements
  - Safety performance targets that are not met

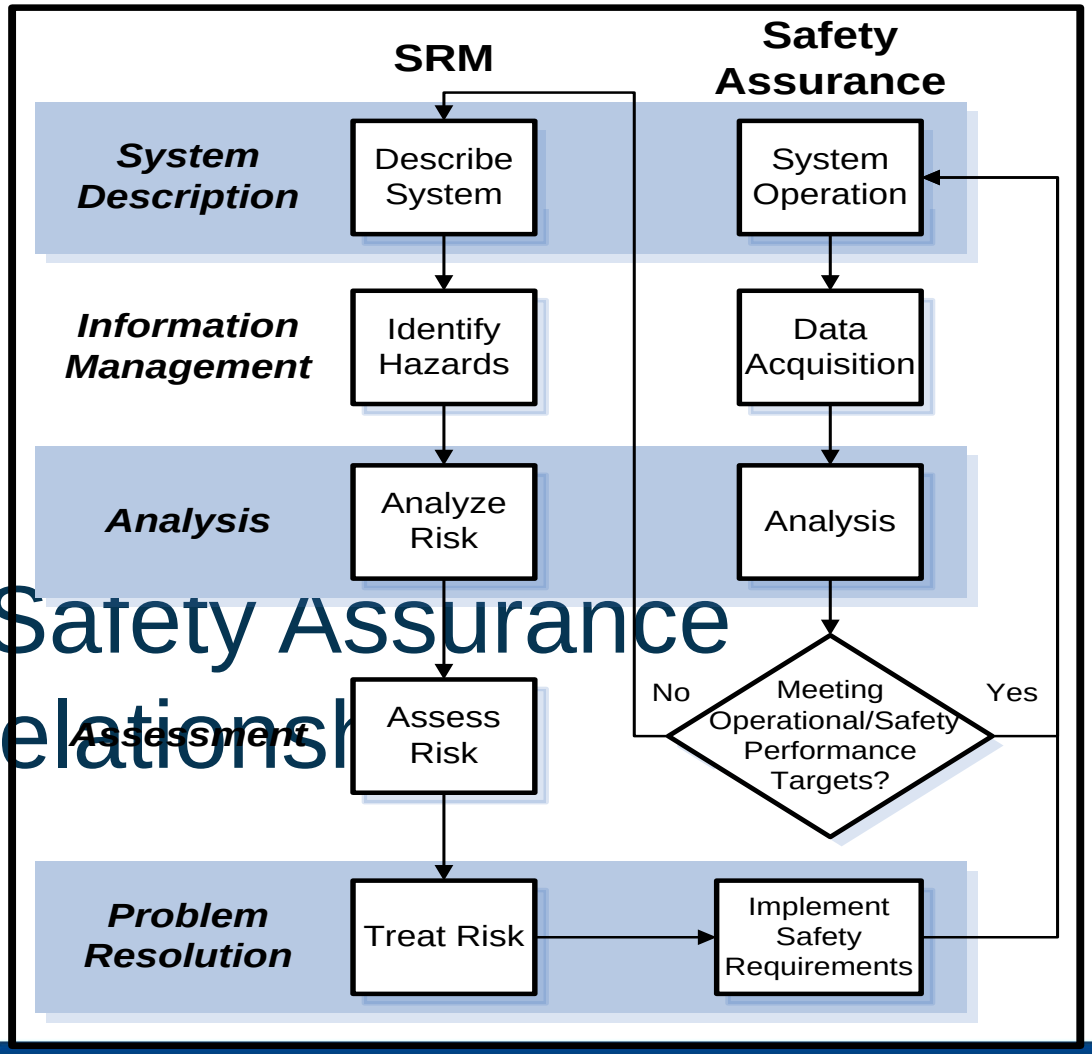
SRMD Revisions

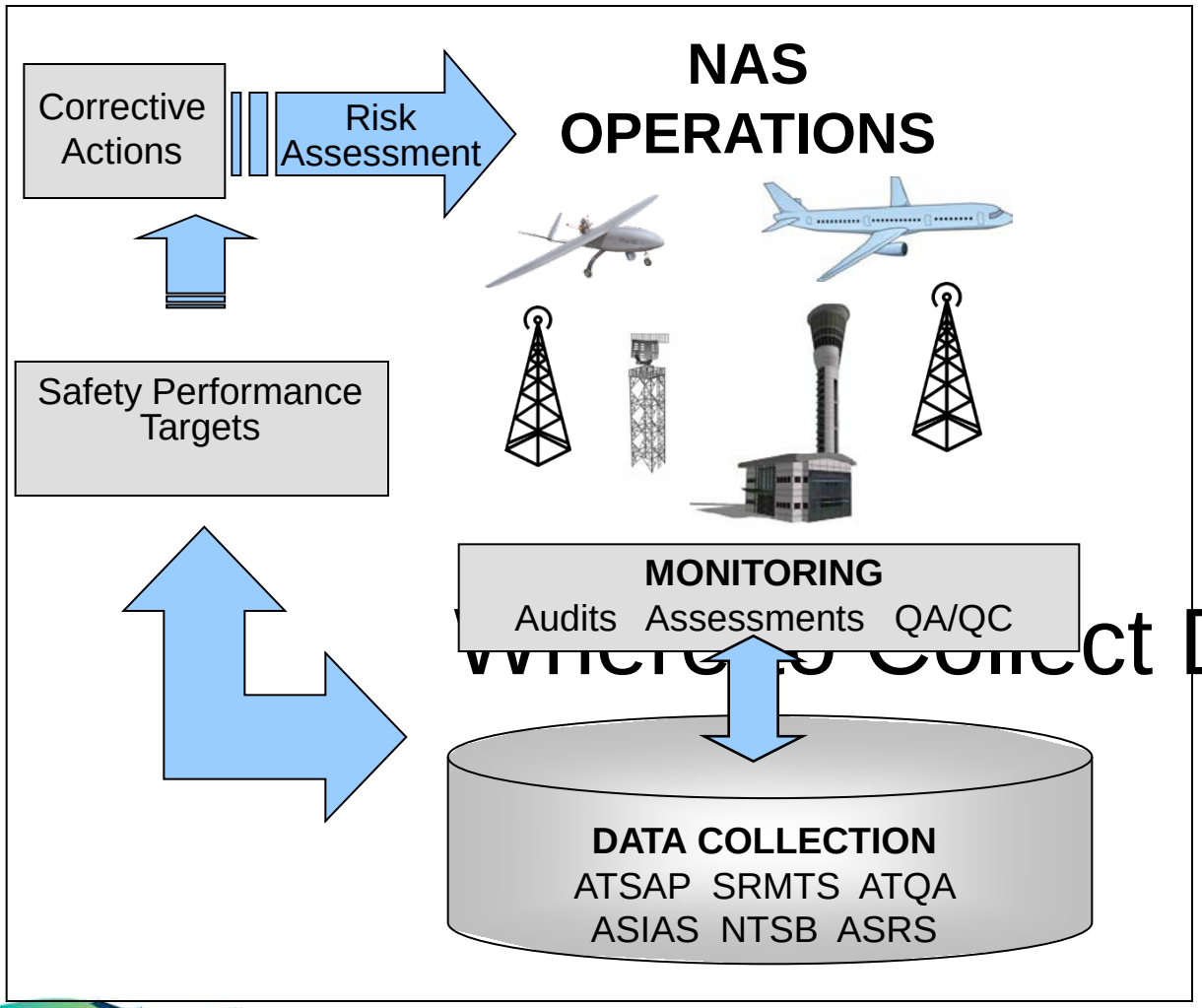
Portion of SRMD Changed	Change to Safety Analysis	Version Protocol	New SRMD Approval Signature and Risk Acceptance Required?
Safety analysis	New hazard; change to predicted residual risk assessment	Whole number revisions (i.e., 1.0 to 2.0)	Yes
Safety analysis and safety requirements	Adding, changing, removing, or not implementing safety requirements (existing or new safety requirements)	Whole number revisions	Yes
System description	Updating charts, maps, airport layout, approach plates (as long as it does not impact hazards or risk level)	Decimal revisions (i.e., 1.0 to 1.1, 1.2)	No
Risk analysis and assessment	Adding rationale or data for risk assessment when risk is not changed, or mitigations are not added or changed.	Decimal revisions	No
Safety requirements, monitoring plan, and appendices	Clarifying safety requirements, including SOPs, LOAs, letters to airmen, and implementation and monitoring reports (as long as risk is not changed or mitigations are not added or changed)	Decimal revisions	No

SRM & Safety Assurance Relationship

SRM and Safety Assurance are both part of the continuous, closed-loop process and cannot exist independently.

Additional emphasis is placed on Safety Assurance as a mechanism to verify predicted residual risk and identify additional or mis-assessed hazards, which must then be re-assessed using SRM.





Where to Collect Data

- **Air Traffic Safety Action Program (ATSAP)**
- **Safety Risk Management Tracking System (SRMTS)**
- **Air Traffic Quality Assurance (ATQA)**
- **Aviation Safety Information Analysis and Sharing System (ASIAS)**
- **National Transportation Safety Board (NTSB) Accident and Incident Database**
- **Aviation Safety Reporting System (ASRS)**

Continuous Monitoring Requirements

Ensure safety performance targets are met and current risk at least meets the predicted residual risk

Is the monitoring plan implemented?
Are additional safety requirements needed?
Are safety performance measures realistic?

Identify any unintended consequences

Update incorrectly assessed risk

Track current risk, performance, and progress in SRMTS

SRM Tracking System (SRMTS)

Central repository for safety and hazard analysis data
Web-based tool on the Stature platform
Tracks and monitors hazards, safety requirements, and identified NAS safety risks
Documents and tracks identified risks and associated safety requirement implementation
Facilitates the process of monitoring safety risks
Supports ongoing risk tracking

When Does a Change Become Part of NAS?

- The change and all mitigations become part of the NAS when:

  The monitoring plan is complete;

  The predicted residual risk is verified; and

  Monitoring activities are assumed by routine QA procedures.

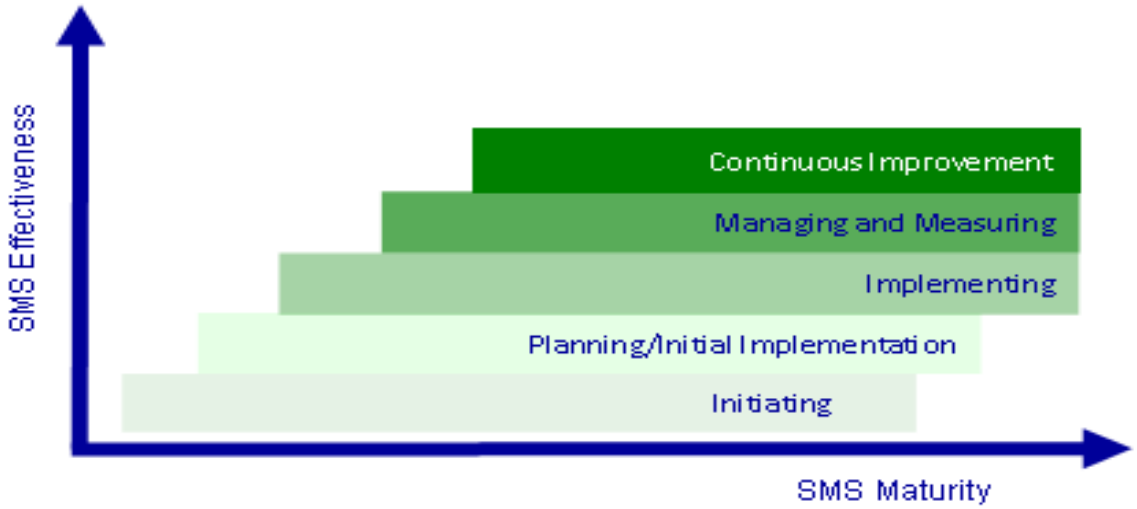
  Change Closeout Form is complete in SRMTS

Waivers of policy are never considered part of the NAS. Associated risks must be continuously monitored.

Lessons Learned Repository (LLR)

- Provides a means for sharing safety and hazard analysis data ATO-wide
- ATO employees can contribute and access:
  - SMS lessons learned (challenges)
  - SMS best practices (successes)
- Web-based repository on the Stature platform

SMS Maturity Model - Stages



- Initiating: The SMS framework is very immature or non-existent in the organization.
- Planning/Initial Implementation: The SMS framework is not yet effective and does not yet meet the required regulatory standard.
- Implementing: The SMS framework meets the required regulatory standard.
- Managing and Measuring: The SMS framework is functioning and is effective in achieving the overall safety policy and objectives of the organization.
- Continuous Improvement: The SMS framework is regularly reviewed and enhanced to achieve excellence in ATM safety management. This step, as the name suggests, is a continual process recognizing that planning for safety is never ending. Ongoing planning must assure that safety management activities are integrated and drive priorities for operational safety improvement.

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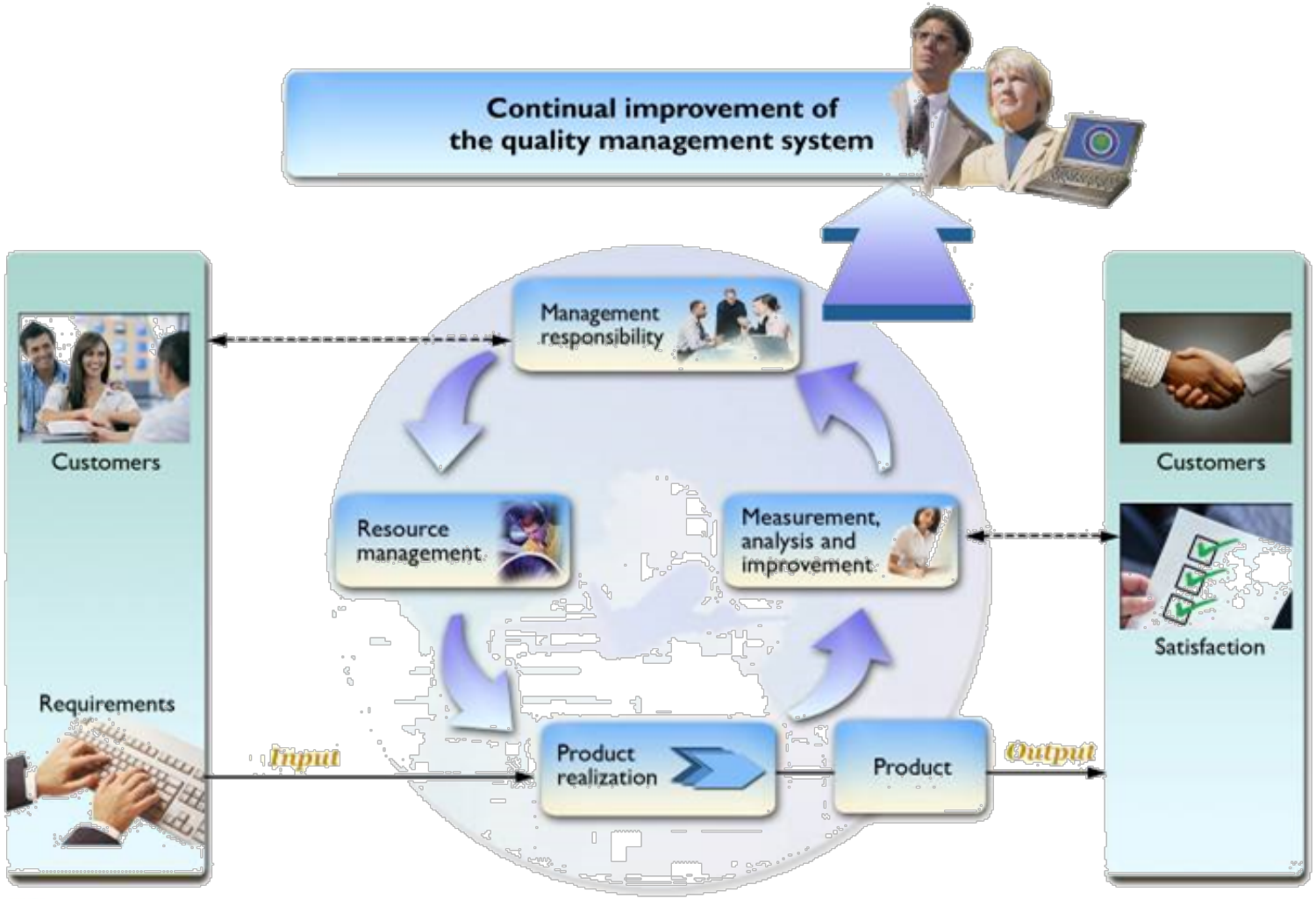
QMS & SMS
Identifying Defects v Hazards

Quality Management System Model

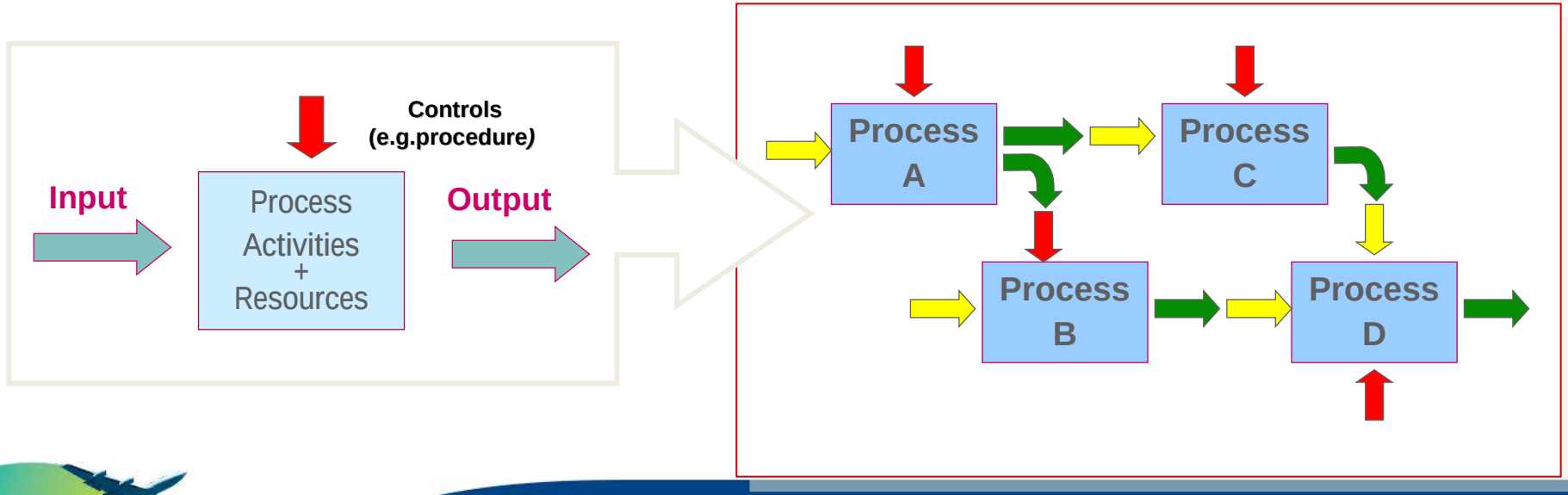


QMS

- QMS is a set of defined policies and procedures that provide a formal framework describing the way an organization conducts its core business with regard to quality

Process Approach

- Process approach to quality management encouraged
- Introduces the process model as conceptual presentation of QMS requirements specified

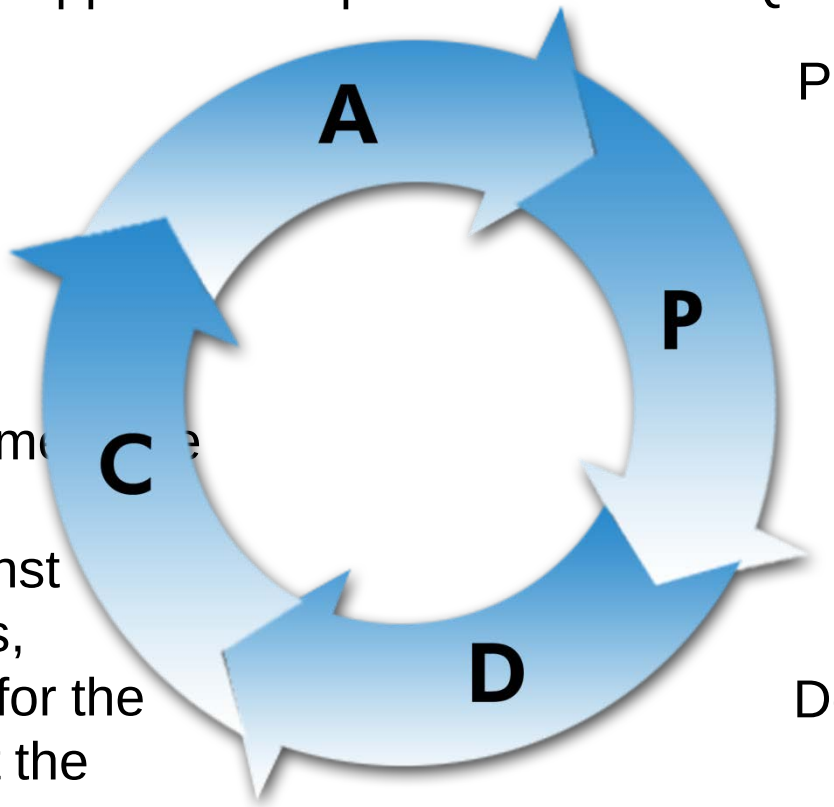


Continual Improvement

The methodology known as **“Plan-Do-Check-Act”** can be applied to all processes of the QMS

Act: Take actions to continually improve process performance

Check: Monitor and me[illegible]e processes and products against policies, objectives, and requirements for the product and report the results



Plan: Establish objectives and processes necessary to deliver results in accordance with customer requirements and the organization’s policies

Do: Implement the processes

A permanent objective of the organization

QMS Benefits

Benefits to FAA and AVS

Benefits to Stakeholders

Benefits to Employees

For FAA and AVS, the QMS:

- **Reinforces accountability and improvement**
- **Promotes standardization of processes**
- **Focuses on improvement of process efficiency**
- **Reduces process variance**
- **Sustains organizational knowledge base**

QMS Benefits

- Benefits to FAA and AVS
- Benefits to Stakeholders
- Benefits to Employees

For Stakeholders, the QMS:

- **Provides clear and timely communication**
- **Allows for fast, accurate responses to inquiries**
- **Provides concise and consistent interpretation of policy**
- **Leads to high-quality products and services**

QMS Benefits

Benefits to FAA and AVS

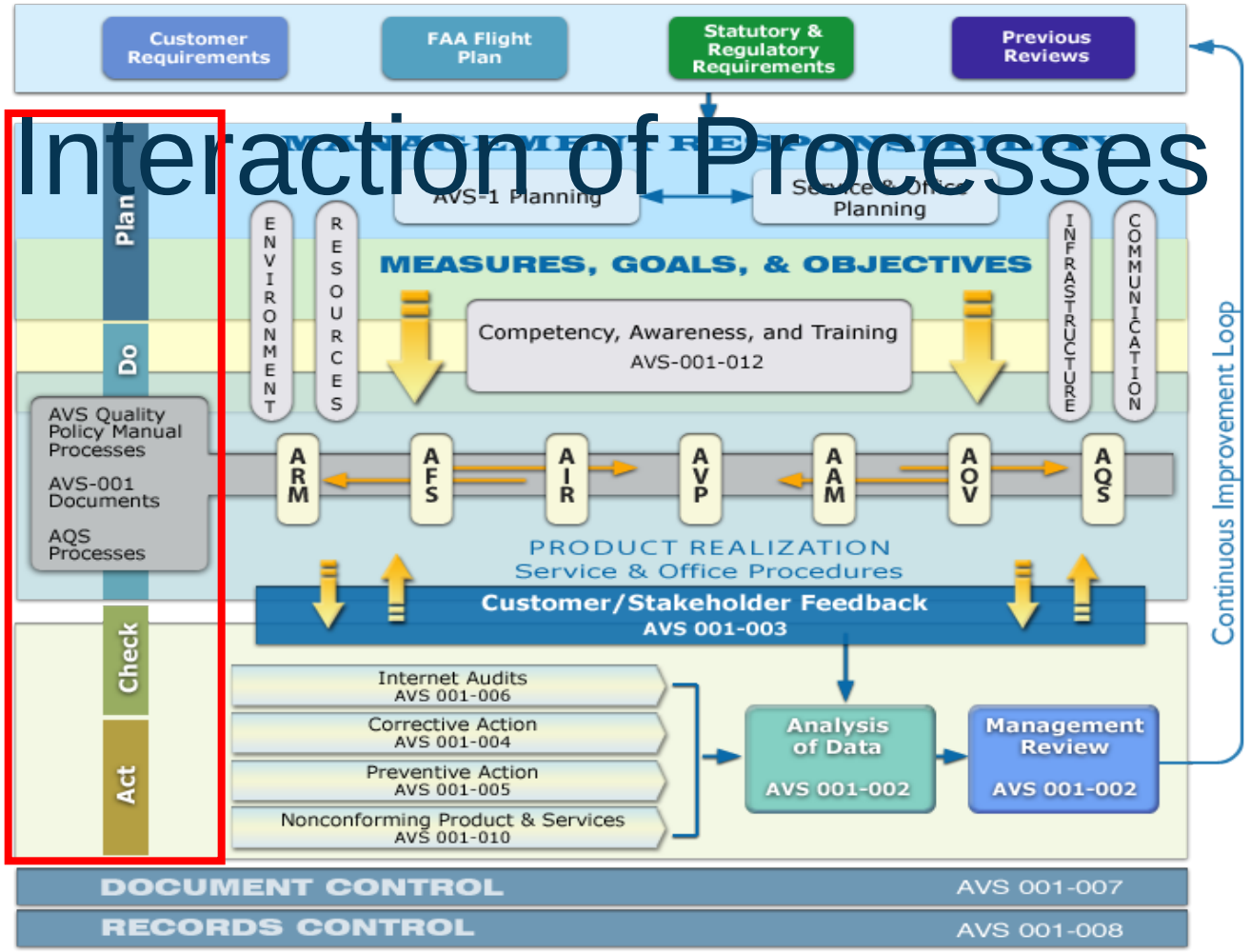
Benefits to Stakeholders

Benefits to Employees

For Employees, the QMS:

- **Provides channels of communication with management**
- **Encourages continual improvement of processes**
- **Promotes exchange of information among Services and Offices**
- **Provides consistent interpretation of policy**
- **Fosters clear rationale for decisions**
- **Sustains organizational knowledge base**

Interaction of Processes



Federal Aviation Administration

SMS Continuous Improvement