

ICAO WACAF Workshop

1st – 4th September 2015

**Quality Assurance
DOC 9906 Vol 1**

**Step 7: Conduct Safety
Activities**



Safety Activities



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Safety activities in DOC 9906

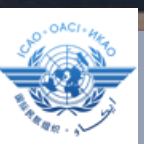
Safety Concept and Wording

Safety Assessment methodology

Role of State

Conclusion

Safety Activities in ICAO DOC 9906



Safety Activities



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- DOC 9906 provides some information. For more detailed information please refer to the *Safety Management Manual* (Doc 9859)
- Safety is generally defined as “freedom from unacceptable risk “. From a formal point of view, a system can only be considered to be safe for operational use if its inherent risks have been identified, assessed and agreed to be below predefined limits.
- Primarily, the safety case is a matter of the organization assuring itself that its operations are safe. Only secondarily is it a matter of demonstrating the safety of the operation to a regulatory body.

Safety Activities



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- Safety assessments for the FPD should therefore focus on two main elements:
 - application of methods for the design of a flight procedure
 - the implementation of a procedure, looking at the interface with other procedures available in that location, the complexity and the workload imposed on ATC, cockpit workload, flyability, etc.

Safety Activities



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- The overall aim should be to address the following five safety assurance goals:
 - show that the underlying concept of the whole procedure is intrinsically safe
 - show that everything necessary to achieve a safe implementation of the procedure — related to equipment, people and airspace design issues — has been specified
 - the design is correct
 - show that the design is robust (external failures, abnormal conditions)
 - show that the risks due to internal failure have been mitigated sufficiently such that, overall, the safety criteria are still satisfied.

Safety Concept and Wording



Safety Concept & Wording – Reason for safety

Why doing safety?

- **To avoid dangerous situations**
 - **To react appropriately to dangerous situations (Reactive Mitigation Mean)**
 - **To prevent incidents and above all accidents (Preventive Mitigation Mean)**

And to ensure **conformity to the regulation** : Annex 19 « safety management » of ICAO defines in appendix 2 (Framework for a SMS) the requirement for the service provider :

- **To develop and maintain a process of identification of the modifications that could affect the safety level of his product and services**

Safety Concept & Wording



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Main concepts used in safety analysis are :

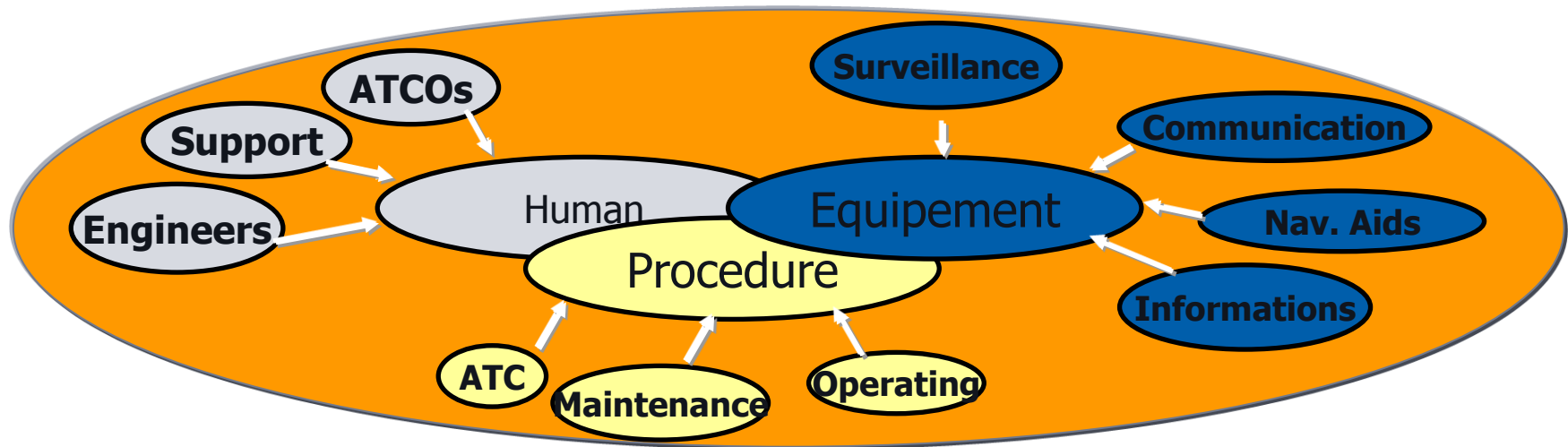
- ATM system
 - Hazard
 - Severity
 - Probability of occurrence (likelihood)
 - Risk
 - Mitigation Mean:
 - ▶ *Mitigation mean to reduce the likelihood (Prevention)*
 - ▶ *Mitigation mean to reduce the severity (Reaction)*

Safety Concept & Wording – ATM system



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ATM system includes Equipment, Procedures and Human:



All these components interact in order to provide ATM services

Safety Concept & Wording – **ATM system**



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Examples of modification of the ATM system :

- Equipment (hardware & software)
 - ✓ Implementation of a new equipment (new radar system, ...)
 - ✓ Modification of an existing equipment (update of the flight data processing system software...)
- Procedures
 - ✓ Modification of the airspace
 - ✓ Creation / modification of operational procedures
 - ✓ Implementation / modification of RNAV procedures
- Humans
 - ✓ Modification of the working method

Any of these modifications is subject to a safety assessment

Safety Concept & Wording - Hazard



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A **hazard** is a an **undesirable event regarding the ATM services** and that could cause an accident.

It may be identified by the users (controllers, pilots).

Examples of hazards :

- *Loss of radar display of the ATCO*
 - *Display of erroneous radar information to the ATCO*

Safety Concept & Wording - Hazard



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A **hazard** is characterized by its:

- **Severity**
 - **Probability of occurrence (likelihood)**

- **The severity** expresses the consequences of the hazard on flight safety. These consequences are assessed on :
 - Flight crew and controllers (workload...)
 - Functional capacities of ground and airborne systems
 - Ability to provide air traffic management services safely

- **The probability of occurrence** express the number of time the hazard could be observed by the users (pilots, controllers) over a given period.

Safety Concept & Wording - Severity



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The severity is :

- Proportional to the **operational consequences** of the hazard
- Evaluated on a five-level's scale (from "Negligible" to "Catastrophic") using a severity table defined by the ANSP :
 - Severity A is assign to hazards with most critical effects
 - Severity E is assigned to hazards with less critical effects

Note: Each ANSP should define its own table

Severity of occurrence	Meaning	Value
Catastrophic	<ul style="list-style-type: none"> — Equipment destroyed — Multiple deaths 	A
Hazardous	<ul style="list-style-type: none"> — A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely — Serious injury — Major equipment damage 	B
Major	<ul style="list-style-type: none"> — A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency — Serious incident — Injury to persons 	C
Minor	<ul style="list-style-type: none"> — Nuisance — Operating limitations — Use of emergency procedures — Minor incident 	D
Negligible	<ul style="list-style-type: none"> — Little consequences 	E

ICAO 9859 Safety Management Manual - Severity classification table

Safety Assessment Methodology - Severity evaluation

- Severity classification table

Severity Class	1 [Most Severe]	2	3	4	5 No safety effect [Least Severe]
Effect on Operations*)	Accidents	Serious incidents	Major incidents	Significant incidents	No immediate effect on safety
Examples of effects on operations Include*):	<ul style="list-style-type: none"> <input type="checkbox"/> one or more catastrophic accidents, <input type="checkbox"/> one or more mid-air collisions <input type="checkbox"/> one or more collisions on the ground between two aircraft <input type="checkbox"/> one or more Controlled Flight Into Terrain <input type="checkbox"/> total loss of flight control. <p>No independent source of recovery mechanism, such as surveillance or ATC and/or flight crew procedures can reasonably be expected to prevent the accident(s).</p>	<ul style="list-style-type: none"> <input type="checkbox"/> large reduction in separation (e.g., a separation of less than half the separation minima), without crew or ATC fully controlling the situation or able to recover from the situation. <input type="checkbox"/> one or more aircraft deviating from their intended clearance, so that abrupt manoeuvre is required to avoid collision with another aircraft or with terrain (or when an avoidance action would be appropriate). 	<ul style="list-style-type: none"> <input type="checkbox"/> large reduction (e.g., a separation of less than half the separation minima) in separation with crew or ATC controlling the situation and able to recover from the situation. <input type="checkbox"/> minor reduction (e.g., a separation of more than half the separation minima) in separation without crew or ATC fully controlling the situation, hence jeopardising the ability to recover from the situation (without the use of collision or terrain avoidance manoeuvres). 	<ul style="list-style-type: none"> <input type="checkbox"/> increasing workload of the air traffic controller or aircraft flight crew, or slightly degrading the functional capability of the enabling CNS system. <input type="checkbox"/> minor reduction (e.g., a separation of more than half the separation minima) in separation with crew or ATC controlling the situation and fully able to recover from the situation. 	No hazardous condition i.e. no immediate direct or indirect impact on the operations.

ESARR 4 severity classification table

Eurocontrol Safety Regulatory Requirements

Safety Concept & Wording – Probability of occurrence



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The probability of occurrence is :

- Proportional to the **causes** of the hazard
- Evaluated on a 5 level scale (from frequent to extremely remote) using a probability of occurrence table defined by the ANSP
- Can be evaluated with a qualitative or quantitative approach

	Meaning	Value
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

ICAO 9859 Probability of occurrence classification table

Frequency	Meaning
Extremely Rare	Can occur once in 1000 years at a given ATC center (or has never happened before)
Rare	Can occur <u>o</u> ince in 5 to 10 years at a given ATC center
Occasional	Can occur once to twice a year at a given ATC center
Likely	Can occur several times per year at a given ATC center
Numerous	Can occur several times per month at a given ATC center

French ANSP table

Safety Concept & Wording – Probability of occurrence



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Quantitative evaluation of the severity :

- is adapted to a technical hazard (that means an hazard associated to an equipment)
- is evaluated by using the reliability data (failure rate / mean time between failure) of the equipment
- Example of quantitative criteria :
 - Extremely improbable : Probability of occurrence is more than 10^{-8} / H
 - Improbable : Probability of occurrence is between 10^{-8} et 10^{-6} / H
 - Occasional : Probability of occurrence is between 10^{-6} et 10^{-5} / H
 - Frequent : Probability of occurrence is between 10^{-5} et 10^{-4} / H
 - Very frequent : Probability of occurrence is less than 10^{-4} / H

Qualitative evaluation of the severity :

- is adapted to a non-technical hazard (example : implementation of a new procedure)
- is evaluated by the users
- Example of qualitative criteria :
 - Extremely improbable : can occur one time every 1000 year in an ATC organism (never happened in the ATC organism) (10^{-7} / operation hour)
 - Improbable : can occur one time every 5 or 10 years in an ATC organism (10^{-5} / operation hour)
 - Occasional : 1 or 2 times a year in an ATC organism (10^{-4} / operation hour)
 - Frequent : Many times a year in an ATC organism (10^{-3} / operation hour)
 - Very frequent : Many times a month in an ATC organism (10^{-2} / operation hour)

Safety Concept & Wording - Risk



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The **risk** associated to an hazard is the **combination** of the **probability of occurrence** and the **severity**.

The **acceptability** of the risk is evaluated, based on the probability of occurrence and the severity, and using a **risk classification matrix** (defined by the ANSP).

Risk probability	Risk severity				
	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	1E

Assessment risk index	Suggested criteria
5A, 5B, 5C, 4A, 4B, 3A	Unacceptable under the existing circumstances
5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C	Acceptable based on risk mitigation. It may require management decision.
3E, 2D, 2E, 1A, 1B, 1C, 1D, 1E	Acceptable

Note: Each ANSP should define its own table

Safety Concept & Wording - Risk



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Example of evaluation of the risk :

- *“Loss of the radio communication” is evaluated as severity B*
- *Probability of occurrence of “loss of radio communication” is evaluated as occasional*
- *Based on the risk classification table, this risk is unacceptable.*

Risk probability	Risk severity				
	Catastrophic A	Hazardous B	Major C	Minor D	Negligible E
Frequent 5	5A	5B	5C	5D	5E
Occasional 4	4A	4B	4C	4D	4E
Remote 3	3A	3B	3C	3D	3E
Improbable 2	2A	2B	2C	2D	2E
Extremely improbable 1	1A	1B	1C	1D	1E

➔ Mitigation shall be implemented to ensure the acceptability of the risk

ICAO 9859 Risk classification table

Safety Concept & Wording – **Mitigation Means**

Mitigations Means are implemented to manage the risk :

- Mitigation means can reduce the **consequences** of a hazard (severity) :

Reactive Mitigation Mean

- Mitigation means can reduce the **Likelihood** of a hazard :

Preventive Mitigation Mean

Safety Assessment Methodology



Step 1 – Environment Description (1/2)

- **Operational Environment:**
 - *Description of the airspace*
 - *Description of the adjacent airspace*
 - *Meteorological conditions*
 - *Traffic flow*
 - *Significant obstacle*
 - *Restricted or dangerous area*
 - *Noise restriction area*
 - *Existing procedures (conventional, PBN)*

Step 1 – Environment Description (2/2)

- **Working method:**
 - *Seperation (Tactical or procedural)*
 - *Coordination*
 - *Phraseology*

- **Equipment:**
 - *Air/Ground communication means*
 - *Ground /Ground communication means*
 - *Surveillance means*

Step 2 – Modification Description

- **Modification Description:**
 - *Approach implemented*
 - *STARs implemented*

- **Integration in the existing Air Traffic System**

Step 3 – Hazards Identification & Mitigation – Risk Matrix

- Hazards Identification
 - *Effects and Consequences*
 - *Initial Severity*

- Identification of Mitigation Means to reduce the Severity
 - *Corrected Severity*

- Identification of Mitigation Means to reduce the *Likelihood*
 - *Corrected Likelihood*

→ ***Check that Risk is acceptable***

Step 4 – Safety Requirements

- **All Mitigation Means are derived in:**
 - **Safety Requirements**
 - *Assumptions*

- **Identify**
 - *Responsible in the entity to put in place the SR*
 - *Planning to put in place the SR*

Role of State





- What is the CAA implication?
 - State Safety Plan
 - Risk Matrix is published by the State
 - Audits (all hazards and mitigation means should be stated and followed-up)

Conclusion





Any Questions?

