Safety Risk Assessment Process for multi-ANSP changes

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Safety Risk Assessment Process

making the difference ...

ES2 short version

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Background

In 2007, FABEC commissioned an analysis of the Safety Risk Assessment Processes (SRAPs) of involved civil ANSPs. The main results were [WP7.2e]:

- The SRAPs have similar process steps
- The SRAPs use many different supporting tools and techniques
- The safety criteria show fundamental differences
- Each ANSP has an NSA-certified SRAP

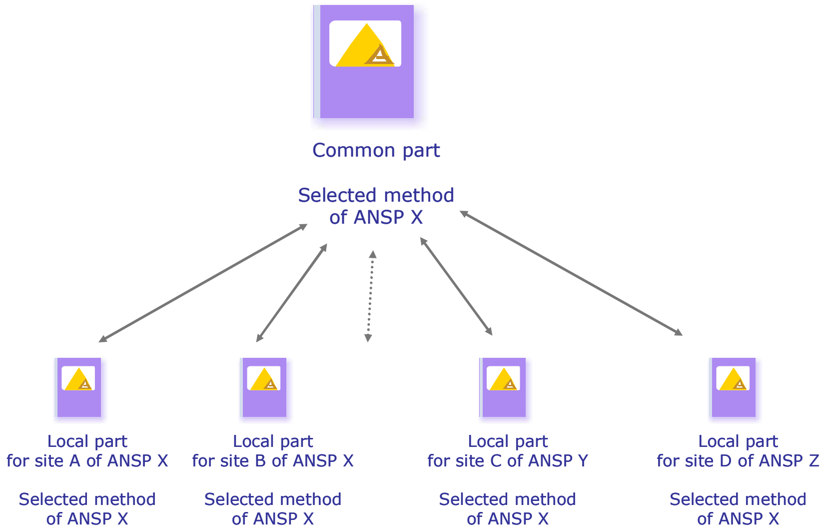
Differences in SRAP complicate reaching joint objectives:

- It is not effective if different safety assessments with different methods and criteria give different results for the same multi-ANSP change
- It is not efficient to develop multiple safety assessments using multiple methods

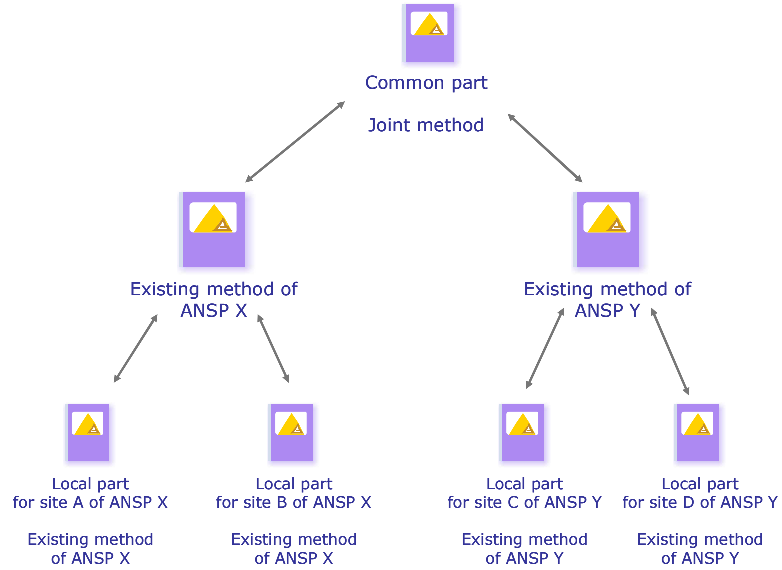
Background

From 2010 on, the ANSPs conducted safety risk assessment in joint projects by pragmatic cooperation.

- No fixed governance or formal joint SMS



SRAP Option 1: All ANSPs use the methodology of one of the ANSPs (e.g., ATFCM Live Trial)



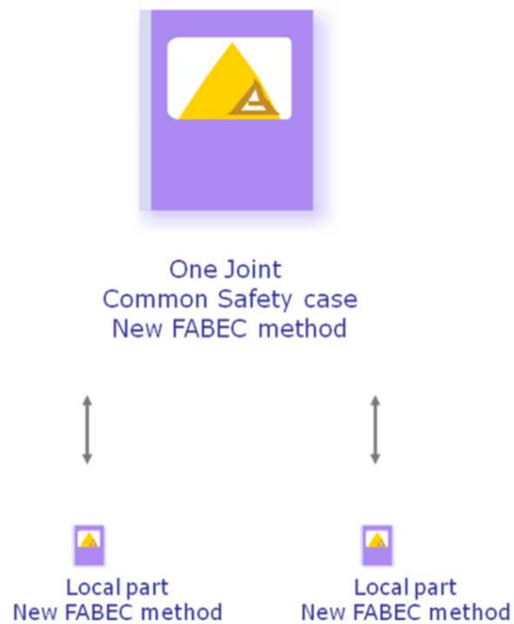
SRAP Option 2: All ANSPs largely use the own methodology, and develop a joint part on top (e.g., AMRUFRA)

Objectives

Simultaneously, the ANSPs started the development of a truly common method.

Main objectives:

- Harmonisation of SRAPs, for effectiveness and efficiency
- Practicability for operational use
- Compliance
  - Current regulatory framework
  - Future regulatory framework
  - NSAC manual
  - How does it fit within current regulatory framework? (1034, 1035, Basic Regulation, …)



SRAP Option 3:
One common method

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Development

The analysis commissioned in 2007 was basis for a kick-start.

Development based on consensus decision-making process

- Trust, open atmosphere and spirit of cooperation resulting from working together in joint projects
- Using extensive experience and expertise of ANSPs
- External support for researching material, moderation, and reporting
- Active participation of some working group members in EASA rulemaking group

Development of Option 3 description and training material

Upcoming application of Option 3 in pilot project

- Feedback to be used for Option 3 maintenance and further development

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Main principles

One safety case

- No separate case per ANSP
- A dedicated safety case template

One method

- Shared process steps, risk models, and safety criteria
- Including a joint Risk Classification Scheme (RCS)

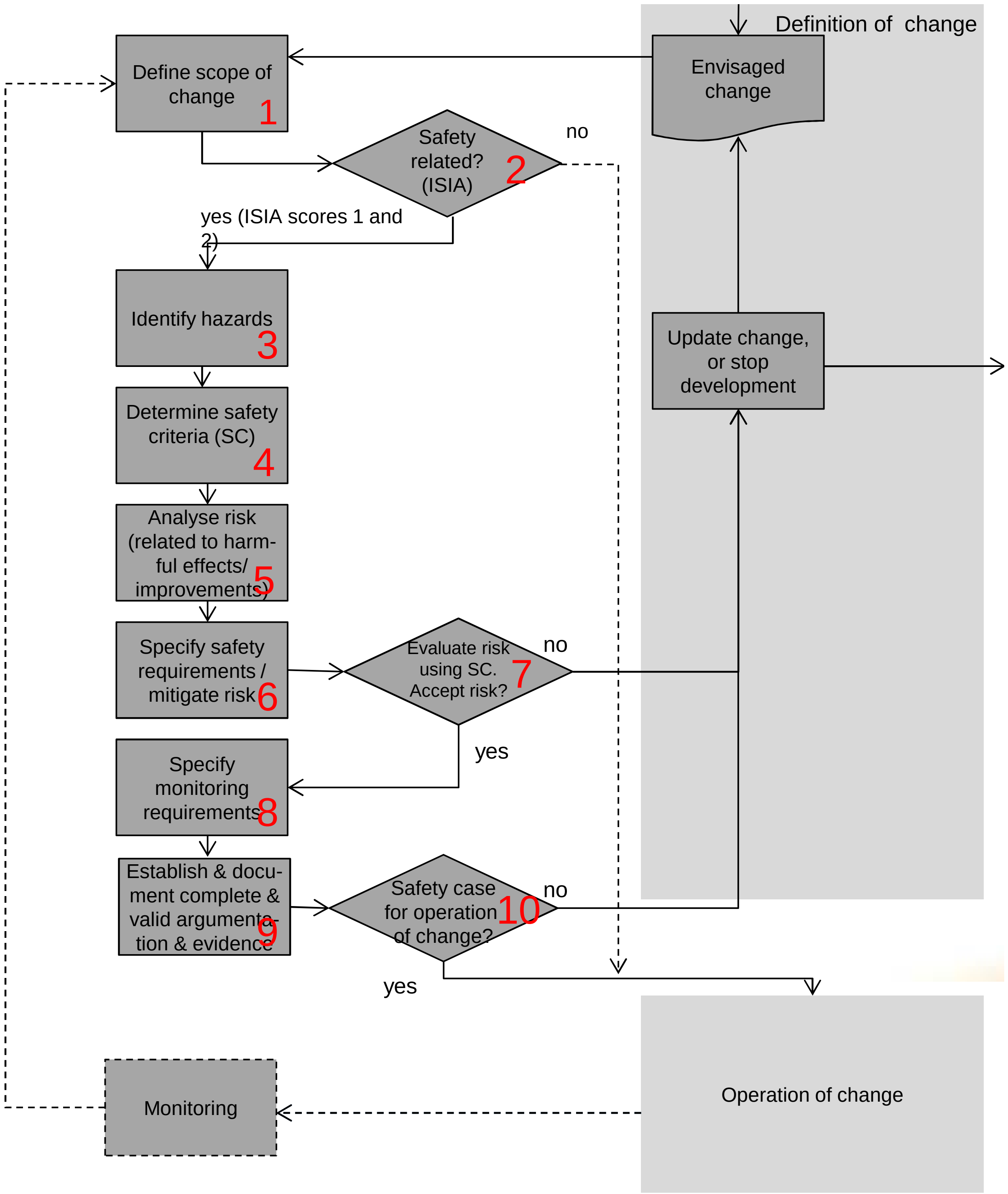
Specific analysis types

- Providing flexibility for effective and efficient safety risk assessment
- Three types, in line with EASA draft Implementing Rule [EASA IR Iss2.3]
- Each type has associated safety criteria

Process steps

Notes

- The order of steps allows selecting analysis type per hazard
- It is suggested to prepare steps early
- In case of iteration, not each step may need revisiting



Applicability and scope

Option 3 is intended for multi-ANSP changes.

- “A safety-related change impacting the functional system in the FABEC area and impacting more than one ANSP in two or more FABEC states” [NSAC Manual]
- ANSPs may apply Option 3 to local changes as well

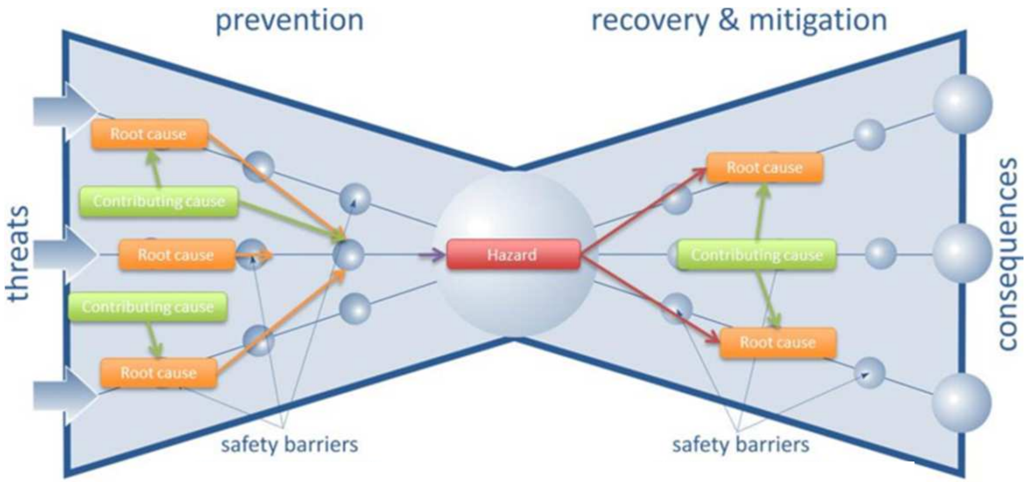
The scope of risk is based on the ***primary purpose of ATC, which is to prevent collisions***

- between aircraft
- between aircraft on the manoeuvring area and obstructions on that area

Analysis types

Three types

- Approach using RCS
- Relative approach
- Proxy approach



Each type is risk-based.

- Barriers, hazards, causes, consequences, risks, use of data,...
- Well-known bow-tie as common risk model
- Proxy is a new terminology, but in hindsight organisations have used it

Selection of type per change and (if desired) per hazard

- Main objectives: effectiveness and efficiency of safety risk assessment
- Combining types within assessment is possible

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Joint RCS: Development (1/2)

The joint RCS is defined in terms of occurrence categories as defined by [ICAO-CAST]

- The types can be summarised as accidents/incidents of “collision” type – recall that the primary purpose of ATC is to prevent collisions

The RCS is based on historical data:

- worldwide commercial air transport accidents from 2000-2009 of selected occurrence types [ICAO-CAST]
- data from [ICAO iSTARS]

The RCS compensates for expected traffic growth

- factor of 1.16 from 2007 to 2018 [Eurocontrol STATFOR]

Joint RCS: Development (2/2)

The RCS uses apportionment to the individual effects of hazards based on Model 1 of [ED-125], and assumptions:

- one flight includes 1.66 airborne flight hours
- maximum allowable frequencies for effects of severity 2, 3, and 4 are factors 10^3, 10^4 respectively 10^6 higher than for severity 1
- there are 100 hazards per Air Traffic Services Unit (ATSU)

A tolerable area of a factor 10 wide is introduced around the resulting figures to obtain some margin and flexibility

Option 3 and the joint RCS will be evaluated and may need further tailoring

RCS for effects in the air

Severity class Frequency (per airborne flight hour)	1	2	3	4
E-3 to E-2				
E-4 to E-3				
E-5 to E-4				
E-6 to E-5				
E-7 to E-6				
E-8 to E-7				
E-9 to E-8	unacceptable			
E-10 to E-9	tolerable			
E-11 to E-10	acceptable			

Provisional RCSs available for effects on runways and on taxiways

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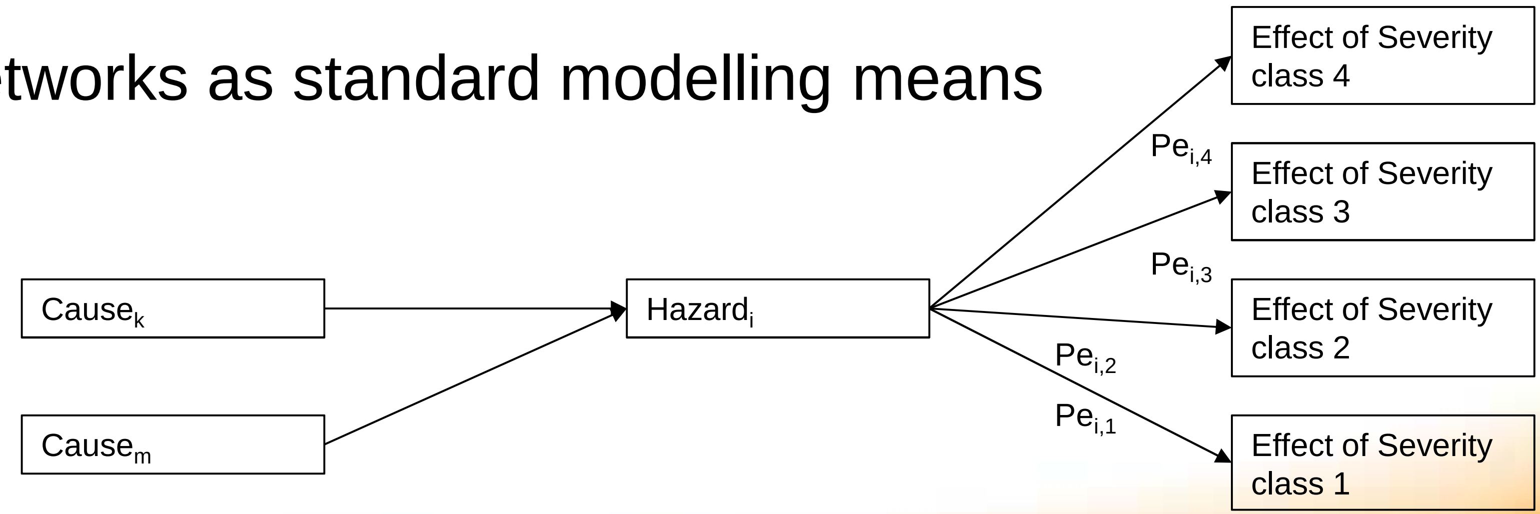
Application of RCS

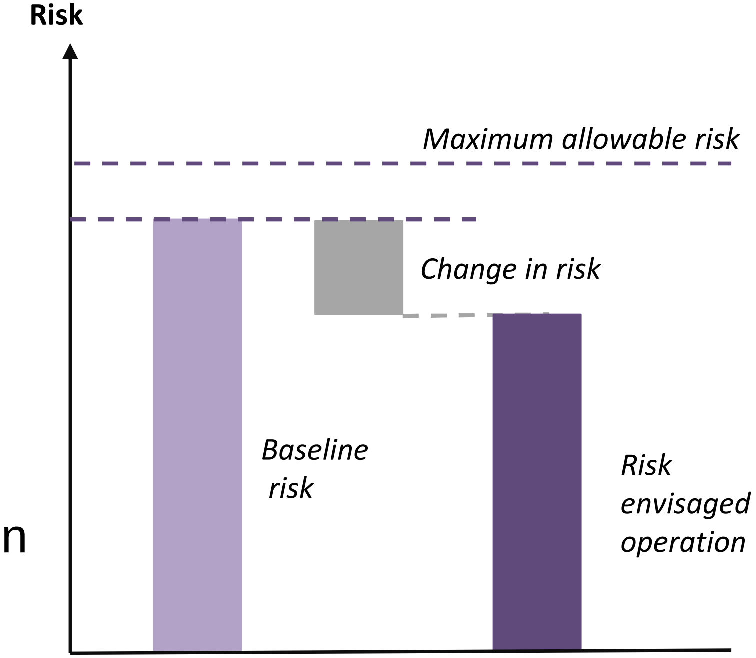
Example: A planned change affects the ATSU "ACC X"

- ACC X controls 500,000 flight hours per year
- The change could cause hazard "h" with effect "e"
- Effect e due to hazard h is estimated to occur 10/year at ACC X
- The expected frequency of effect e due to hazard h would then be 10/500,000 = 0.2×10^{-5} per flight hour

Event networks as standard modelling means



Relative approach



Overview of approach:

i. Estimate baseline risk
ii. Analyse difference in risk
iii. Estimate risk in envisaged operation

Supporting template for argued classification

i. Estimate baseline risk. Define baseline, and estimate risk based on
   - Previous safety assessment results
   - Safety data (e.g., cause/ hazard occurrences in last 10 years)
   - Additional arguments, expert judgement

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Relative approach

ii. Analyse difference in risk. Analysis supported by classification in template using indicators for:

- Changes in effectiveness of safety barriers (see illustration)
- Change in controller working conditions

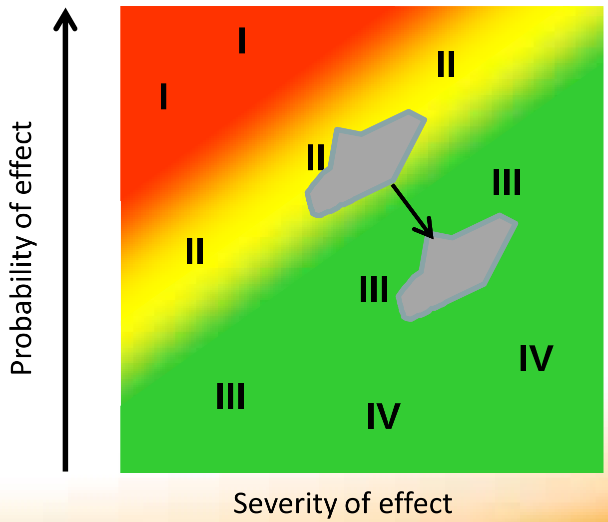
Impact on the effectiveness of barriers						Argumentation
Hazard	Rate of occurrence of the hazard increases significantly	Rate of occurrence of the hazard increases slightly	Rate of occurrence of the hazard remains unchanged	Rate of occurrence of the hazard decreases slightly	Rate of occurrence of the hazard decreases significantly	In the new operation, one of the two restrictions is removed [Concept]. In current operations, this hazard mainly occurs in this area [Data1]. Hazard probability will reduce significantly.
Conflict because of hazard	Probability of a conflict is significantly higher than in baseline	Probability of a conflict is somewhat higher than in baseline	The probability of a conflict remains unchanged.	Probability of a conflict is somewhat lower than in baseline	Probability of a conflict is significantly lower than in baseline	The traffic rates and main routes in this area do not change [Concept]. If the situation occurs, the probability of conflict therefore is the same [Exp]
Conflict detection & Resolution	Conflict is significantly less easily detected and resolved	Conflict is somewhat less easily detected and resolved	Detection and resolution of the conflict remains unchanged	Conflict is somewhat more easily detected and resolved	Conflict is significantly more easily detected and resolved	The situation in this airspace becomes less complex due to removal of a restriction and the more optimal route. Monitoring will become easier [Exp].
Geometry	Given an unresolved conflict, the probability of a collision is significantly higher than in baseline	Given an unresolved conflict, the probability of a collision is somewhat higher than in baseline	Given an unresolved conflict, the probability of a collision remains unchanged	Given an unresolved conflict, the probability of a collision is somewhat lower than in baseline	Given an unresolved conflict, the probability of a collision is significantly lower than in baseline	In case the hazard would occur and would lead to an undetected conflict, the situation would be similar as if this would occur in the baseline situation.

Relative approach

iii. Estimate risk in envisaged operation. Combine estimates of baseline risk and of change in risk

- Use respective classifications and the underlying data
- Estimate safety acceptability of changed operation (unacceptable, tolerable, acceptable, or negligible)

- Illustration of presentation of results:



- In addition, relative classification of effect on safety (e.g., medium+)

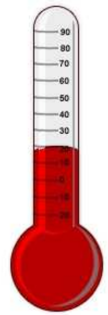
Relative approach

- Principles
  - LARGE effects are away from or to the Unacceptable area:
    - LARGE +: away from the red area
    - LARGE –: to the red area
  - MEDIUM effects are away from or to the Tolerable area:
    - MEDIUM +: from the yellow area to the green area
    - MEDIUM –: from the green area to the yellow area
  - SMALL effects stay within the same colour

New risk / Baseline risk	Red	Yellow	Green
Red	SMALL–/NO EFFECT/ SMALL+	LARGE+	LARGE+
Yellow	LARGE–	SMALL–/NO EFFECT/ SMALL+	MEDIUM+
Green	LARGE–	MEDIUM –	SMALL–/NO EFFECT/ SMALL+
Consequence for decision-making	Safety criteria not met	Management decision/ ALARP	Safety criteria met

Proxy criteria

Proxy criterion: a safety criterion that is not directly expressed in terms of safety risk (severity and probability), but in a different measure related to safety risk



A proxy criterion consists of:

- A measure (the proxy)
- Definition of acceptable values for the measure

A proxy criterion is used for the analysis of selected hazards of selected changes. Minimum conditions:

- It must contribute to effective and efficient safety assessment
- it must be justifiable to evaluate the safety acceptability of the change using the selected criteria (all hazards must be appropriately addressed)

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Use of proxy criteria

A proxy is defined closely connected to what is locally considered as a main operational issue.

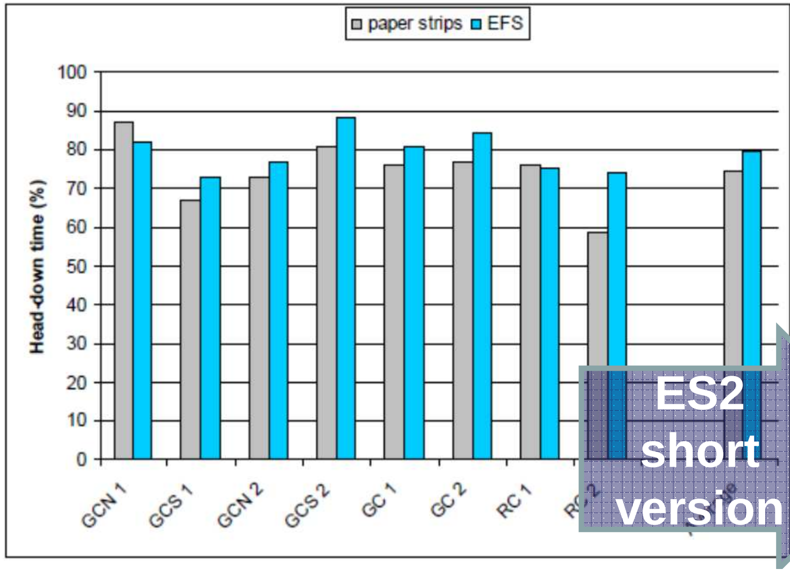
- A proxy may efficiently address the same part of multiple bow-ties at once
- A proxy criterion may be used in combination with complementary safety criteria to cover an entire hazard or change

Acceptable values are defined by interpretation of relevant recognized sources and expertise.

- Overarching safety objective: absolute numbers of accidents and incidents shall not increase, even in a context of traffic increase [Feasibility study]
- Acceptable values may be defined in a relative or absolute way

Illustration of proxy approach

Change:	Introduction of electronic flight strips at the tower
Hazard:	Manipulation of electronic strips takes time, at the cost of the out-of-the-window view
Proxy criterion:	No increase of head-down time
Analysis:	Comparison of head-down time before and after change using simulations



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Examples of possible proxies

- Head-down time
- Workload
- Frequency of airspace infringements
- False alert rate
- Situation awareness level
- Fraction of read-back errors
- Vigilance/ distraction
- …

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Pilot project

Option 3 available for first application in pilot project

- What is the support of NSAC?

Responsibilities in pilot application:

- SC SAF: The method is effective, efficient, and compliant
- SC SAF: Provide support to pilot project
- Pilot project: Apply safety risk assessment in line with method
- NSAC: …?

We are all in a transition in the context of FABEC ...

- Governance structure and joint SMS still under development
- Regulation and oversight structures also under further development

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Training and future steps

Option 3 developers provide introduction to their colleagues.

- Audience including foreseen safety practitioners of pilot project
- Feedback collected for further development of the training material

Future steps

- Structural training of Option 3 for future users
- Obtain regulatory compliance verification
- Evaluation, maintenance and further improvement of Option 3 using feedback from experiences
- Embedding Option 3 in SMS(s)
- Making Option 3 available

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Concluding remarks (1/2)

Option 3 is expected to deliver improvement in effectiveness and efficiency of safety assessment of airspace changes.

- One safety case
- One method
- Analysis types tailored to change or hazard: approach using RCS, relative approach, or proxy approach
- Quality improvement

Option 3 is an important joint result.

- Built on solid basis of experience and expertise of working group
- Developed by creative involvement and consensus of ANSPs
- Objective research for selected topics
- Taking into account latest regulatory developments

Concluding remarks (2/2)

Successful application of Option 3 is dependent on

- Establishing exemplary applications in pilot project
- Support, evaluation, maintenance and further development of Option 3 by SC-SAF
- NSAC role

Do you have any questions?

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References (1)

[ED-125] EUROCAE, ED-125: Process for specifying risk classification scheme and deriving safety objectives in ATM, March 2010.

[EASA IR Iss2.3] EASA, Rule text – RMG.0469, Issue: 2.3 – 21/1/2013

[Eurocontrol STATFOR] EUROCONTROL, Seven-Year Forecast Flight Movements 2012 – 2018, September 2012.

[Feasibility study] FABEC, Creating the Functional Airspace Block Europe Central, Feasibility Study Report, v2.0, September 2008.

[ICAO-CAST] ICAO-CAST, Aviation occurrence categories, definitions and usage notes, October 2011 (4.2) http://www.intlaviationstandards.org/Documents/OccurrenceCategoryDefinitions.pdf

[ICAO iSTARS] ICAO, Integrated Safety Trend Analysis and Reporting System, http://www.icao.int/safety/iStars/Pages/default.aspx

References (2)

[NSAC Manual] FABEC, Manual for the common activities of the FABEC NSAs, NSAC Manual WG, FABEC NSAC Manual v2.0, 13.12.2012.

[WP7.2e] FABEC, Analysis of safety assessment methodologies and criteria, FABEC-SAF-WP7.2-extra-v1.0, October 2008; see also [WP7.2e paper]

[WP7.2e paper] - J.J. Scholte, Analysis of safety assessment methodologies and criteria of FAB Europe Central partners, Eurocontrol Safety R&D Seminar – München, Germany, 21&22 October 2009.

[Option 3] - FABEC SRAP Option 3: A common FABEC method – Concise method description, version 1.1, 2013.

[Option 3 Training Material] – Collected Option 3 training material, version 1.0, March 2013.

Comparison of the joint RCS with ESARR 4 (1/2)

As basis of the joint RCS, maximum acceptable accident rates were derived for the occurrence categories MAC, TURB+ATM, RI-VAP, and $GCOL_{man.\ area}$.

Under assumptions regarding

- The fractions of MAC, TURB+ATM, RI-VAP and $GCOL_{man.\ area}$ accidents that have direct ATM contribution, and
- The number of accidents per flight with direct ATM contribution outside these categories,

this yields:

Converted to a maximum acceptable rate of accidents with direct ATM contribution, the RCS is a factor of about 4 less stringent than the figure of 2.31×10^{-8} accidents per flight of ESARR 4.

A factor 2 can be attributed to too high traffic expectations underlying ESARR 4.

Comparison of the joint RCS with ESARR 4 (2/2)

Direct comparison of

- the RCS for effects in the air, and
- ESARR 4's "maximum tolerable probability of ATM directly contributing to an accident of a Commercial Air Transport aircraft of 1,55 $*10^{-8}$ accidents per Flight Hour"

With 100 hazards' effects of severity class 1 in the air, this yields that:

in the air, the maximum acceptable accident rate per flight hour in the RCS is a factor 1.55 lower than in ESARR 4.

Assuming that

- few hazards' effects with higher accident frequency are tolerated
- many hazards have a lower accident rate

this joint RCS is thus reasonably in agreement with the ESARR 4 figure.