This is a presentation about the new methodology for Operational Risk Assessment, developed by the ARMS working group. ARMS stands for Airline Risk Management Solutions.

The presentation was initially created in Dec-08 and has been updated in Jun-09.

More material on this methodology, including a comprehensive detailed report, can be found at the website Skybrary.aero

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1. Do we need a New Methodology?
2. The ARMS Mission
3. The two levels of ARMS Deliverables
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5. Risk Management in the organizational context

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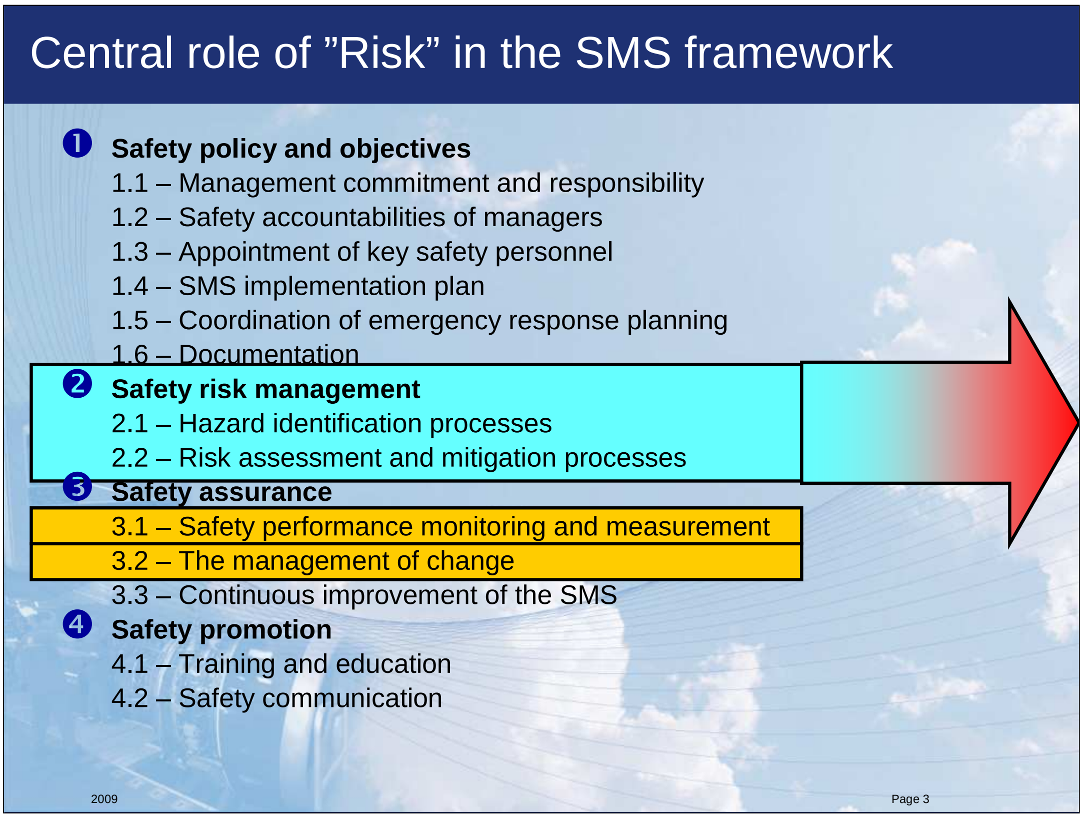


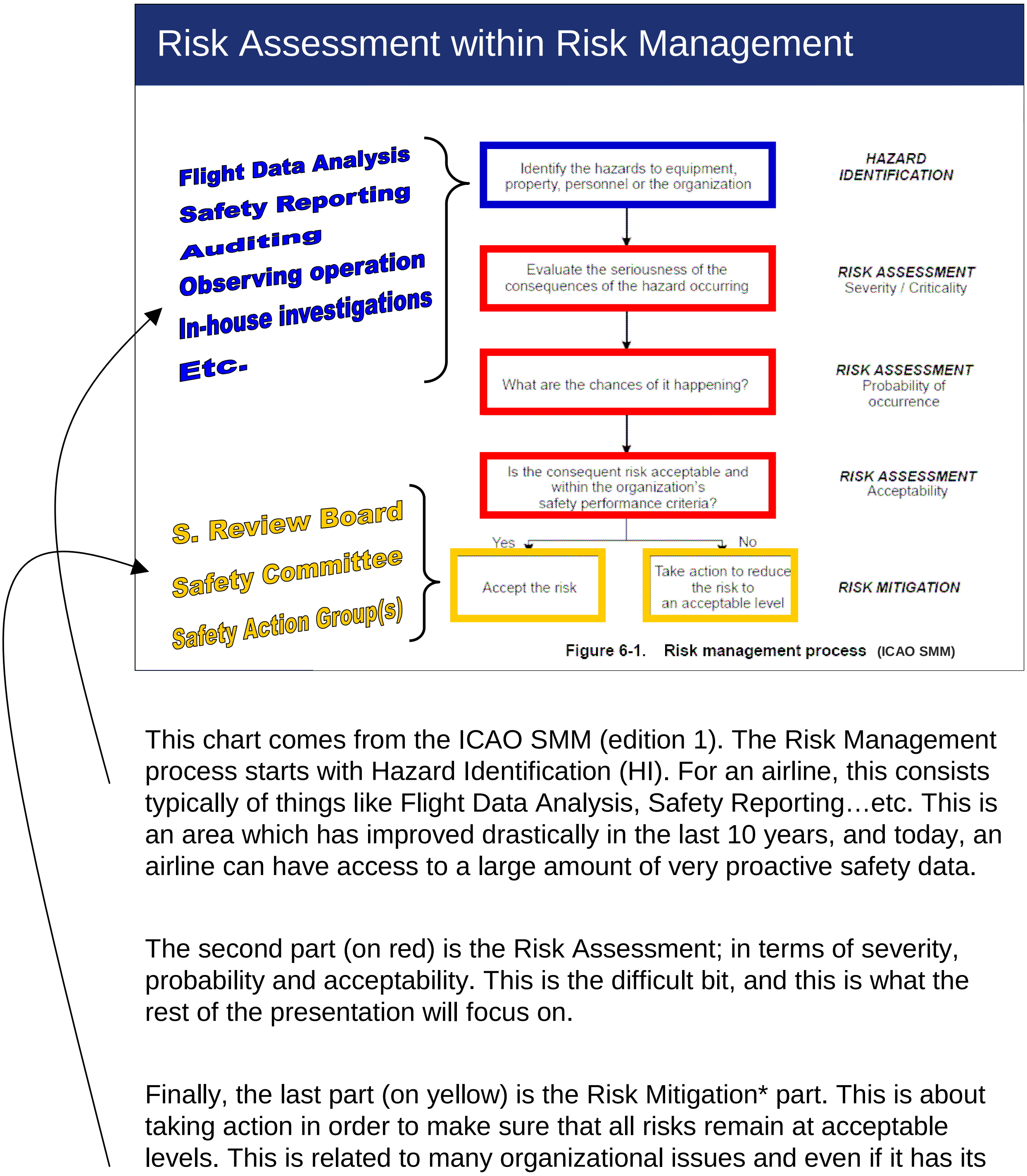
Risk Management has a very central role in the new SMS Framework, introduced by ICAO.

The component 2 of the SMS Framework, "Safety Risk Management" is the part where safety is concretely delivered, by identifying hazards, risk assessing them, and by taking action to manage the risks.

Risk-based information is also very useful for "Safety Assurance". Risk-based Safety Performance Indicators overcome many of the problems with classic SPI's (ref. Component 3.1 in the framework).

The Management of Change (ref. 3.2 on slide) process often requires making a Risk Assessment (or a "Safety Assessment") on the new planned activity; for example, opening a new route or introducing a new aircraft type. This again calls for a good practical method.

Let's now look more in depth into the component 2, "Safety Risk Management"…

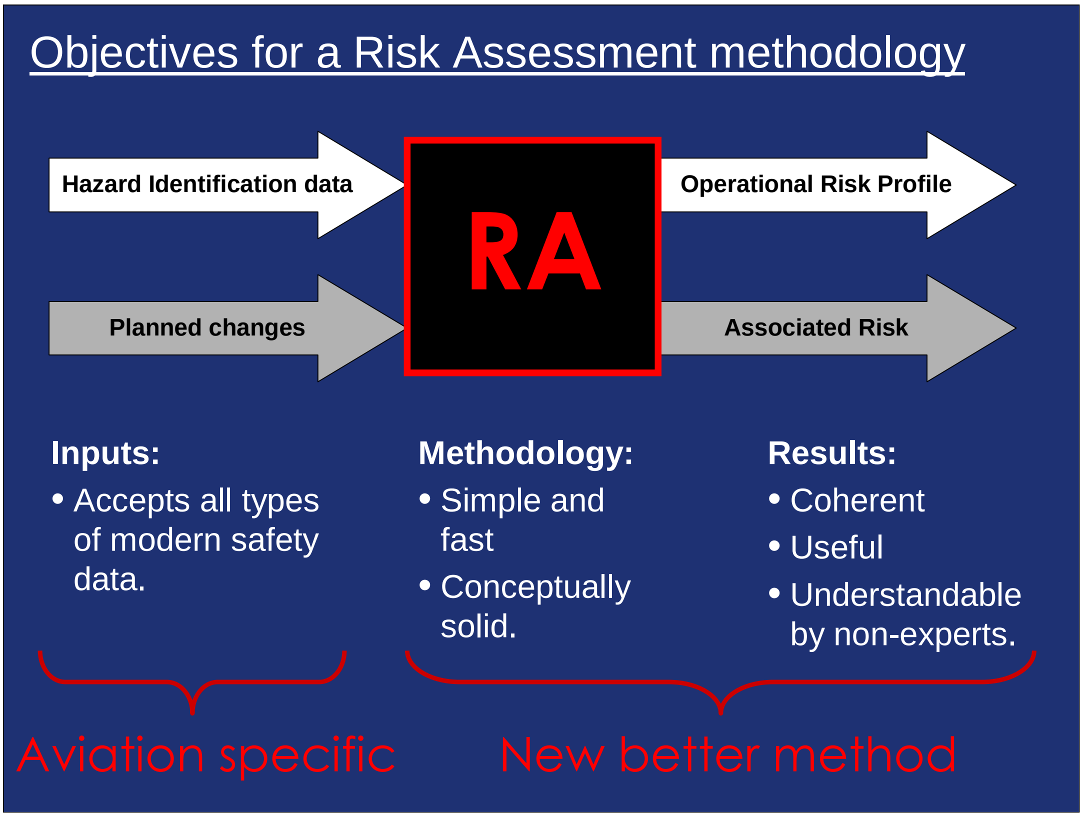


This chart comes from the ICAO SMM (edition 1). The Risk Management process starts with Hazard Identification (HI). For an airline, this consists typically of things like Flight Data Analysis, Safety Reporting…etc. This is an area which has improved drastically in the last 10 years, and today, an airline can have access to a large amount of very proactive safety data.

The second part (on red) is the Risk Assessment; in terms of severity, probability and acceptability. This is the difficult bit, and this is what the rest of the presentation will focus on.

Finally, the last part (on yellow) is the Risk Mitigation* part. This is about taking action in order to make sure that all risks remain at acceptable levels. This is related to many organizational issues and even if it has its own challenges, they are not related to the Risk Assessment Methodology itself. A typical arrangement is to use the Safety Review Board and Safety Action Groups to take care of this part.

**The ARMS group does not use the term "mitigation" due to its double meaning. See definitions in chapter 4.*



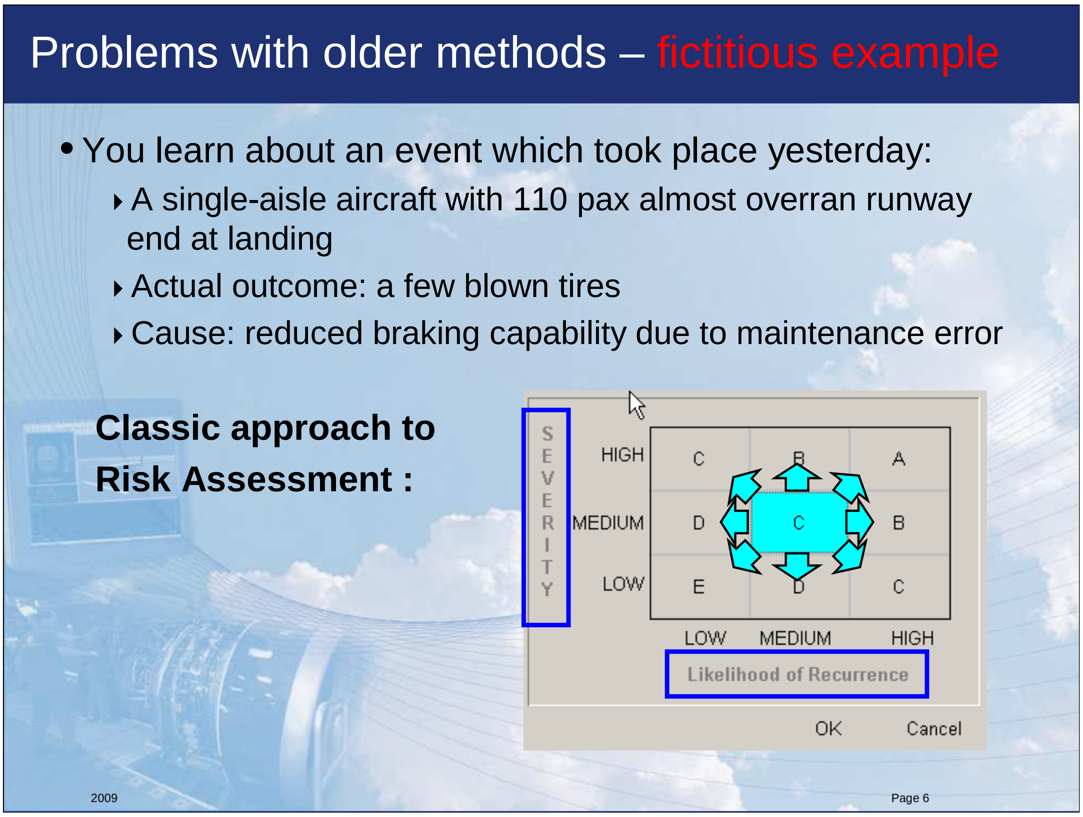
Before we start discussing any methodology for Risk Assessment, we should first be very clear about the overall objectives for Risk Assessment.

There are two main inputs. The first one is the operational Hazard Identification data (produced by the source listed on blue on the previous slide). The Risk Assessment method should be able – based on that data – to create a good overview of operational risks; we could call this the Operational Risk Profile.

The second input is a planned change. This comes back to the "Management of Change" process, where something new is started, so by definition there is no in-house data available for risk assessment, but a proactive "future risk assessment is still necessary". The RA method should help assess the Risk associated to the planned change.

We can now list objectives concerning the acceptable inputs, the method itself and the results (see bullets).

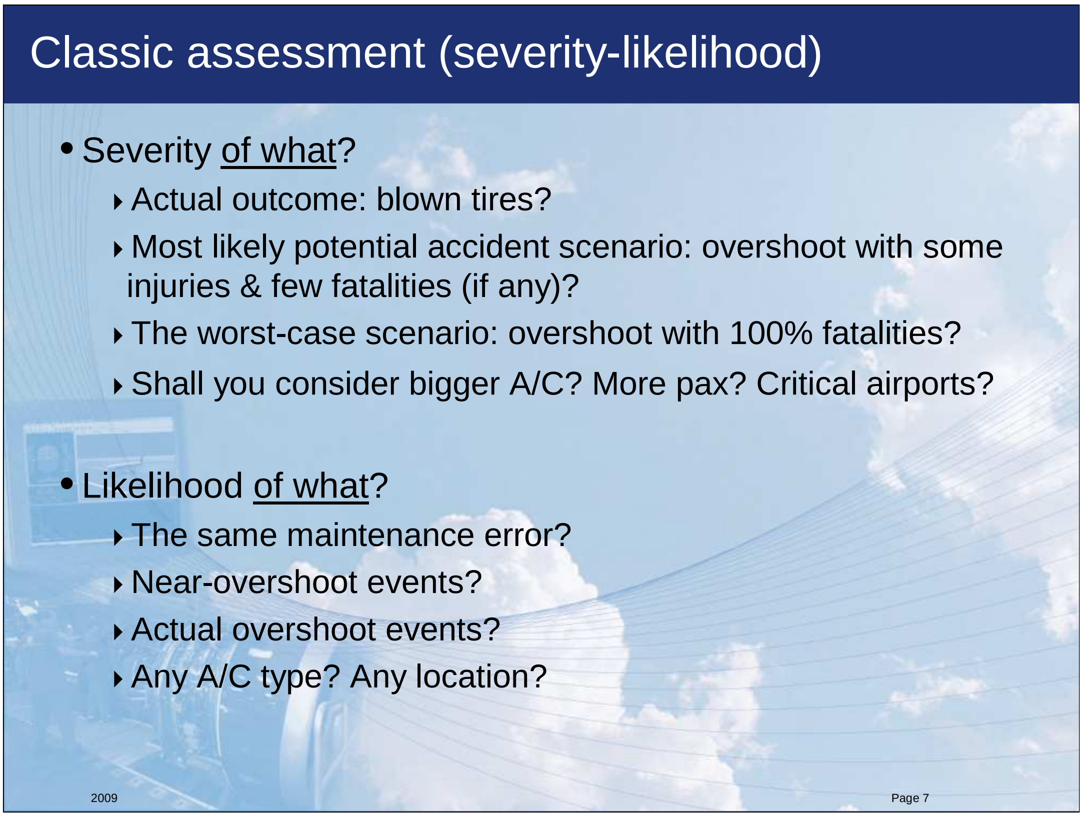
These requirements lead to two main conclusions. First, due to the specificity and quantity of the input data, the method needs to be specifically adapted for aviation. Secondly, it is argued that none of the existing methods fulfill the listed requirements on the methodology and the results. Therefore, a new better method needs to be developed.



Let's look at some of the problems with older methods.

Typically, an incoming event is classified in terms of risk using a matrix with two dimensions: severity and likelihood. The risk assessment becomes an exercise of picking the "right" square in the matrix.

This may seem as a simple task, but a closer study of the problem reveals fundamental problems caused by a deficient underlying conceptual framework.

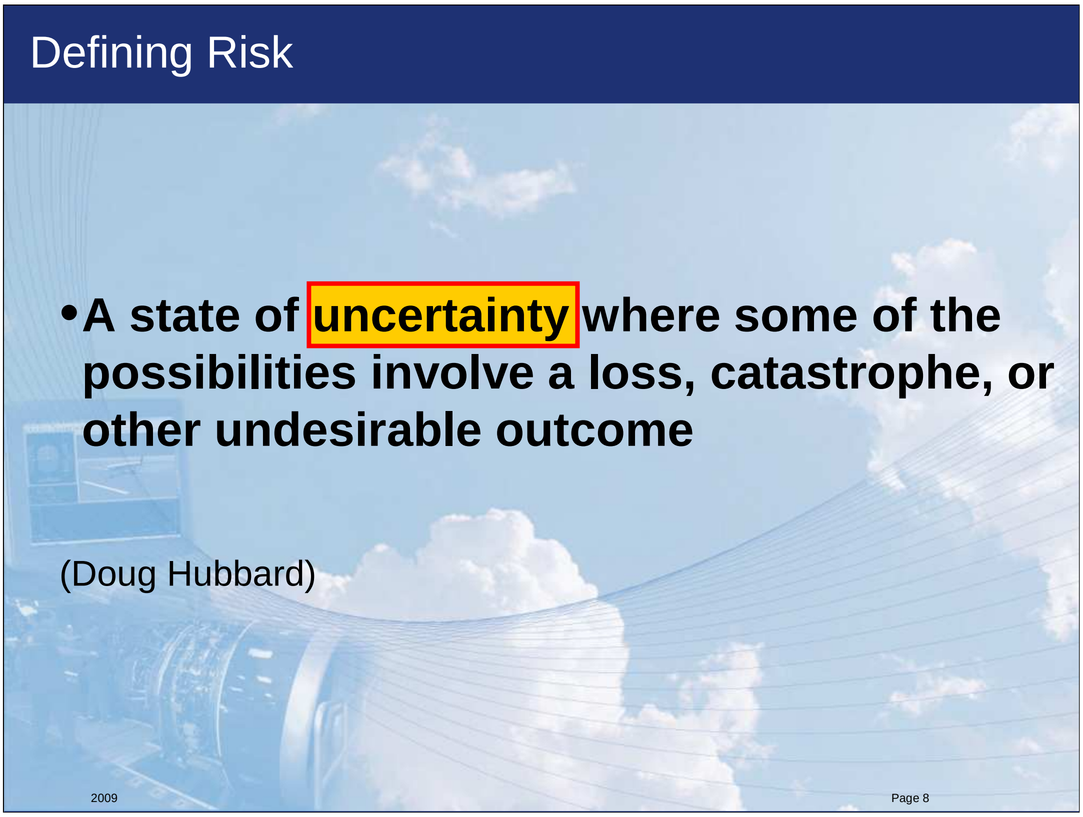


Severity…but severity of what? The actual concrete outcome? The most probable accident scenario, or perhaps the worst-case scenario?* Should we take into account that there could have been more passengers on board, especially if bigger aircraft types are considered? Should we consider that this could have happened at a more critical airport?

Likelihood…but of what? Even if we have thousands of events in a database, we first need to define what type of events we are looking for, to determine the statistical frequency and thereby the estimated likelihood.

Every event has hundreds of factors and circumstantial facts. It is not definable, when changes in these items is big enough so that the event is no longer "similar" to the original one.

*The ICAO definition of risk refers to the "worst foreseeable situation", which tends to imply 100% fatalities. But this is not the same as the "most probable accident outcome", which in real life may be a more useful concept.

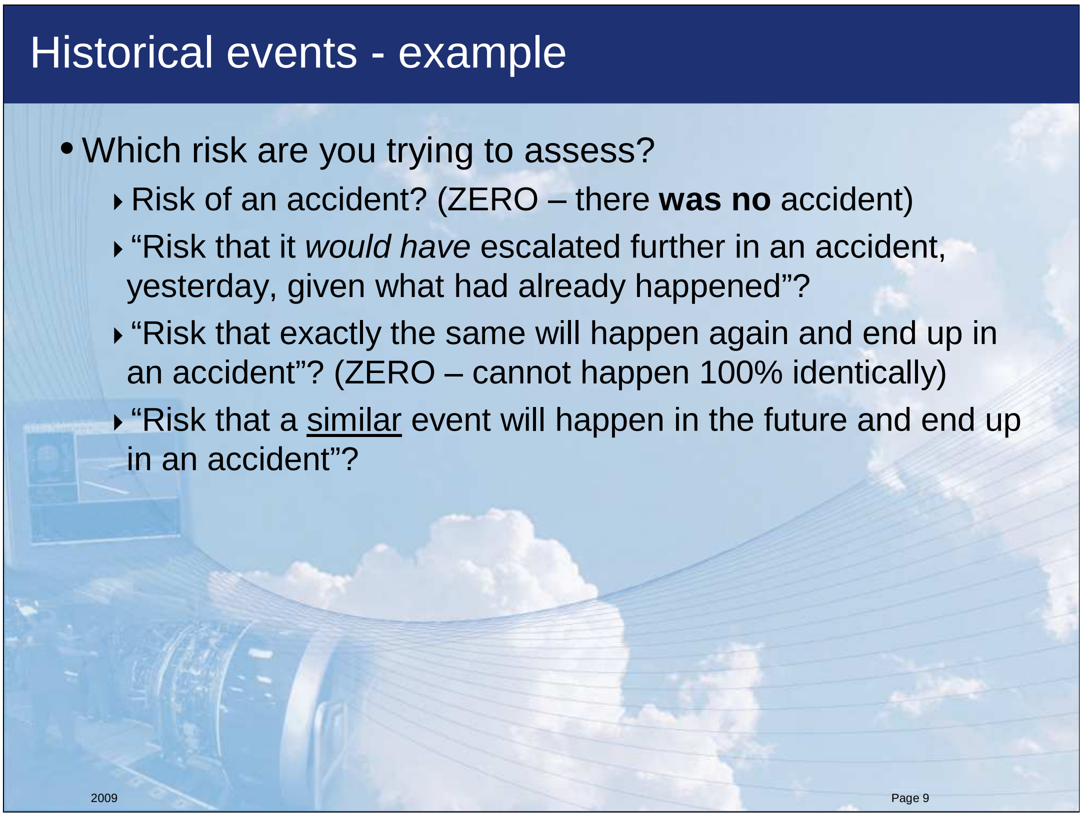


To tackle the problem of “risk assessing something that already happened”, we need to go all the way back to a very generic definition of risk.

Uncertainly is a key feature of risk. If there is no uncertainty, then there is no risk – perhaps losses, damages, injuries or fatalities – but all those are facts, historical certainties.

This means that already the idea of “risk assessing” historical events should make alarm bells sound. And yet, we do want to get some risk information out of the hundreds or thousands of safety data pieces we have.

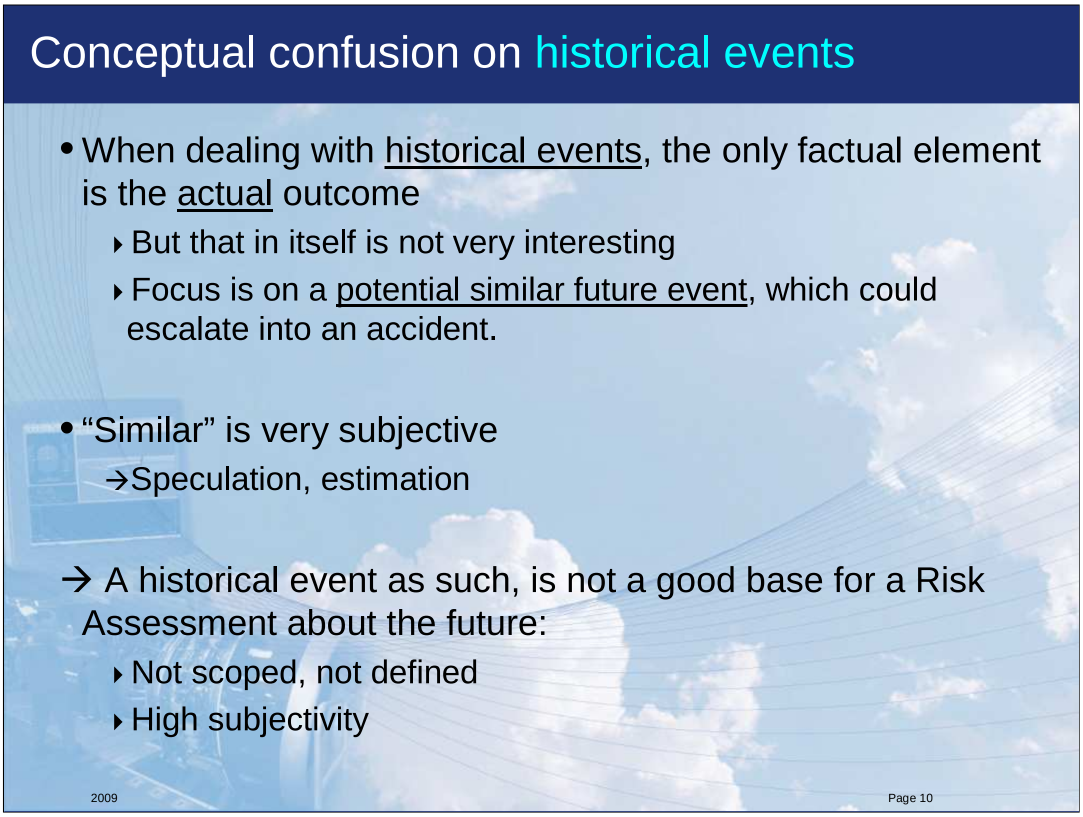
Is there any sensible way of “risk assessing” things that already happened?



First we need to be very clear about WHICH risk we are trying to assess. We have at least the above four alternatives.

Such a thinking exercise may seem somewhat silly, but in fact it is the fundamental step in building a robust risk assessment methodology.

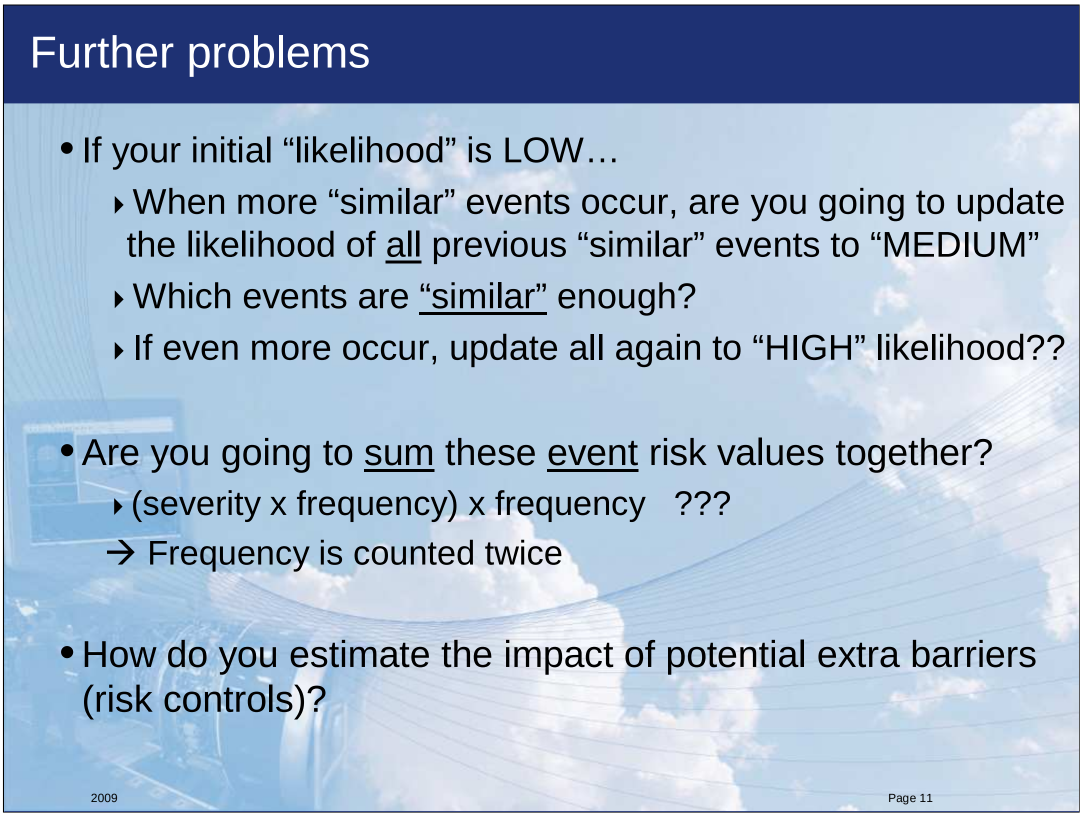
It turns out that so far we have tried to use the last option, with some now-well-known problems.



It is important to realize two things concerning the risk analysis of historical events: First, the only factual part is the event exactly as it happened and its actual outcome. Secondly, the historical event in itself is actually not the real interest of the risk assessment. Factually, if it ended well, the risk is zero. Furthermore, there is nothing we can do about the historical event.

Rather, we are interested in the capability of some hazard reflected by the event to harm us <u>in the future</u>. Such assessment is no longer based on factual elements, but subjective projections. And when one starts projecting into future, the whole assessment becomes completely under-defined. For example, this event took place on an A320, shall we only consider A320's, or also other aicraft types? This event took place in HKG, shall we also consider other airports – and which? This took place on a Sunday…in clear weather…with experienced crew…with one thrust reverser inop…etc, etc.

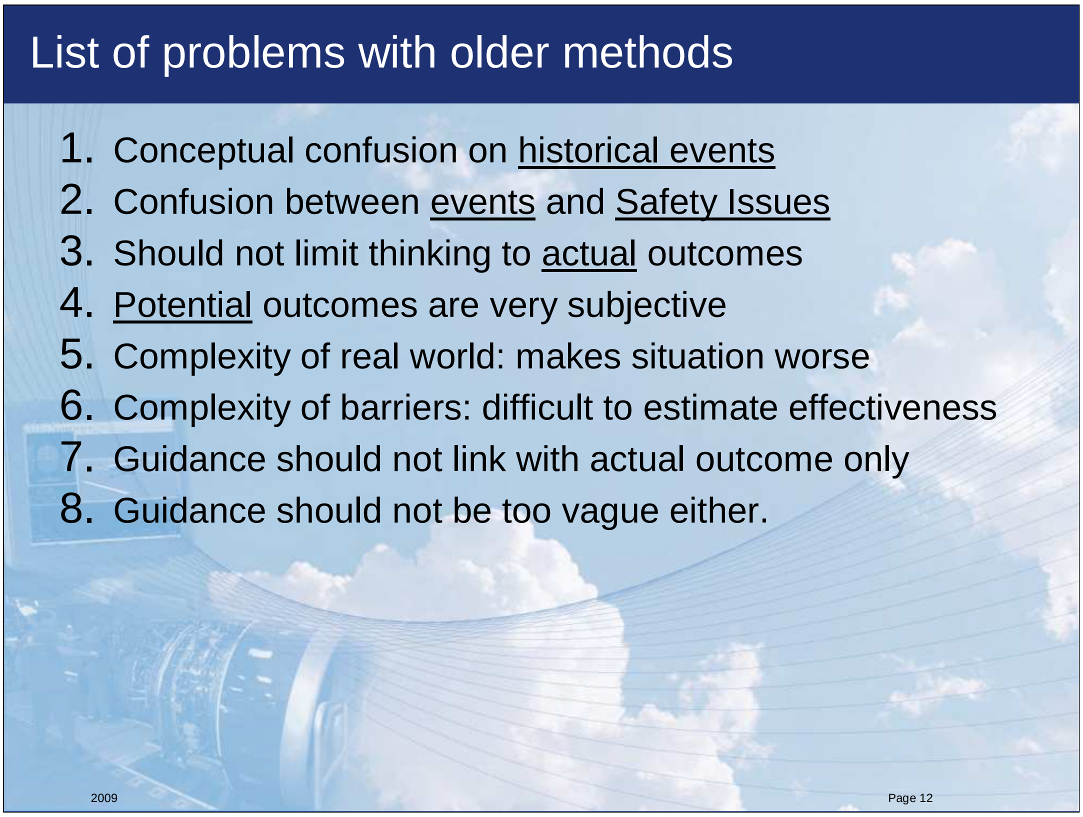
These questions are usually not addressed consciously and systematically, which makes the object of the risk assessment unclear and the whole assessment deficient. On the other hand, one cannot only limit the study to the event exactly as it happened, because it will <u>never</u> re-occur <u>exactly</u> the same way.



Trying to assess the likelihood when dealing with individual events causes other problems. Importantly, when an event type becomes more frequent, one should re-assess the risk of previous events by correcting the likelihood higher, otherwise their risk level does not reflect the increased likelihood. Such continuous re-assessment is not feasible in the real-life context.

Moreover, if one wants to estimate the total risk over an event type (e.g. TCAS events during approach to LHR), the temptation is to sum together the risk values of the individual events. If likelihood was one the two axes in the initial assessment, likelihood is now being taken into account twice vs. severity only once. The answer is flawed.

Another problem is trying to assess the risk reduction impact of barriers that are not in place, but could be put in place. There is no methodological guidance for this step, which becomes an extremely subjective estimate.



2. The whole concept of risk assessment of historical events is strange. We come back to the concept of Safety Issue later.

5. The aviation system with its various actors, technology and variable conditions is extremely complex.

6. The system of barriers (risk controls) in itself if usually very complex. Some barriers are vital: their failure makes the whole system fail. Some others are in series – their failure reduces the safety margin but as such do not cause an immediate impact, if other barriers are still in place. There are interactions between barriers, and often the humans can by-pass or de-activate barriers.

8. Typically, words like “severe” and“occasional” mean different things for different people. They are so vague that if they are used in a risk assessment matrix (without further guidance), the results are not coherent.

ARMS Methodology

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Due to the complexity of aviation and the nature of risk assessment, it will never be 100% scientific and objective, but we are convinced it can be done significantly better than with existing methods and that's our aim.

The result are valuable only if they are actually useful in the real-life operational context. We wanted this methodology to be developed by operational practitioners, so that almost by definition the result is pragmatic.

As you can see, we have people from airlines, maintenance organizations, the ATC domain and other aviation organizations. The resulting methodology is the fruit of excellent contribution by many people from various organizations.

The ECAST SMS WG took ARMS as the reference for operational risk assessment, not trying to duplicate the ARMS work in any way.

ARMS Mission Statement

The Mission of the ARMS Working Group is to produce **useful and cohesive Operational Risk Assessment methods for airlines and other aviation organizations** and to clarify the related Risk Management processes.

The produced methods need to **match the needs of users** across the aviation domain in terms of integrity of results and simplicity of use; and thereby effectively support the important role that Risk Management has in Aviation Safety Management Systems.

Through its deliverables, the Working Group also aims at **enhancing commonality** of Risk Management methodologies across organizations in the aviation industry, enabling increased sharing and learning.

In its work, the Working Group seeks contribution from aviation safety experts having knowledge on the user needs and practical applications of risk management in the operational setting.

The deliverables of the Working Group will be **methodology definitions** – not necessarily software tools. The first results will be delivered before 1-Jan-09 after which the potential continuation of the work will be reviewed.

The results of the Working Group will be available to the whole industry.

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ARMS Methodology

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Level 1 deliverable:

Conceptual methodology

On light blue background

Perhaps the most important deliverable of the ARMS working group is the conceptual methodology for Operational Risk Assessment.

This covers the developed concepts, terminology definitions, explanation of how risk assessment is carried out and the organizational aspects of risk assessment.

This part of the deliverables should be universally applicable to all aviation (and similar) organizations.

In this presentation, these deliverables are shown on a light blue background.

Level 2 deliverable:

Example application

On yellow/orange background

A little "C" in the corner reminds that this part may sometimes be further customized for specific contexts.

C

In addition to the conceptual methodology, the ARMS group has develop a concrete example application, including all necessary matrices and guidance text.

Most aviation organizations should be able to use this detailed methodology as such, but it should be expected some customization may be preferable or even necessary for some organizations. The working group gives guidance on how such customization can be done without compromising the overall methodology.

ARMS deliverables at this detailed level are presented on an orange background with a "C" in the bottom right corner.

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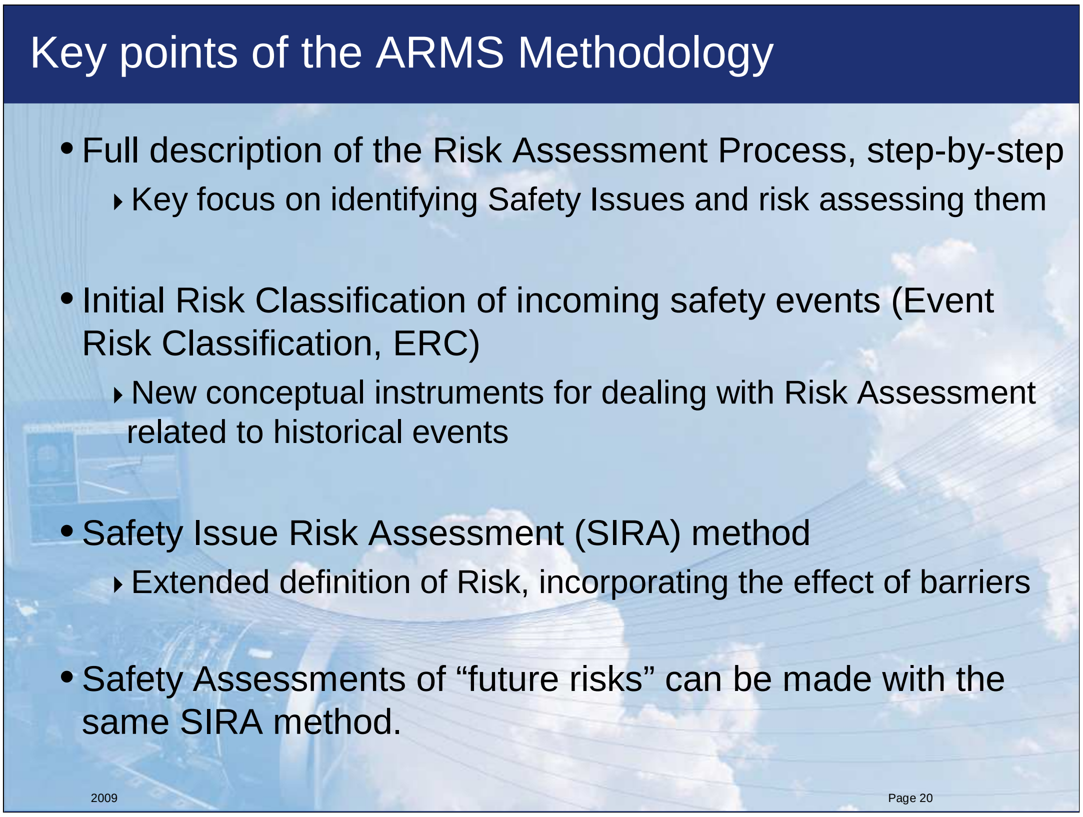


Before going into the Terminology and the Methodology itself, here the key points of this new Methodology summarized on one slide.

Terminology

- **<u>Hazard</u>:**
  - **Condition, object or activity with the potential of causing injuries to personnel, damage to equipment or structures, loss of material, or reduction of ability to perform a prescribed function.** (ICAO)

- **<u>Safety Issue</u>:**
  - **A manifestation of a hazard or combination of several hazards in a specific context. The Safety Issue has been identified through the systematic Hazard Identification process of the organization. A SI could be a local implication of one hazard (e.g. de-icing problems in one particular aircraft type) or a combination of hazards in one part of the operation (e.g. operation to a demanding airport).** (ARMS)

In order to talk the same language, we have listed on the next few slides, the Terminology definitions used by the ARMS group.

As far as possible, we use existing definitions and avoid making new ones.

We used ICAO's definition of Hazard as such.

Safety Issue is a very important concept for us. In everyday language, Safety Issue is a safety problem that you have identified as one in your operation. It is usually the local, specific implication of a generic hazard (e.g. Windshear in approach to HKG) but it could also be a combination of hazards present at once, e.g. landing to Quito (terrain, short runway, displaced ILS, tailwind, wet runway, high altitude, etc.).

Why is Safety Issue such an important concept? Two reasons. First of all, you can do something about Safety Issues. Managing Safety pretty much equals managing your Safety Issues. Secondly, you can define a Safety Issue precisely and therefore carry out a good Risk Assessment without much room for subjectivity.

Terminology

- **(Safety) Event:**
  - **Any happening that had or could have had a safety impact, irrespective of real or perceived severity** (ARMS)
- **Triggering Event:**
  - **In Safety Issue Risk Assessment (SIRA) the first of the four factors - the event which triggers the accident scenario by introducing the initial risk factor. Whether the sequence will then escalate into an UOS or Accident will depend on the avoidance and recovery barriers.**
- **Undesirable Operational State (UOS):**
  - **The stage in an accident scenario where the scenario has escalated so far that (excluding providence) the accident can be avoided only if an recovery measure is available and activates. Risk Controls prior to the UOS are part of Avoidance and post-UOS are part of Recovery.** (ARMS)

An event is basically anything that happened in the operation that at least potentially could have had some kind of safety implication.

The “Triggering Event” and “UOS” are closely related to the new conceptual framework of Risk, based on four factors, instead of the old two (severity x likelihood).

The UOS is the point at which things start “getting out of hands”. This is the limit between prevention (prior to the UOS) and recovery (after the UOS). The UOS is therefore more an imaginary abstract concept than a real-life event. It helps analyze the accident scenarios in a more systematic manner and to assess the various barriers better.

Terminology

RISK

- **A state of uncertainty where some of the possibilities involve a loss, catastrophe, or other undesirable outcome** (Doug Hubbard)

- **Probability of an accident x losses per accident** (classic engineering definition)

- **The predicted probability and severity, of the consequence(s) of hazard(s) taking as reference the potential outcomes.** (adapted from ICAO by ARMS)

We started with the ICAO definition of Risk, but were forced to modify it a little bit.

First of all, as risk is fundamentally “a state of uncertainty”, we did not like saying like ICAO that “risk is an assessment”.

Secondly, we have discovered that the “worst foreseeable situation” is not necessarily what you should be looking at in an assessment, so we replaced those words by “potential outcomes” which catches the main point that risk assessment should not be limited to the actual, real outcomes.

Preferred use related to “Risk Controls”

- Synonyms:
  - Risk Control
  - Barrier
  - Protection
  - Defense
- Used by ARMS:
  - Risk Control
  - Barrier
- Not used by ARMS:
  - Safety Barrier (misleading)
  - Protection, defense (for harmonization reasons)

- **Measures to avoid or to limit the bad outcome; through prevention, recovery, mitigation.** (SHELL)
- **Measures to address the potential hazard or to reduce the risk probability or severity.** (ICAO)

To harmonize the language, among the several synonyms for “risk control”, we use “barrier” and “risk control”.

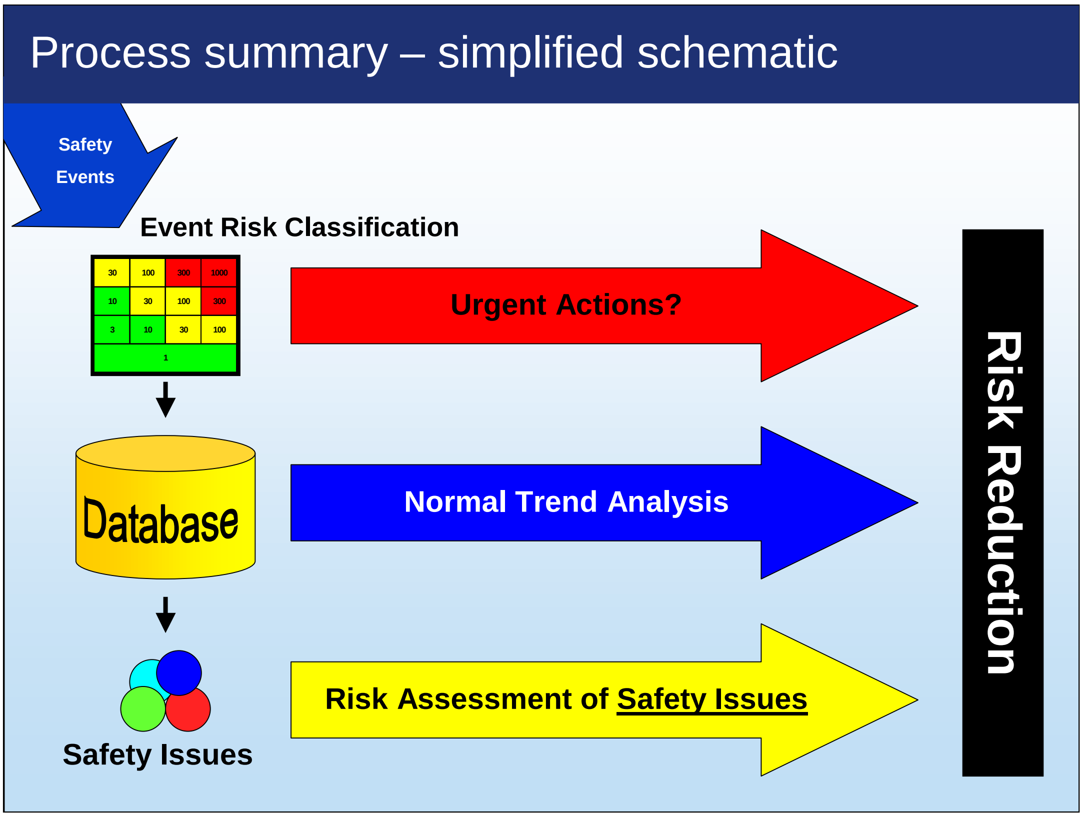
Not used due to several meanings

- Threat
  - Another meaning in the TEM context
  - Usually the word **scenario** can be used instead

- Mitigation
  - Classic = post-accident risk controls
  - ICAO = all risk controls (prevention, recovery, mitigation)
  - Used by ARMS: **controlling risks** or **reducing risks** (verbs)
  - Used by ARMS: **Risk Controls, Barriers** (nouns)

“Threat” is a difficult word, because it is largely used in classic Risk Management literature, but has another meaning in Threat and Error Management. ICAO does not use “threat” in the Risk Mgt context. We decided to avoid using it, and to try to use “scenario” instead.

Mitigation again has two meanings. We try to avoid the word all together.

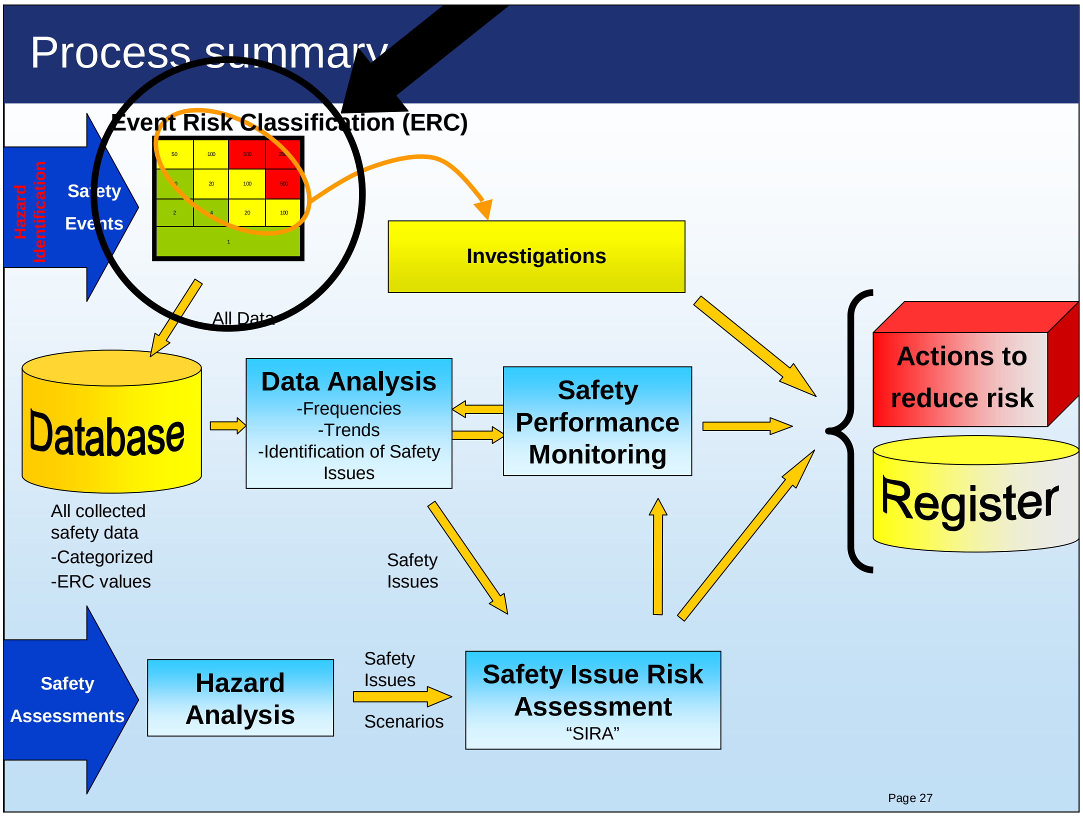


Let’s now go into the methodology itself. It is important to start from the overall process. This is a simplified summary.

The starting point is the safety data, which flows in from Hazard Identification. The incoming elements are typically events. Due to this fact, and due to the need to screen for item requiring urgent actions, the first step has to be a quick screening of all incoming events. The purpose is not a thorough analysis, but only a first-cut classification.

The data flows into a safety database, which is used for trend analysis. This may lead to actions due to increasing trends, etc, sometimes without a formal risk assessment. A key step here is to identify the Safety Issues.

The Safety Issues (SI) are then subject to a detailed Risk Assessment. Safety Issues are no longer single events, but well-defined Issues, typically highlighted by several events.



This is a more detailed presentation of the process. The same three "loops" are visible: one going directly from the Event Risk Classification (ERC) to investigation and action; second going from the Database through Data Analysis and Performance Monitoring to Action; and the third one going to Safety Issue Risk Assessment.

The ERC applies a specific risk assessment developed for historical events to determine the urgency of associated action and whether the event requires further analysis or investigation.

The Database has all the safety data in a structured format, enriched by descriptors covering things like date, a/c type, location, flight phase. But each event now also has a risk index value coming from the ERC. These values can be used in statistics. Data Analysis is about looking at the data with the help of the descriptors, statistical tools and graphs/charts in order to detect Safety Issues. It is also the basis for monitoring the Safety Performance.

Identified Safety Issues are risk assessed in the "Safety Issue Risk Assessment" (SIRA). This will provide risk tolerability information on all detected risks.

Finally, Risk values and related actions are monitored through the Risk Register database.

Risk Assessing something that already happened

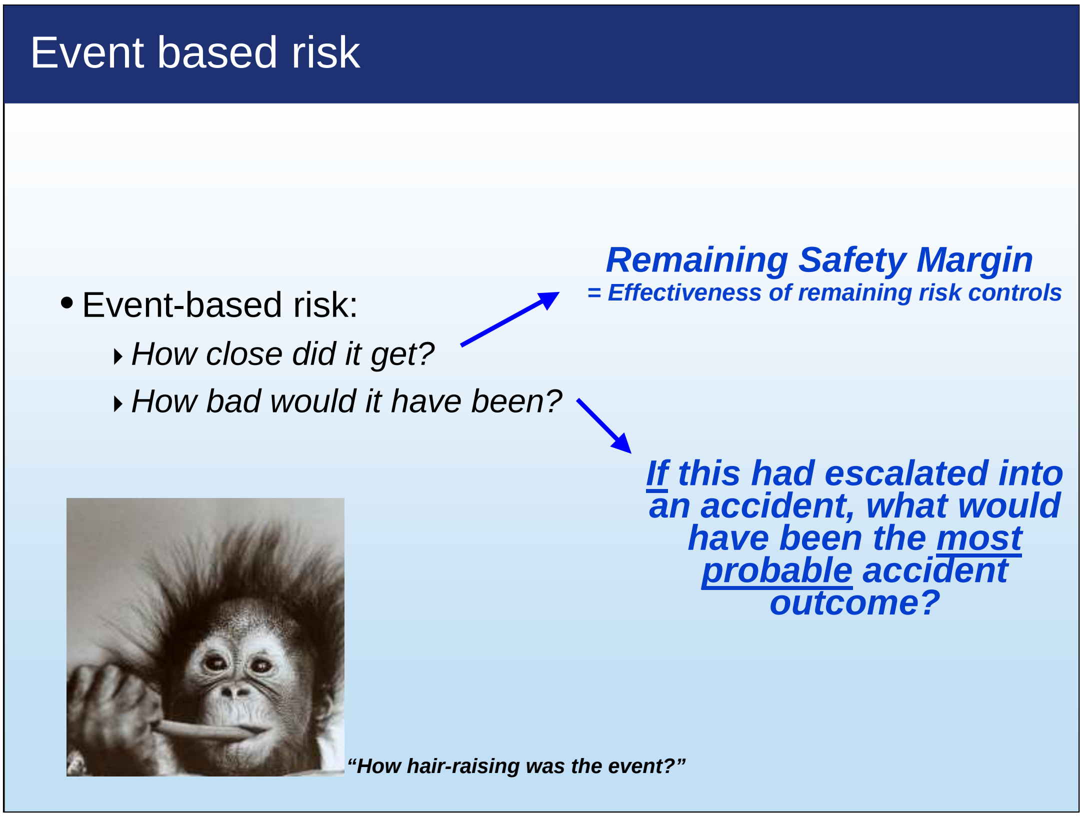
- Let's define the "risk of a historical event":
  - "What ***was*** the Risk that the event *would have escalated* into an accident that day"
  - i.e. the risk to which the occupants of the plane were exposed *that day*.
  - The **actual outcome** is taken as a given, the focus is in the **further escalation** until an accident.

- "Event-based risk"
  - Focus on one single event
  - Likelihood of recurrence ("frequency") not considered

The first step in the process is the Event Risk Classification (ERC).

We now answer the previous question: "which risk are we assessing?".

We use the concept of "event-based risk".



We spent a lot of time working on how to deal with *historical events*, and the concept of risk related to them. The first conclusion, which we hope makes sense to everybody, is that when dealing with an individual event, we should not try to estimate its frequency.

When you ask the question: "what really makes an event worrying, concerning, frightening?", you realize there are two main factors: how bad could it have been (as an accident) and how close did it get (to the accident). The Risk Assessment of historical events is based on these two dimensions, which translate to more specific questions.

What we are measuring is the risk experienced in the event under study, that day, in those conditions. This acknowledges that some barriers have already been breached, and what really matters is the remaining set of barriers and their effectiveness. This is the Risk we measure with the ERC matrix, presented on the next slide. If you look at tomorrow, the risk would be different, because now you would assume all the barriers to be in place, a priori.

Is the ERC value really a "risk" or just the "severity"? ERC includes also the probability dimension (the horizontal axis) in the form of the Safety Margin; therefore we do consider it Risk. This is in line with our Risk definition which we adapted from the ICAO definition.

Event Risk Classification (ERC)

Question 2

What was the effectiveness of the remaining barriers between this event and the most probable accident scenario?

Question 1

If this event had escalated into an accident, what would have been the most probable outcome?

Effective	Limited	Minimal	Not effective	Question 1 outcome	Description	Typical accident scenarios
50	102	502	2500	Catastrophic Accident	Loss of aircraft or multiple fatalities (3 or more)	Loss of control, mid air collision, uncontrollable fire on board, explosions, total structural failure of the aircraft, collision with terrain
10	21	101	500	Major Accident	1 or 2 fatalities, multiple serious injuries, major damage to the aircraft	High speed taxiway collision, major turbulence injuries
2	4	20	100	Minor Injuries or damage	Minor injuries, minor damage to aircraft	Pushback accident, minor weather damage
1				No accident outcome	No potential damage or injury could occur	Any event which could not escalate into an accident, even if it may have operational consequences (e.g. diversion, delay, individual sickness)

- Risk index numbers developed based on accident loss data
- Long evolution of content, tested by several ARMS members

This is a concrete example of an ERC matrix.

We have guiding questions to take the user through the ERC assessment. Having only 4 classes both ways helps making this assessment easily. The guidance text for each class can be customized to specific applications.

One has to keep in mind that the overall purpose is only to make an initial estimate of the risk, so that the event is classified correctly. This is not the final risk assessment. This classification should be possible even *without* the guiding text, just based on the two questions.

Why is the bottom row just one block? Because if you say that this event could not have escalated into an accident, then it makes no sense to estimate the remaining safety margin.

The guidance is given on the following slides.

ERC Guidance – Question 1

- Take all the contextual factors as they were (the location, airport, crew, aircraft, time of day, weather, etc.)
- In your mind, try to escalate the event into an accident outcome*.
  - If it was virtually impossible that the event could have escalated into an accident outcome, then you are at the bottom row, at ERC value 1.
  - If you can imagine credible accident scenarios (even if improbable ones), then consider the most probable scenario and judge its typical consequence (→ pick the resulting row in the matrix).

***Including "minor injuries or damage" which would fall outside the ICAO Accident definition while still having some concrete safety consequence.**

C

This type of step-by-step guidance can be customized for each organization using the method.

The more the method is used, the less the guidance will be needed on a daily basis.

It may turn out that ready-made flowcharts can be used for some relatively simple repetitive events; e.g. harmless birdstrikes.

The event is always treated exactly as it happened, except that it is escalated in an imaginary accident. Exceptions to this rule should be extremely rare, e.g. in a case of a loadsheet error, it may be justified to consider that the error in numbers could have been bigger than it was (if it is only a question of wrong numbers having been typed in or read).

ERC Guidance – Question 2

- Now think how much "safety margin" existed between the real-life event and the imagined accident scenario. Consider both the number of the remaining barriers and how strong they are. Barriers that already failed are ignored. Only the barrier which worked and any subsequent barriers still in place are taken into account. You should pick…
  - The extreme right column, if the only thing separating the event from an accident was pure luck or exceptional skill, which is not trained nor required
  - The 3rd column from the left, if some barrier(s) were still in place but their total effectiveness was "minimal" – e.g. this could be a GPWS warning just before an imminent CFIT.

C

The barrier systems are easily so complex that no simple rules exist for determining the "effectiveness of remaining barriers".

ERC Guidance – Question 2 (cont'd)

- The 2nd column if the effectiveness of the barrier(s) was "limited". Typically, this is an anormal situation, more demanding to manage, but with still a considerable remaining safety margin – e.g. a moderate error in loadsheet or loading vs. slight rotation problems at take-off.

- The extreme left column, if the safety margin was "effective", typically consisting of several good barriers – e.g. pax smoking in the lavatory v.s. in-flight fire accident.

C

Event Risk Classification (ERC) - example

- Maintenance error, reduced braking capability. A single-aisle aircraft with 110 pax almost overran runway end at landing. Blown tires.

Question 2

What was the effectiveness of the remaining barriers between this event and the most probable accident scenario?

Question 1

If this event had escalated into an accident, what would have been the most probable outcome?

Effective	Limited	Minimal	Not effective		
50	102	502	2500	Catastrophic Accident	Loss of aircraft or multiple fatalities (3 or more)
10	21	101	500	Major Accident	1 or 2 fatalities, multiple serious injuries, major damage to the aircraft
2	4	20	100	Minor Injuries or damage	Minor injuries, minor damage to aircraft
1				No accident outcome	No potential damage or injury could occur

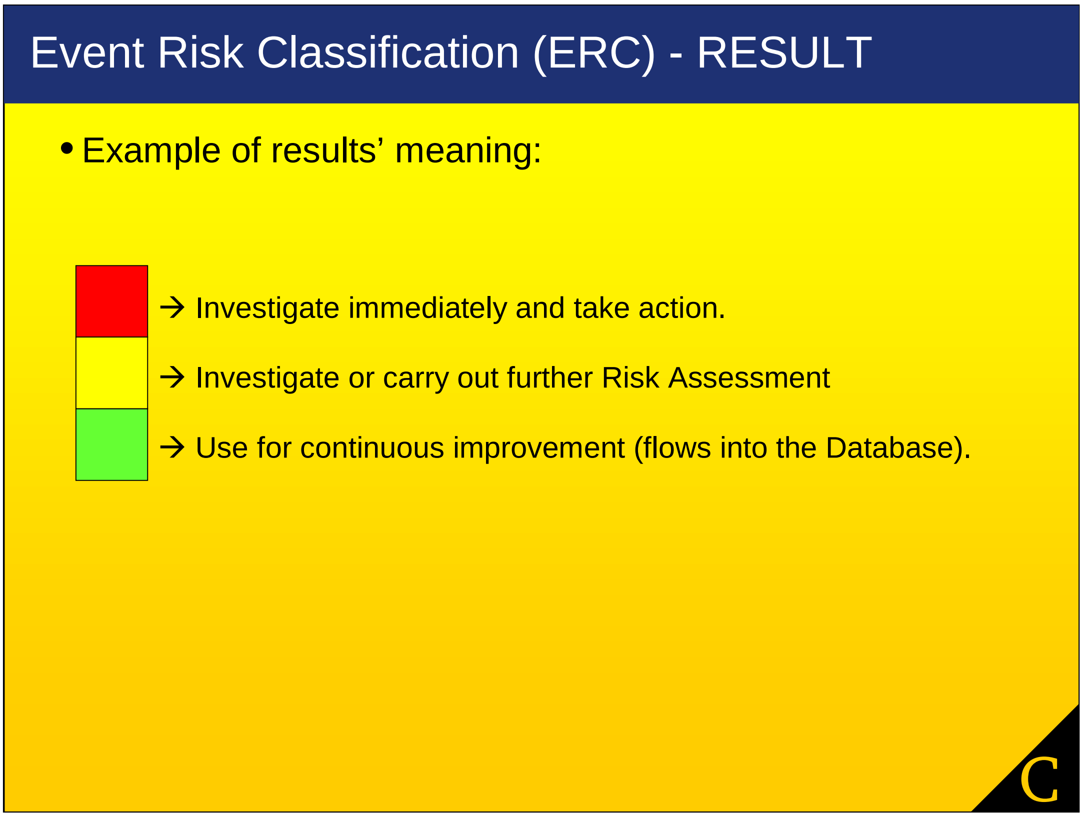
C

Let's use the earlier example.

The most probably accident outcome would have been a slow speed overrun with injuries but without multiple fatalities. (This is a good example of why we did not like the risk definition phrasing "worst foreseeable situation" which would often be too severe).

There were no remaining barriers left. It was pure luck (or favorable conditions) which made the plane stop on the runway and not just after. (A physical net at the end of the runway would be such an extra barrier, though).

This leads you to the red zone of the matrix with risk index 500.



The first result is the color.

Typical examples of the color's meaning are presented above. These are naturally subject to adaptation in each organization.

Event Risk Classification (ERC) - RESULT

- The ERC will also produce a numerical Risk Index value (or "ERC value") for each event
- The Index is an estimated risk value
  - Can be used to quantify risk
  - Useful for summing up risks of similar events and making statistics
  - Helps in identifying Safety Issues
- Examples:
  - Risk per each airport
  - Risk per flight phase
  - Risk per time of year
  - Etc.

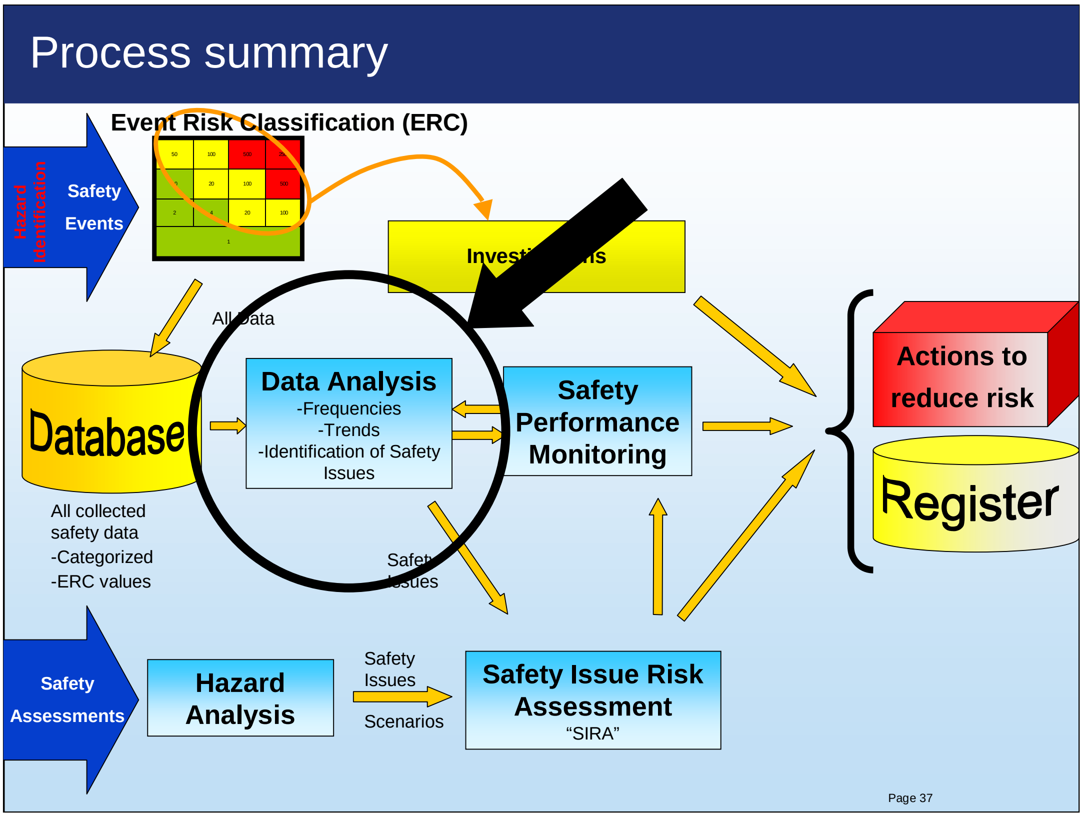
50	102	502	2500
10	21	101	500
2	4	20	100
1			

The second result is the risk index value.

These values can be used numerically in statistics to quantify risk.

The values (which can naturally be customized) have been derived semi-scientifically by looking at insurance data on accidents. The date shows that the amount of loss in different categories of accidents was roughly 1:5:25. The objective is also to create roughly exponential scales both ways and make sure the difference between the lowest and highest value is at least about 1000.

You can ask yourself how many of your least severe events you would need, to consider their cumulative risk as high as that of one of your most severe events (fatal accident avoided by pure luck).



Let’s now look into the Data Analysis.

Data Analysis

- Looking at Safety data statistics
  - Frequencies (e.g. how many unstabilized landings this month)
  - Rates (e.g. long landings / landings to that airport)
  - Trends (e.g. are ATC problems decreasing or increasing)
- Some safety actions may be launched at this point
  - Formal risk assessment not done yet
  - In obvious cases (e.g. duty of care) the risk assessment is a quick mental, informal one
- **However, the main task in Data Analysis is the identification of Safety Issues**

This is the step where the safety data is looked at statistically. The main objective is to identify Safety Issues.

While doing this, some things may become very visible in the safety data, tempting the analyst to initiate actions. Sometimes action is launched without delays, based on a pragmatic, informal “risk assessment”. Even then, a proper risk analysis may be needed for further evaluation of the matter.

Safety Issue defined

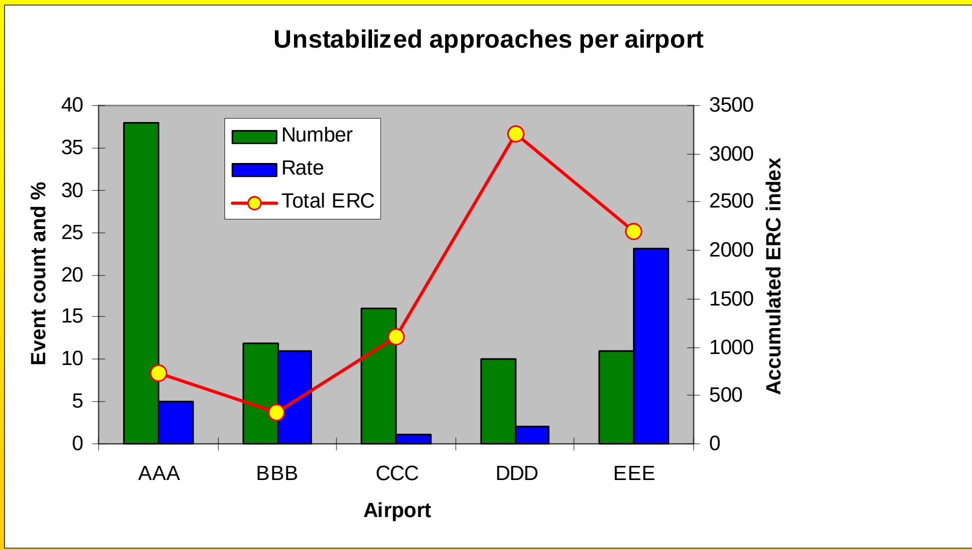
- **Safety Issue** is the manifestation of a hazard or combination of several hazards in the specific context of your operation.
  - Could be a <u>local implication</u> of one hazard (e.g. de-icing problems in one particular aircraft type)
  - Could be a <u>combination of hazards</u> in one part of the operation (e.g. operation to a demanding airport)
  - Identified through systematic Hazard Identification
- Examples:
  - Windshear at approach to XXX
  - Quality of de-icing in YYY
  - Operation into ZZZ (high-altitude, short runway, …)
  - Fatigue on red-eye flights
  - Excess carry-on luggage on certain routes

Safety Issues are the specific implications of various hazards in your operation, detected through systematic Hazard Identification methods.

They evolve in time, old ones disappear and new ones emerge. For example, high fuel price makes companies try fuel saving through new procedures, which may introduce new Safety Issues.

Safety Issues can be precisely defined, which makes the eventual Risk Assessment clear, transparent and credible.

Data Analysis - example

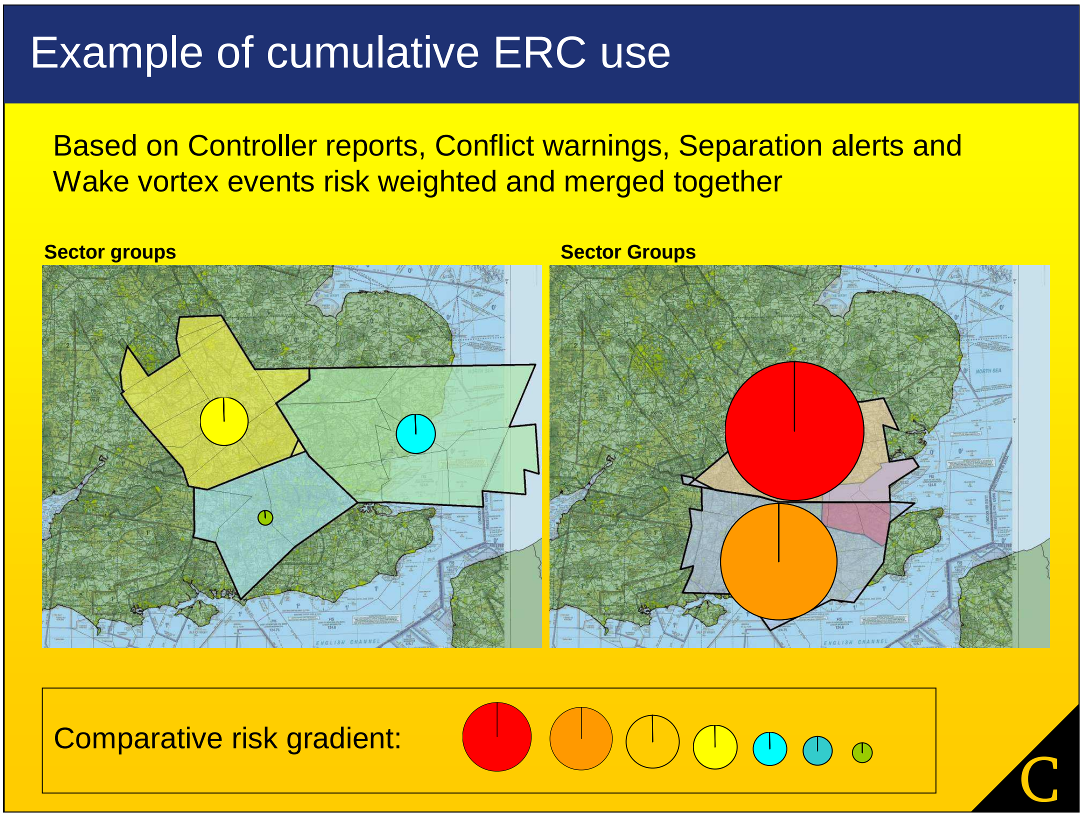


This is an example of Data Analysis and the use of ERC risk index values.

Just looking at the absolute numbers of events (in this case unstabilized approaches) can be misleading. Using rates is better, because the data is normalized based on the exposure data. But still, it is only looking at frequency of events, not their severity or risk.

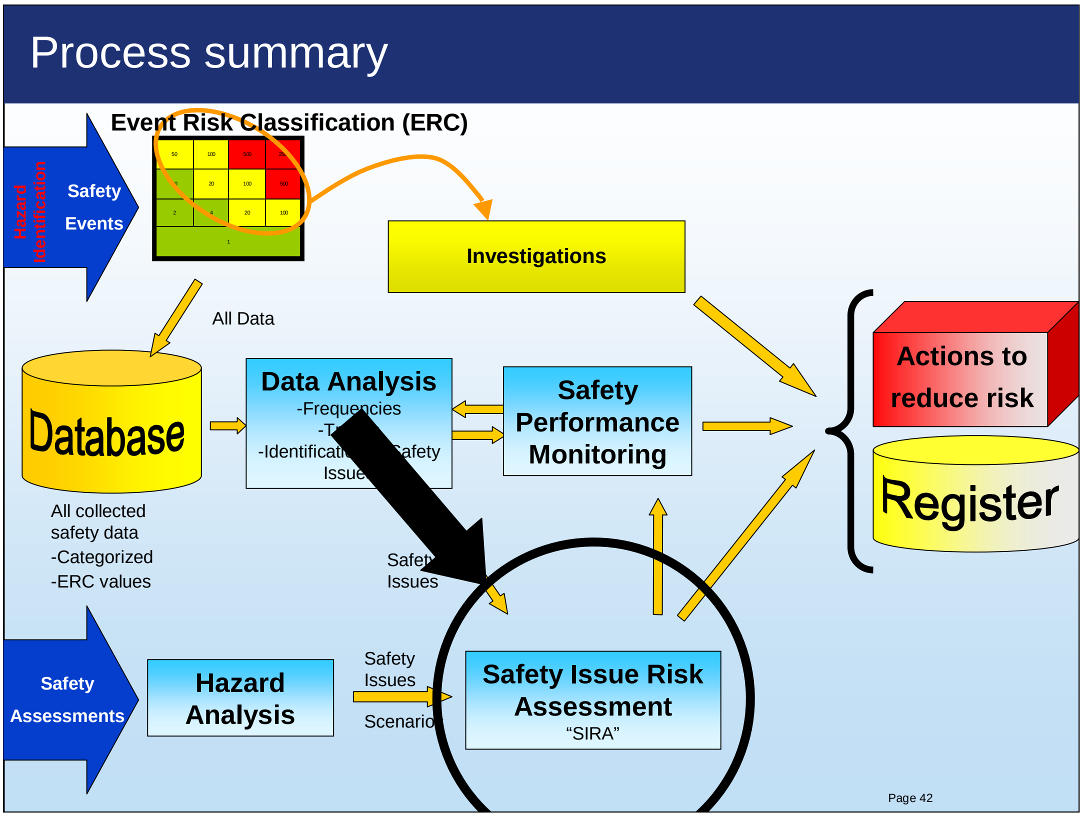
By summing the ERC values of the events (in this case per airport), one gets an estimate of the risk of these events, cumulatively, per airport. This can give a completely different picture, like the above example illustrates.

Each graph tells a true but a different story and it is important to look at each one of them. Airport AAA has the highest <u>number</u> of related events. When the event number is divided by the number of landings to each airport, the resulting blue bars show that EEE has the highest <u>rate</u> of events. Finally, the red risk graph shows that neither of the previous, but DDD, has the highest <u>cumulative risk value</u>. This could typically be because the conditions around this airport are so unforgiving that an overrun, for example, would cause close to 100% fatalities, whereas the case for other airports might be much better.



This is an example where data from Separation Loss events was used to assign an ERC value semi-automatically to each event, and finally create a visual presentation of accumulated risk per ATC area around London.

Even if the ERC is supposed to provide only a fast and approximate risk value, it may prove extremely useful in creating very interesting risk-based statistics, as it can be relatively quick to give an ERC value to a large number of events.



All detected Safety Issues need to be regularly Risk Assessed.

Risk Assessments for current & future operation

- Risk Assessment on the current or future operation must be based on **Safety Issues**
  - You can Risk Assess Safety Issues because you can **define** & **scope** them precisely
  - You can **manage** Safety Issues

…neither of which you could do with historical events.

Safety Issue Risk Assessment (SIRA)

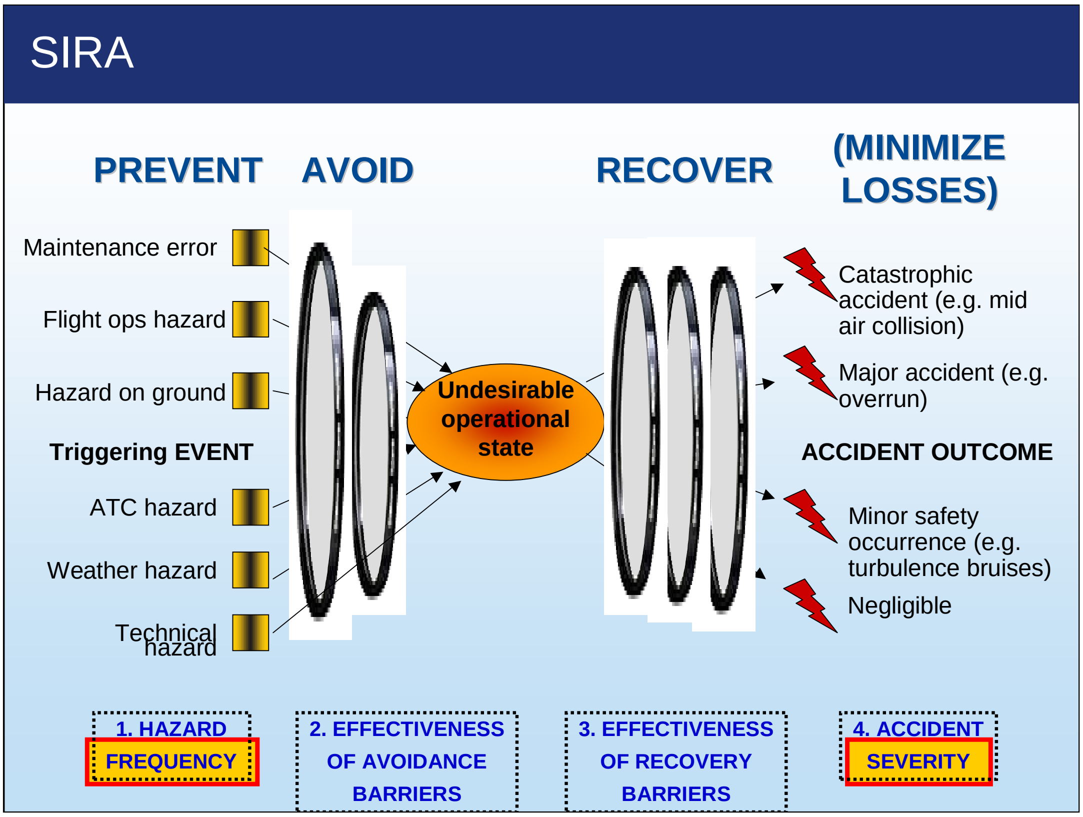
- Classic risk formula “Severity x Probability” is expanded to cover the **Barriers**

→ Risk is the product of **4 factors**

A new conceptual model is used for the Risk Assessment of Safety Issues.

One of the problems of the older methods was that they did not include the Barriers. Another problem was the lack of clarity on…frequency of WHAT….severity of WHAT.

The new model has FOUR factors, including the barriers.



Here the new conceptual model behind Safety Issue Risk Assessment (SIRA).

The first part of the model is the Triggering Event, which is the starting point for the sequence and thus potential accident. Avoidance Barriers try to stop the escalation before the Undesirable Operational State (UOS) is reached. The UOS could be a collision course, an aircraft upset, etc.

The UOS is the point in time marking the transition from Avoidance to Recovery. Recovery Barriers make the third factor of the assessment and the (potential) accident severity the fourth.

It is now clear that the Frequency (or likelihood) is always the likelihood OF THE TRIGGERING EVENT; and the Severity is always the severity of the ACCIDENT outcome.

Safety Issue Risk Assessment (SIRA)

- The practical SIRA tool can be:
  - An Excel sheet
  - A paper-based system with 3 matrices
  - Etc.
- JAR/FAR 25-1309 risk tolerability limits can be applied
- A key step is to define the Safety Issue and its scope!
  - Hazard description
  - A/C types
  - Time period
  - Locations
  - Other

The actual method for SIRA can be constructed in many different ways. As input, there are the values for the four factors, and as output the risk level.

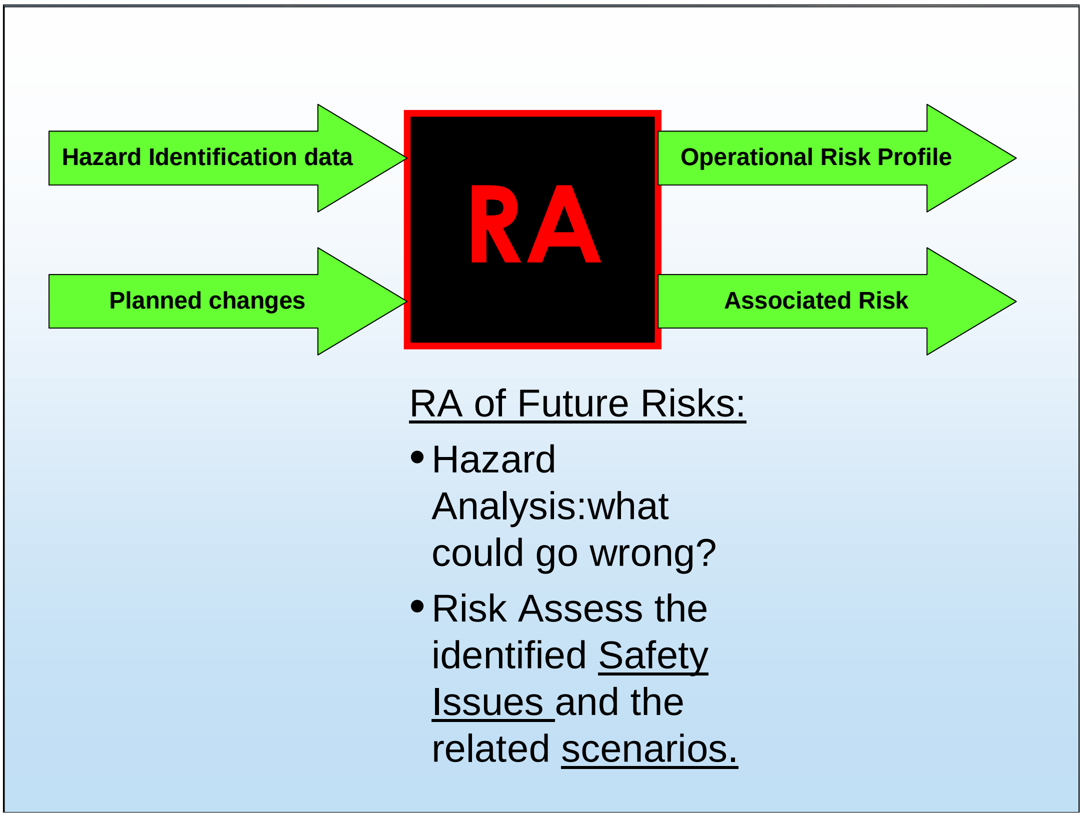
JAR/FAR 25-1309 is used in building the method, to define the acceptable combinations of likelihood and accident outcomes.

JAR/FAR-25.1309 says, for example that *catastrophic* outcomes are acceptable only at 10^{-9} probability. This can be used to calibrate colors in the matrix, i.e. calibrate the tolerability of various combinations of severity and probability.

SIRA – Excel application

- ARMS has created an example application for SIRA, based on Excel
- This tool is downloadable from the Skybrary website

C

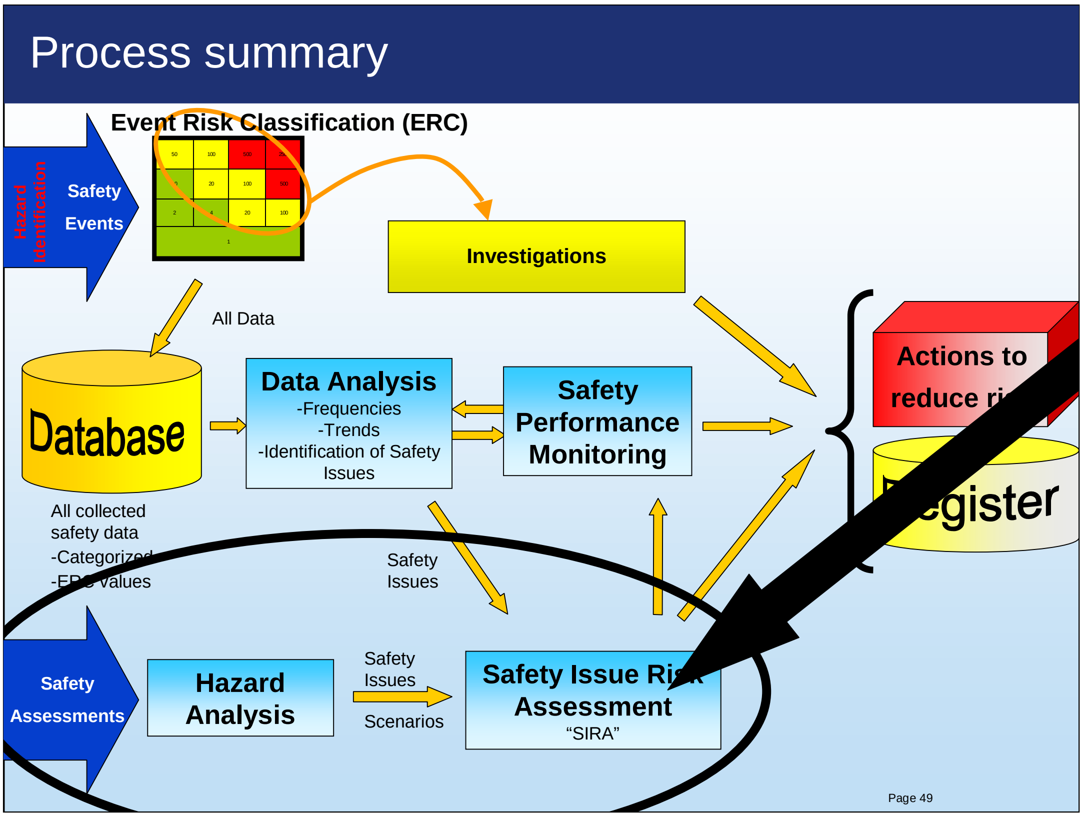


Let’s come come back to the objectives for the Risk Assessment methodology for a while.

So far we have seen that the ARMS methodology can digest Hazard Identification data and transfer it into an Operational Risk Profile. This is done through plotting Safety Issues on a “risk map” using the SIRA values, and also based on statistics using the ERC risk index values.

But what about the Safety Assessments on Future Risks?

The ARMS methodology addresses such Safety Assessments too.



Safety Assessment is the second entry point to the process. Now the input is not Safety Data, but a will to make a Safety Assessment on a well defined part of the operation, typically an operation that has not started yet.

ARMS Methodology

1. Do we need a New Methodology?
2. The ARMS Mission
3. The two levels of ARMS Deliverables
4. The ARMS Methodology
5. Risk Management in the organizational context

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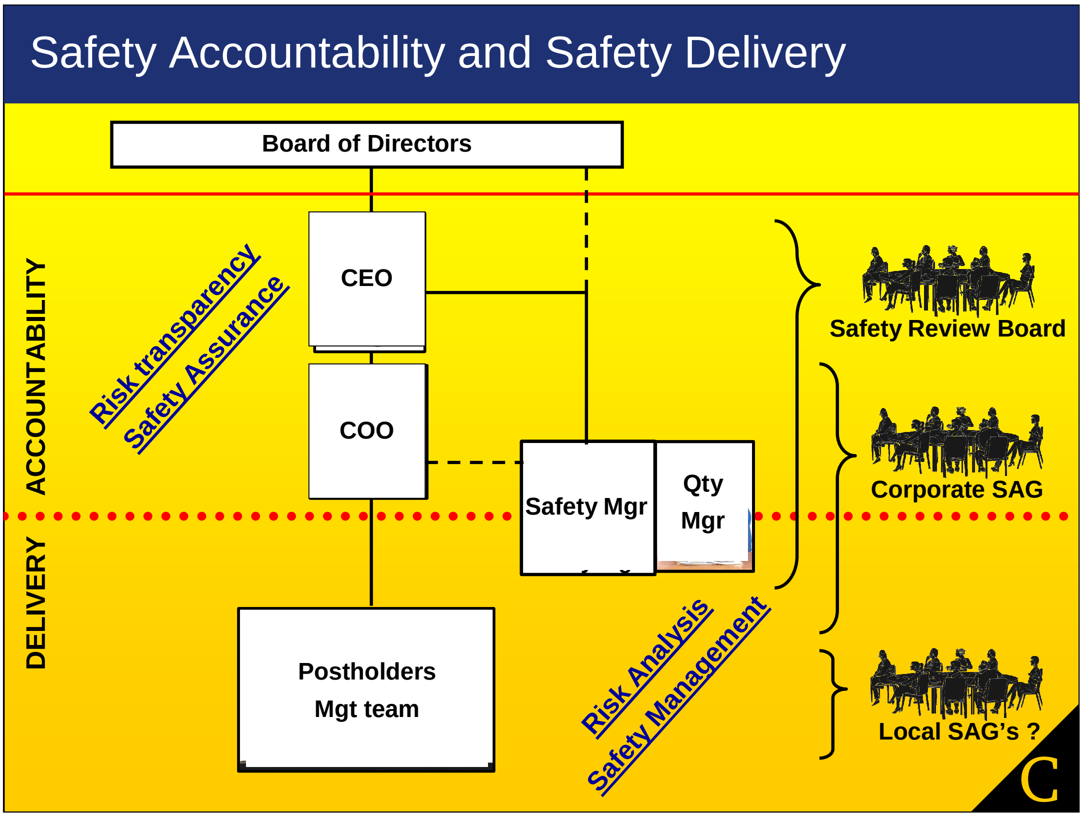

This presentation has focused on the Risk Assessment Methodology. To close the loop regarding Risk Management, let's take a brief look into the organizational aspects of Risk Management.

The fundamental split is between the Top Management and the rest of the organization – the former having the Safety Accountability and the latter being responsible for the Safety Delivery.

The Risk review and action managing tasks at different levels of the organization are managed through the Safety Review Board (SRB) and one or more Safety Action Groups (SAG) – sometimes called Safety Committees.

The Safety Manager is not accountable for the Safety Performance, but responsible for the Safety Management System itself.

Roles and organization

- Top Management – SAFETY ACCOUNTABILITY
  - CEO, COO
  - Safety Review Board (SRB)

→Monitoring Safety Performance
→Demanding and contributing to high safety performance
→Making decisions on what is acceptable in terms of risk and signing them off
→Providing necessary decision power when needed
→Contributing to and deploying the Safety Plan (targets)
→Participating in safety communications
→Providing Safety visibility to the Regulator

The quality of Risk-based information greatly influences the ability of the Top Management to form a reliable overall picture of Operational Risks and make informed decisions on the acceptability of risks.

The quality of the Risk-based information relies on the data produced by Hazard Identification and the Risk Assessment Methodology.

Roles and organization

- Others – SAFETY MANAGEMENT & DELIVERY
  - Postholders / Directors:
    - Safety responsibility at their level
    - Participate in SAG and SRB
  - Safety Manager:
    - Responsible for the Safety Management System
    - Expert, gives advice
  - Quality managers

→Hazard Identification
→Tools, methods
→Risk Assessment
→Expertise
→Ensuring safety actions
→SMS quality and evolution

The operational management and other operational people need information on risks that are present in their work and on risks that they are responsible for.

Again, the methodology has a high impact on the capability to produce useful and up-to-date risk information to guide operational people.

Conclusion

- This presentation has covered the new Risk Assessment Methodology created by the ARMS Working Group
- The Methodology has been created by safety practitioners from various aviation organizations and aims to be pragmatic and useful, while remaining conceptually robust.
- The Methodology is available to the whole industry and is hoped to deliver a significant improvement compared to older methods.