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Operational Risk Management

Work by the ARMS WG

ARMS Methodology

1. The ARMS Mission

2. The two levels of ARMS Deliverables

3. The ARMS Methodology

4. Delivering the results

Central role of "Risk" in the SMS framework

❶ Safety policy and objectives

1.1 – Management commitment and responsibility

1.2 – Safety accountabilities of managers

1.3 – Appointment of key safety personnel

1.4 – SMS implementation plan

1.5 – Coordination of emergency response planning

1.6 – Documentation

❷ Safety risk management

2.1 – Hazard identification processes

2.2 – Risk assessment and mitigation processes

❸ Safety assurance

3.1 – Safety performance monitoring and measurement

3.2 – The management of change

3.3 – Continuous improvement of the SMS

❹ Safety promotion

4.1 – Training and education

4.2 – Safety communication

Risk Assessment within Risk Management

Flight Data Analysis
Safety Reporting
Auditing
Observing operation
In-house investigations
Etc.

Identify the hazards to equipment, property, personnel or the organization	**HAZARD IDENTIFICATION**
Evaluate the seriousness of the consequences of the hazard occurring	**RISK ASSESSMENT** Severity / Criticality
What are the chances of it happening?	**RISK ASSESSMENT** Probability of occurrence
Is the consequent risk acceptable and within the organization's safety performance criteria?	**RISK ASSESSMENT** Acceptability

Yes   No

S. Review Board
Safety Committee
Safety Action Group(s)

Accept the risk	Take action to reduce the risk to an acceptable level

RISK MITIGATION

Figure 6-1.   Risk management process (ICAO SMM)

Objectives for a Risk Assessment methodology

Hazard Identification data →

RA

→ **Operational Risk Profile**

Planned changes →

→ **Associated Risk**

Inputs:
- Accepts all types of modern safety data.

Methodology:
- Simple and fast
- Conceptually solid.

Results:
- Coherent
- Useful
- Understandable by non-experts.

Aviation specific   New better method

Problems with older methods – fictitious example

- You learn about an event which took place yesterday:
  - ▸ A single-aisle aircraft with 110 pax almost overran runway end at landing
  - ▸ Actual outcome: a few blown tires
  - ▸ Cause: reduced braking capability due to maintenance error

Classic approach to
Risk Assessment :

SEVERITY			
HIGH	C	B	A
MEDIUM	D	C	B
LOW	E	D	C
	LOW	MEDIUM	HIGH

Likelihood of Recurrence

OK   Cancel
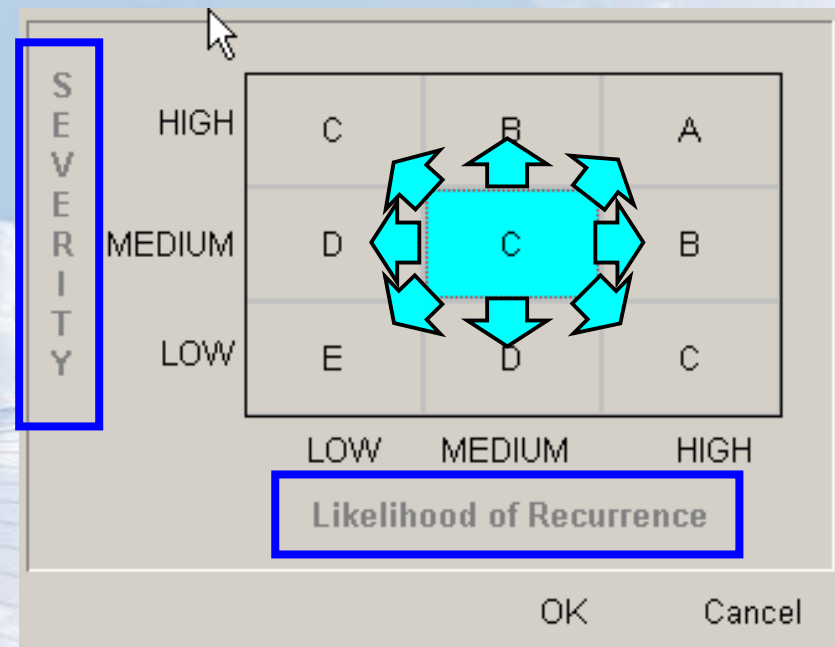
Fictitious example (cont'd)

- Severity <u>of what</u>?
  - ▸ Actual outcome: blown tires?
  - ▸ Most likely potential accident scenario: overshoot with some injuries & few fatalities (if any)?
  - ▸ The worst-case scenario: overshoot with 100% fatalities?
  - ▸ Shall you consider bigger A/C? More pax? Critical airports?

- Likelihood <u>of what</u>?
  - ▸ The same maintenance error?
  - ▸ Near-overshoot events?
  - ▸ Actual overshoot events?
  - ▸ Any A/C type? Any location?

Conceptual confusion on historical events

- When dealing with <u>historical events</u>, the only factual element is the <u>actual</u> outcome
  - ▸ But that in itself is not very interesting
  - ▸ Focus is on a <u>potential similar future event</u>, which could escalate into an accident.

- "Similar" is very subjective
  - → Speculation, estimation

- Further question:
 - ▸ Should we assess <u>events</u> or <u>Safety Issues</u>?

Further problems

- If your initial "likelihood" is LOW…

  ‣ When more "similar" events occur, are you going to update the likelihood of <u>all</u> previous "similar" events to "MEDIUM"

  ‣ Which events are "<u>similar</u>" enough?

  ‣ If even more occur, update all again to "HIGH" likelihood??

- Are you going to <u>sum</u> these <u>event</u> risk values together?

  ‣ (severity x frequency) x frequency   ???

  → Frequency is counted twice

- How do you estimate the impact of potential extra barriers (risk controls)?

List of problems with older methods

1. Conceptual confusion on <u>historical events</u>
2. Confusion between <u>events</u> and <u>Safety Issues</u>
3. Should not limit thinking to <u>actual</u> outcomes
4. <u>Potential</u> outcomes are very subjective
5. Complexity of real world: makes situation worse
6. Complexity of barriers: difficult to estimate effectiveness
7. Guidance should not link with actual outcome only
8. Guidance should not be too vague either.

When your conceptual framework is wrong…
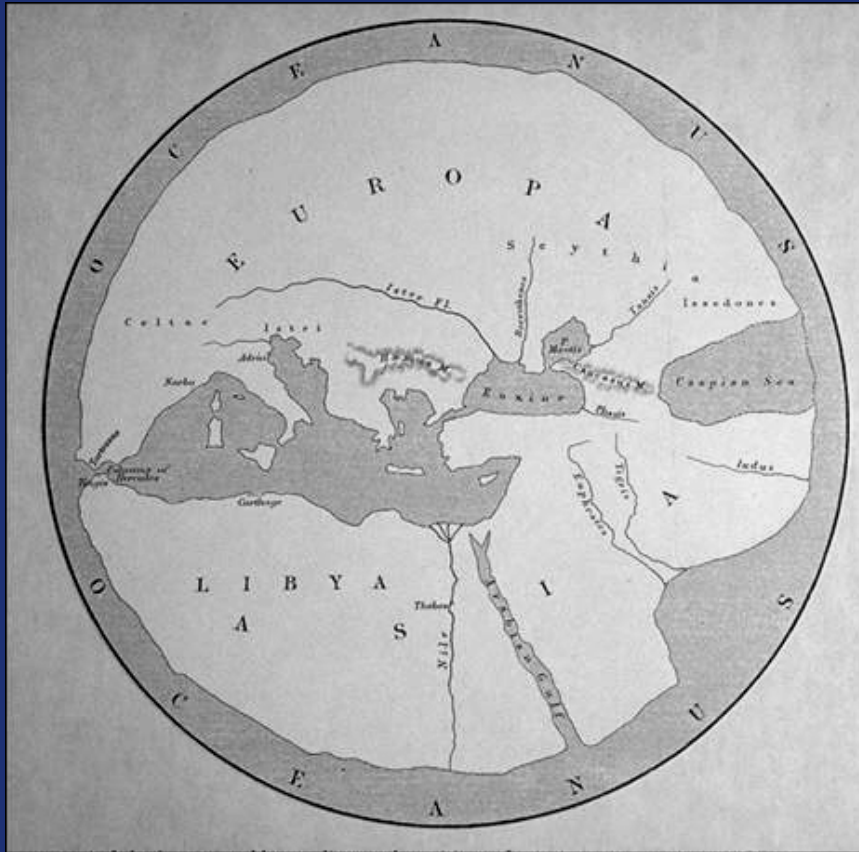
Everything is wrong!

Airline Risk Mgt Solutions (ARMS) Working Group

- Aim: Significantly improved methodology
- Safety practitioners from airlines and other organizations
- Over 150 man-days of work since Jun-07
- Two levels of deliverables by the end of 2008:
    - Conceptual methodology → Universal
    - Matrices etc. → Customizable at company level

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.

ARMS Methodology

1. The ARMS Mission

2. The two levels of ARMS Deliverables

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4. Delivering the results

Level 1 deliverable:

Conceptual methodology

On 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

ARMS Methodology

1. The ARMS Mission

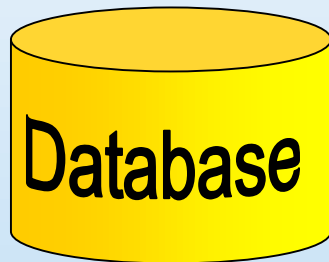2. The two levels of ARMS Deliverables

3. The ARMS Methodology

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Process summary – simplified schematic

Safety Events

Event Risk Classification

30	100	300	1000
10	30	100	300
3	10	30	100
1			

Urgent Actions?

Database

Normal Trend Analysis

Safety Issues

Risk Assessment of Safety Issues

Risk Reduction

Terminology

- **Hazard – 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)

- **Safety Issue is 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)

Terminology

- **(Safety) Event**
  - ‣ **Any happening that had or could have had a safety impact, irrespective of real or perceived severity** (ARMS)

- **Undesirable Event (UE): 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 UE are part of Avoidance and post-UE are part of Recovery.** (ARMS)

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 <u>potential</u> outcomes.** (adapted from ICAO by ARMS)

Preferred use related to "Risk Controls"

- Synonyms:
  - Risk Control
  - Barrier
  - Protection
  - Defense

- Used:
  - Risk Control
  - Barrier

> **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)

- Not used:
  - Safety Barrier (misleading)
  - Protection, defense (for harmonization reasons)

Not used due to several meanings

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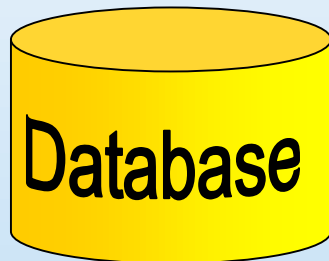 - ‣ Usually the word **scenario** can be used instead

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

Process summary

Safety Events

Event Risk Classification

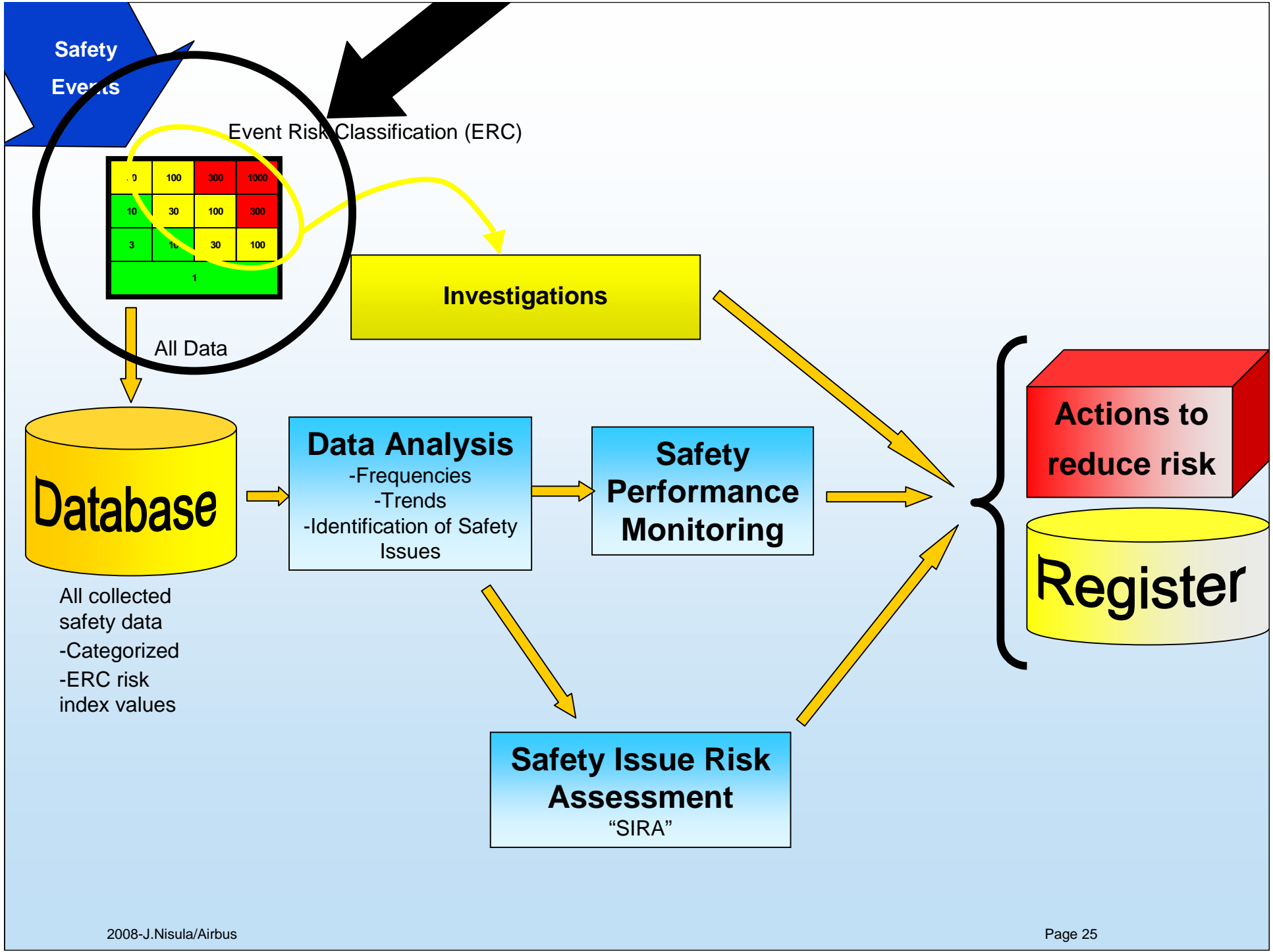| 30	100	300	1000
10	30	100	300
3	10	30	100
1			

Urgent Actions?

Database

Normal Trend Analysis

Safety Issues

Risk Assessment of Safety Issues

Risk Reduction

Safety Events

Event Risk Classification (ERC)

0	100	300	1000
10	30	100	300
3	10	30	100
1			

All Data

Database

All collected safety data
-Categorized
-ERC risk index values

Investigations

Data Analysis
-Frequencies
-Trends
-Identification of Safety Issues

Safety Performance Monitoring

Safety Issue Risk Assessment
"SIRA"

Actions to reduce risk

Register

Event Risk Classification (ERC)

- All incoming data must be screened timely:
  - ‣ Urgent actions?
  - ‣ Further investigation / risk assessment necessary?
  - ‣ Just feed into the database?

- Historical Events: use "event-based risk"
  - ‣ Focus on one single event
  - ‣ Likelihood ("frequency") not considered

Remaining Safety Margin
= Effectiveness of remaining risk controls

- Event-based risk:
  - ‣ *How close did it get?*
  - ‣ *How bad would it have been?*

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

Event Risk Classification (ERC)

Question 2

What was the effectiveness of the remaining barriers between this event and the most probable accident scenario?			
Effective	Limited	Minimal	Not effective
50	100	500	2500
10	20	100	500
2	4	20	100
1			

Question 1

If this event had escalated into an accident, what would have been the most probable accident outcome?	
Catastrophic	Loss of aircraft or multiple fatalities (3 or more)
Major	1 or 2 fatalities, multiple serious injuries, major damage to the aircraft
Minor	Minor injuries, minor damage to aircraft
Negligible	No potential damage or injury could occur

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

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

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Event Risk Classification (ERC) - RESULT

- Example of results' meaning:
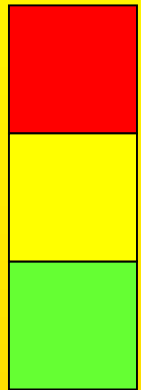
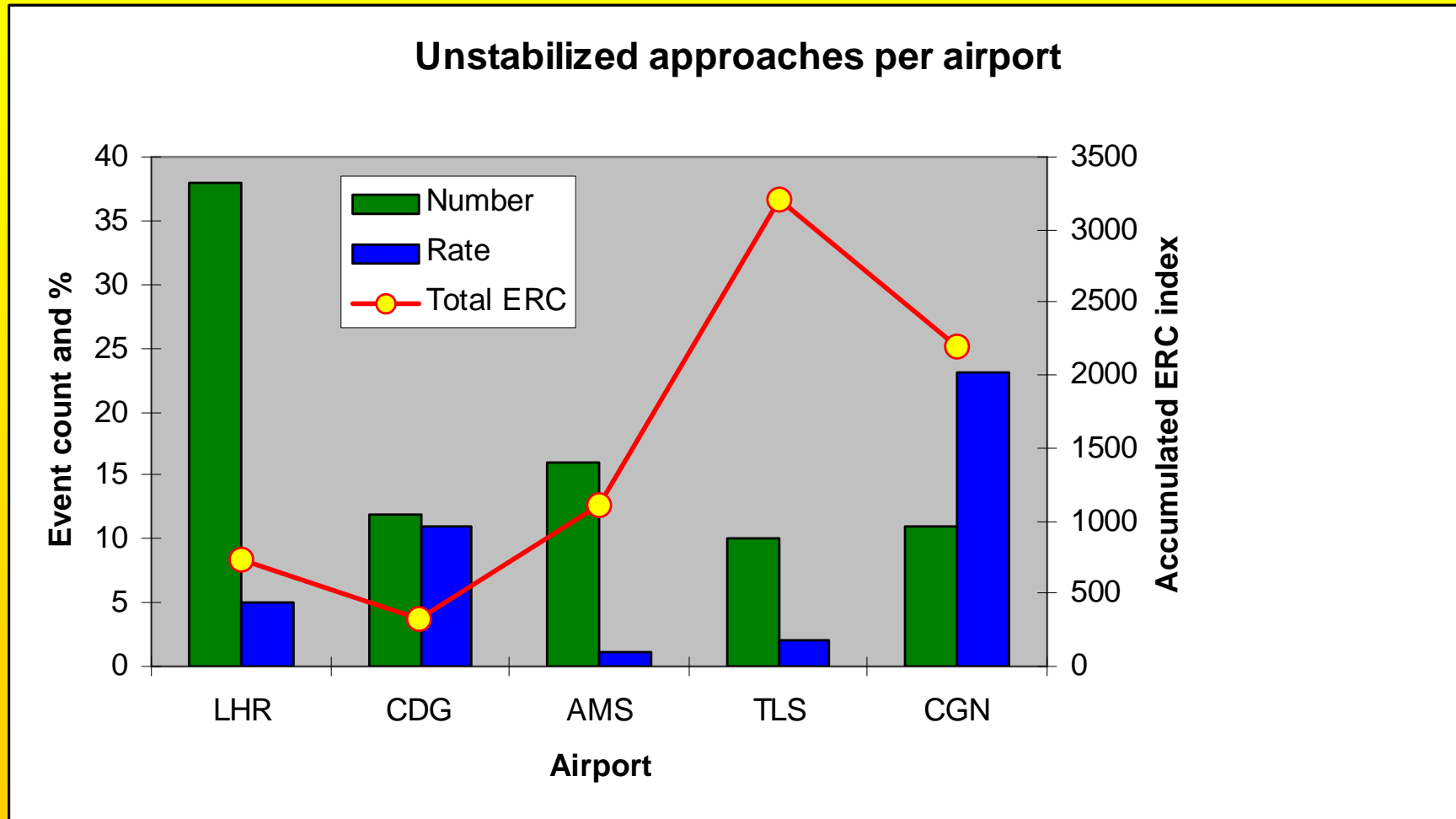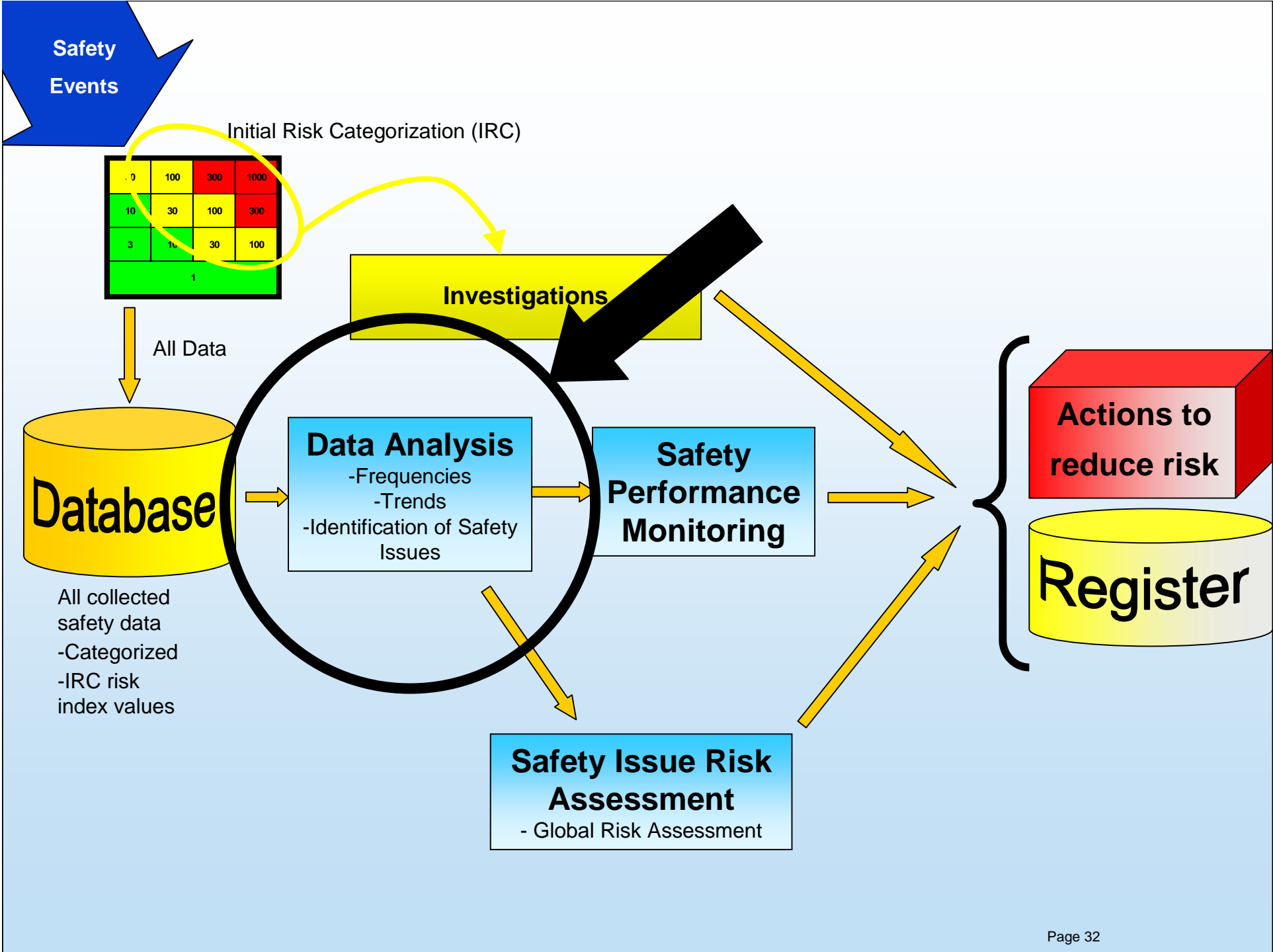|	
■	→ Investigate immediately and take action.
■	→ Investigate or carry out further Risk Assessment
■	→ Use for continuous improvement (flows into the Database).

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Event Risk Classification (ERC) - RESULT

- The ERC will also produce a numerical <u>Risk Index</u> 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	100	500	2500
10	20	100	500
2	4	20	100
1			

C

Data Analysis - example

Safety Events

Initial Risk Categorization (IRC)

	100	300	1000
10	30	100	300
3	10	30	100
		1	

All Data

Database

All collected safety data
-Categorized
-IRC risk index values

Investigations

Data Analysis
-Frequencies
-Trends
-Identification of Safety Issues

Safety Performance Monitoring

Safety Issue Risk Assessment
- Global Risk Assessment

Actions to reduce risk

Register

Events vs. Safety Issues

- Risk Management is about managing <u>Safety Issues</u>
  - You cannot manage (historical) <u>events</u>
  - A Safety Issue usually links with <u>several</u> events

- Examples (fictitious):
  - Windshear at approach to XXX
  - Quality of de-icing in YYY
  - Operation into ZZZ (high-altitude, short runway, …)
  - Fatigue on red-eye flights

- You can Risk Assess Safety Issues because you can <u>define</u> & <u>scope</u> them precisely

Adopting a proper conceptual framework!
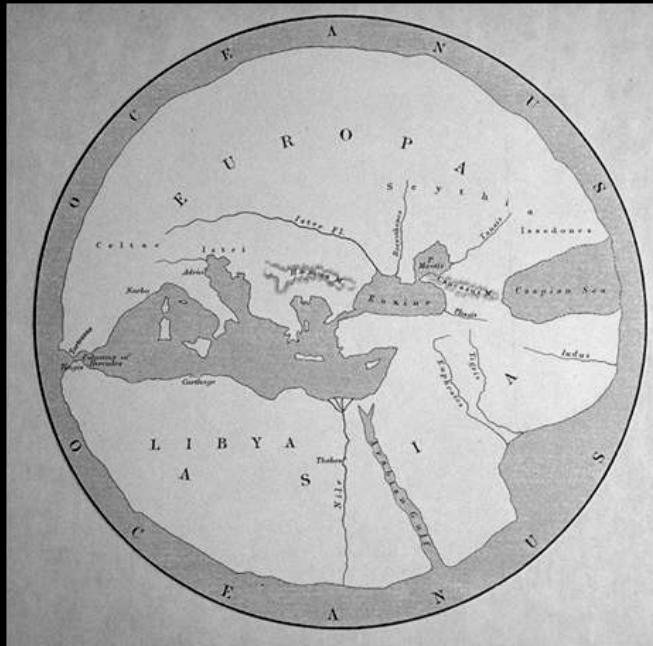
Conceptual framework for Risk Assessment

Safety Issue Risk Assessment (SIRA)
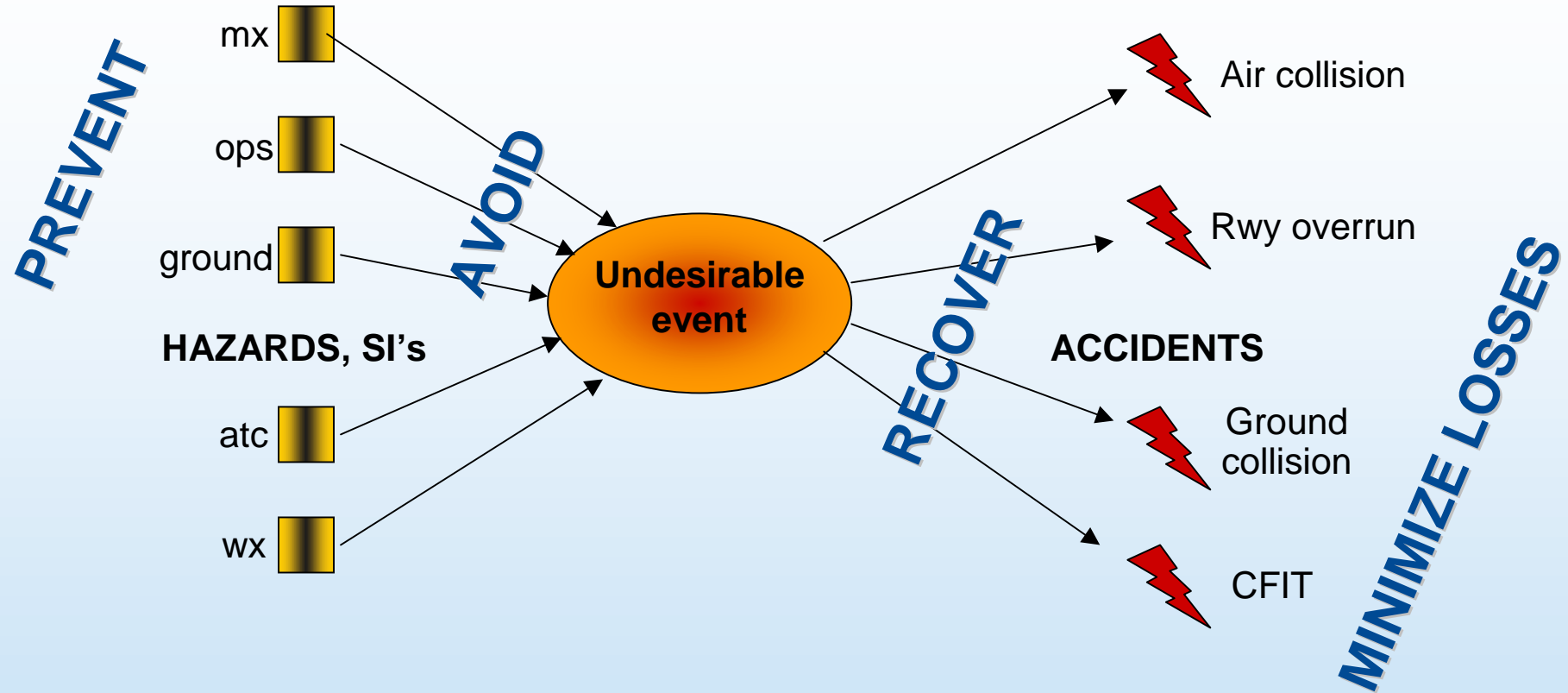
- A value is estimated for each of the 4 factors:
  - ▸ Frequency of the initial hazard
  - ▸ Avoidance barriers
  - ▸ Recovery barriers
  - ▸ Severity of the most probable accident outcome

- As a result, we get the acceptability of the risk.

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

Safety Issue Risk Assessment (SIRA)

1. How frequent is the initial hazard (per sector)?

10^{-4}	2	3	4	5
10^{-5}	1	2	3	4
10^{-6}	1	1	2	3
10^{-7}	1	1	1	2

2. How often do barriers fail to AVOID the Undesirable Event?

10^{-3} | 10^{-2} | 10^{-1} | 1

3. How often do barriers fail to RECOVER From the Undesirable Event?

B	C	D	E	**Catastrophic**
A	B	C	D	**Major**
A	A	B	C	**Minor**
A	A	A	B	**Negligible**

4. Most probable accident scenario

5				
4				
3				
2				
1				

A   B   C   D   E

C

SIRA - Example

Safety Issue:

- Risk of runway overrun at any airport in the current route network including typical alternate airports
- Due to poor braking caused by maintenance error XYZ
- Applicable to A/C types A, B, C.
- Time period: winter operation 2008-2009.

1. How frequent is the initial hazard (per sector)?

10^{-4}	2	3	4	5
10^{-5}	1	2	3	4
10^{-6}	1	1	2	3
10^{-7}	1	1	1	2

2. How often do barriers fail to AVOID the Undesirable Event?

10^{-3}	10^{-2}	10^{-1}	1

3. How often do barriers fail to RECOVER From the Undesirable Event?

B	C	D	E	**Catastrophic**
A	B	C	D	**Major**
A	A	B	C	**Minor**
A	A	A	B	**Negligible**

C

Note:

- Another SIRA application uses Excel instead of the intermediate matrices.

Safety Events

0	100	300	1000
10	30	100	300
3	10	30	100
	1		

Investigations

All Data

Database

All collected
safety data
-Categorized
-IRC values

Data Analysis
-Frequencies
-Trends
-Identification of Safety
Issues

**Safety
Performance
Monitoring**

**Actions to
reduce risk**

Register

**Hazard
Analysis**

**Safety Issue Risk
Assessment**
- Global Risk Assessment

**Plan to make
a significant
change.**

nsula/ rbus
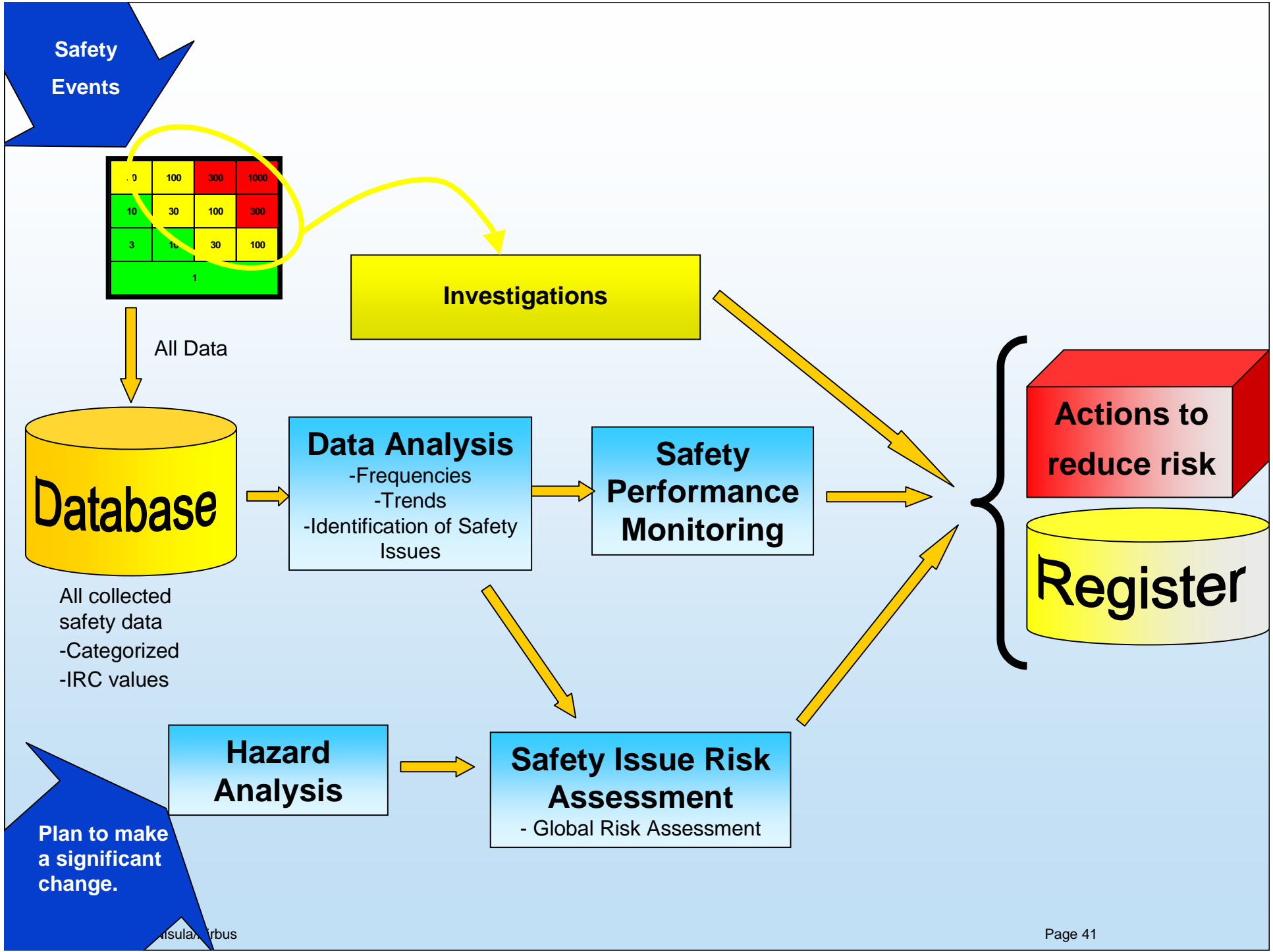
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Delivering the results

- In the coming weeks:
  - ▸ Full documentation in word-format
  - ▸ More examples

- Communication
  - ▸ Conferences
  - ▸ Websites
  - ▸ Etc…

- Training
  - ▸ ARMS will try to promote adequate training opportunities
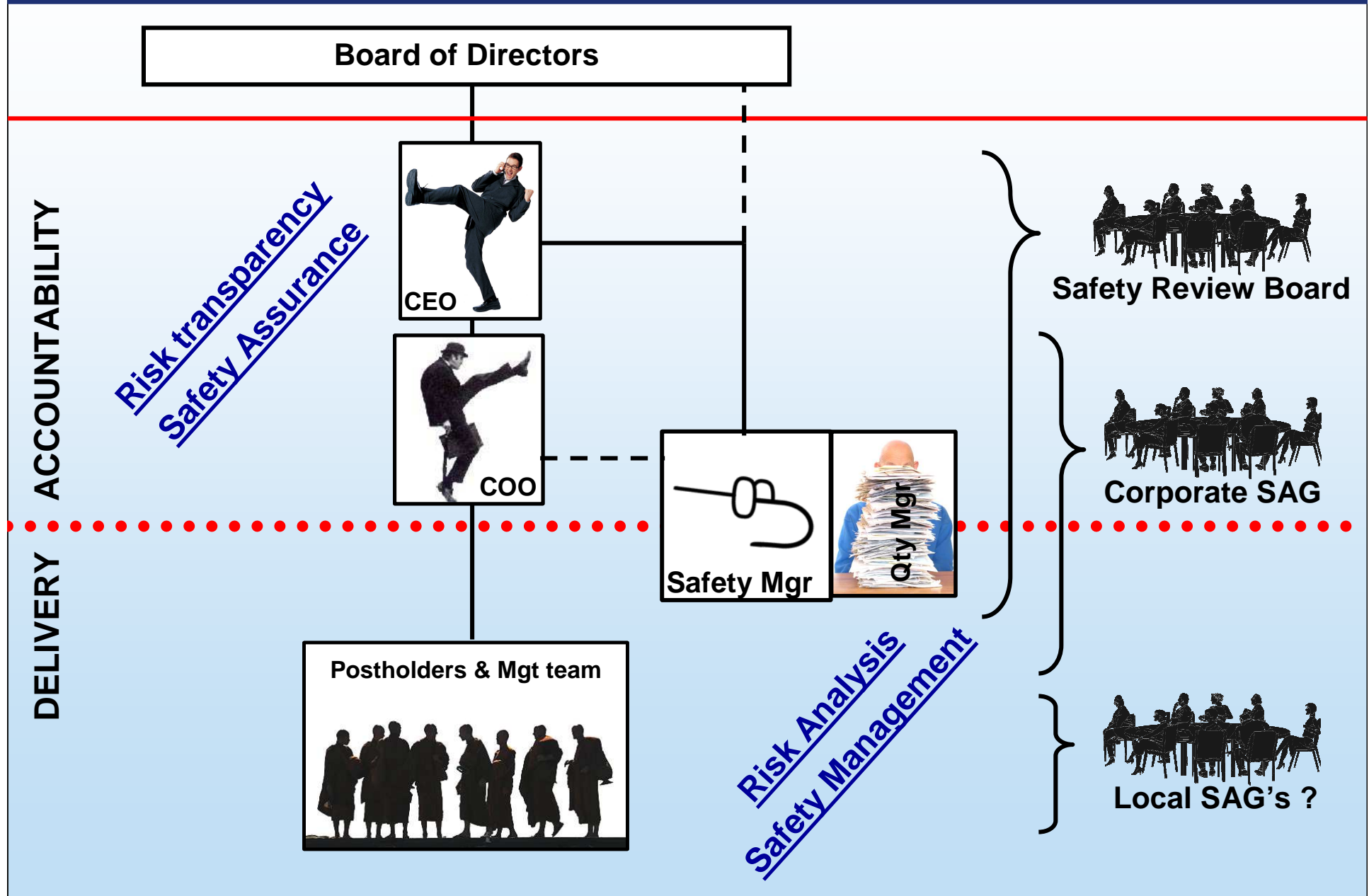 - ▸ Safety tool providers are a high priority

Extra:

Organizational Roles

Around Risk Mgt

Safety Accountability and Safety Delivery

Board of Directors

ACCOUNTABILITY

DELIVERY

Risk transparency
Safety Assurance

CEO

COO

Safety Mgr

Qty Mgr

Postholders & Mgt team

Risk Analysis
Safety Management

Safety Review Board

Corporate SAG

Local SAG's ?

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

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 <u>System</u>
    - – Expert, gives advice
  - ▸ Quality managers

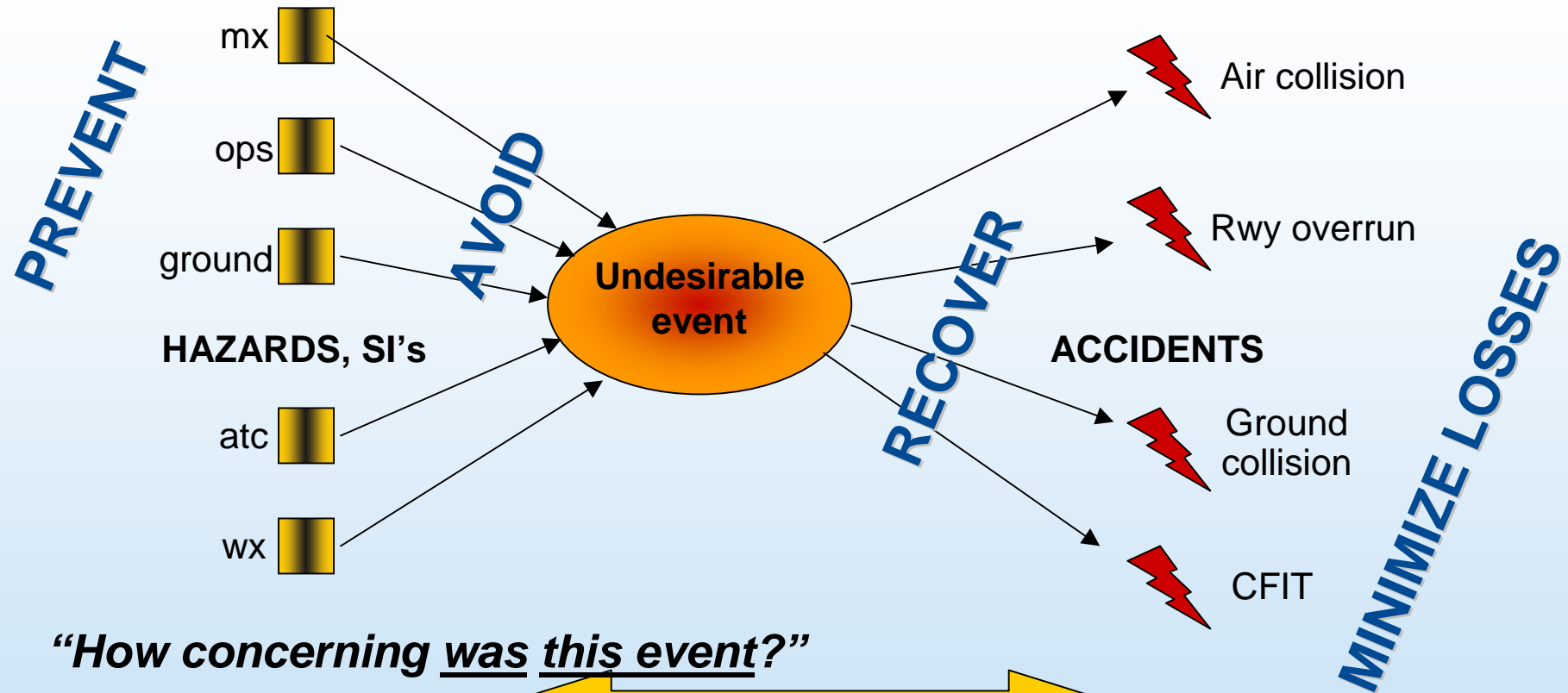 - →Hazard Identification
  - →Tools, methods
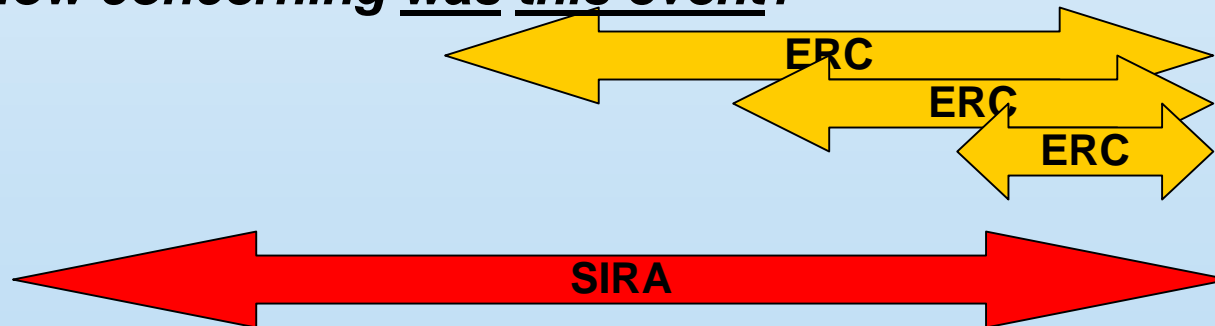 - →Risk Assessment
  - →Expertise
  - →Ensuring safety actions
  - →SMS quality and evolution

Conceptual difference between ERC and SIRA