NLR Air Transport Safety Institute

Research & Consultancy

Safety has Value - ASICBA project

Job Smeltink

HIASF07 Atlantic City - 29 October 2007

ASICBA project

NLR Air Transport Safety Institute
Research & Consultancy

ECORYS
Research and Consulting

D'APPOLONIA

NLR

AIRCLAIMS

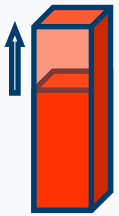
Aeroporto
Olbia Costa Smeralda
GEASAR

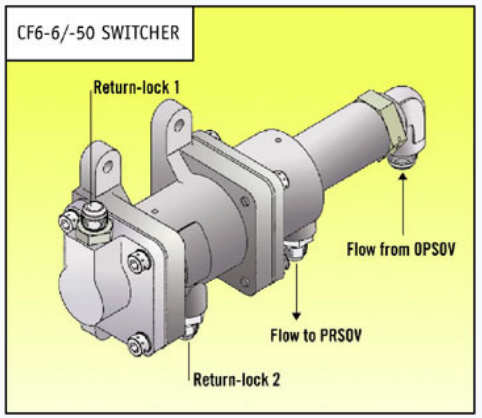
POLITECNICO
DI MILANO

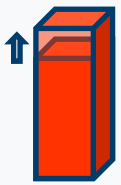
Meridiana
Low cost, high quality.

POLISH AIRLINES
LOT
A STAR ALLIANCE MEMBER

Safety investment







Budget

Alternatives

Safety results

Monetary results

Description

NLR Air Transport Safety Institute
Research & Consultancy

The main concept:

- Express safety effects in monetary terms (safety value)
- Compare to the costs via a cost-benefit trade-off

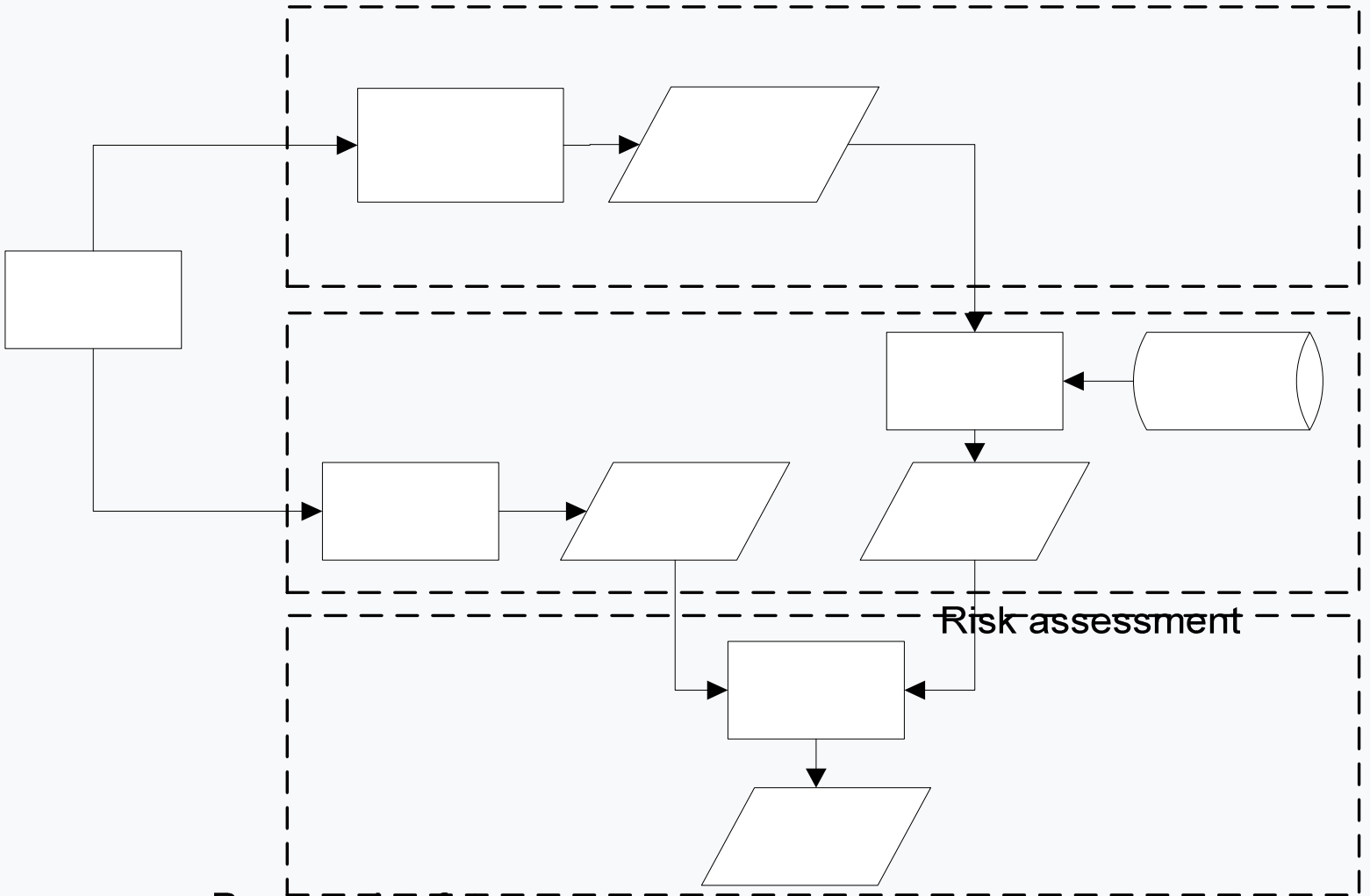
Overall model

NLR Air Transport Safety Institute
Research & Consultancy

1. Risk model
2. Linking of Risk and Cost model
3. Cost model

Overall model

NLR Air Transport Safety Institute
Research & Consultancy



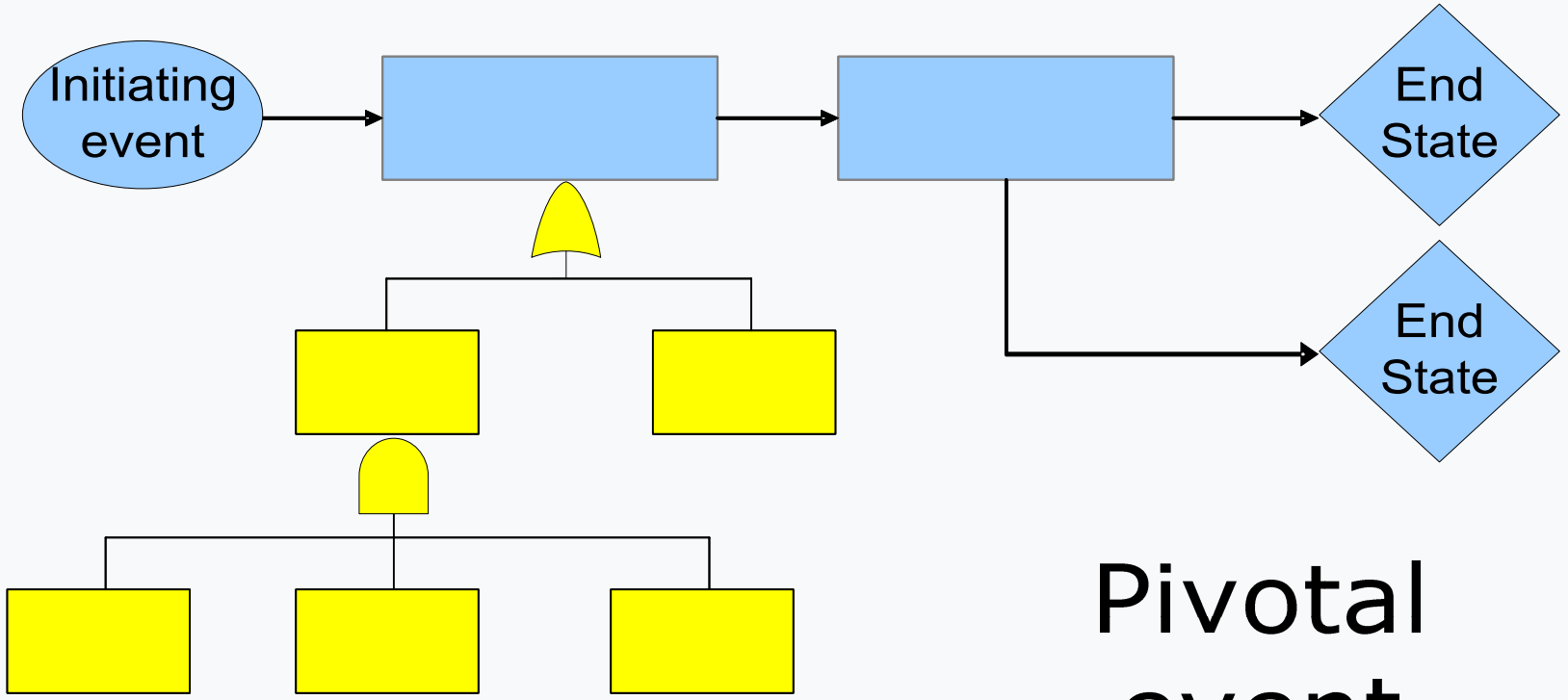
Differen
probab
Impa
Vect

Proposed safety measure

NLR Air Transport Safety Institute
Research & Consultancy

1. Case description
2. Scope
3. Time horizon
4. ...

Risk model structure



Pivotal event

OR

Quantification

NLR Air Transport Safety Institute
Research & Consultancy

- **Focus on western-built commercial air transport (>5700kg)**
- **NLR Air Safety Database**
  - Collection of databases
  - Accidents and incidents of fixed wing aircraft world-wide from 1960 onward
  - Non-accident related data (flight exposure, weather)

Linking Risk & Cost model

NLR Air Transport Safety Institute
Research & Consultancy

Consequences of a scenario (impact categories):

Direct:

- Aircraft
- Occupants
- Operation (aircraft involved)

Indirect:

- Other airlines
- Airport
- Third party

Linking Risk & Cost model

NLR Air Transport Safety Institute
Research & Consultancy

	Direct			Indirect		
	Aircraft	Occupants	Operation aircraft involved	Other airlines	Airport	Third party
4	>75% damage (beyond economical repair)	=>80% killed or seriously injured.	>4hrs delay (Flight aborted)	Many flights cancelled	Airport closed for 12 hours and runway closed for 10 days	>10 killed or seriously injured
3	50% damage	40 % killed or seriously injured (i.e. 10 to 80%)	2 hrs < delay < 4 hrs	Many delays	Airport closed for 2 hours and runway closed for 2 days	1 <= killed or seriously injured < 10
2	15% damage	5% killed or seriously injured (i.e. 1 to 10%)	30min < delay < 2hour	Less than many delays	Airport closed for 30 minutes and runway closed for 12 hours	Some property damage and/or minor injuries
1	1% damage	<1% killed (and/or <5% seriously injured)	15min < delay < 30min	Little delays	Runway closed for 3 hours	Some property damage
0	No Impact	No impact (no fatalities or seriously injured but could have a few minor injuries	No Impact (less than 15min delay)	No Impact	No Impact	No Impact

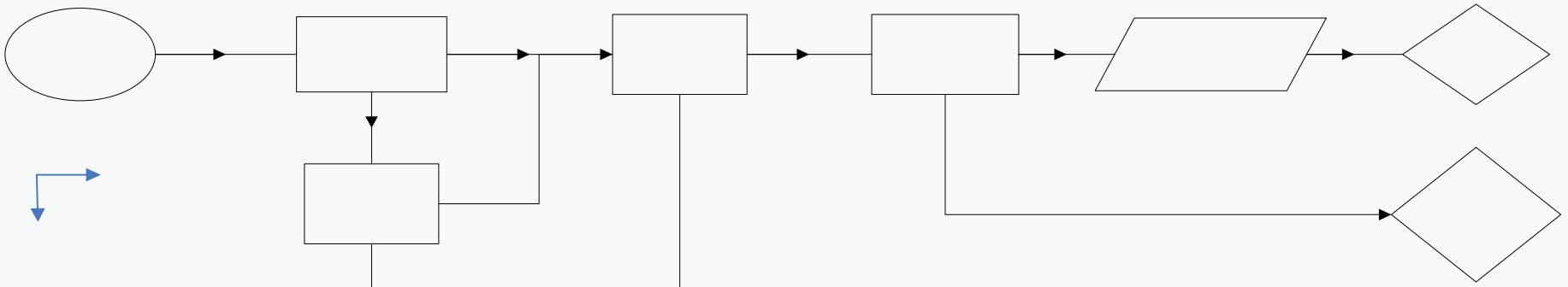
Cost model structure

NLR Air Transport Safety Institute
Research & Consultancy

- **Accident costs are key notion**
- **24 Heads of cost identified:**
  - Aircraft physical damage (cost of repair/replacement)
  - Aircraft loss of use
  - Site contamination and clearance
  - Airline costs for delay (diversion, passenger management etc.)
  - Airport closure
  - etc.
- **Each impact category is linked to one or more heads of costs**
- **Allocated to particular stakeholders**

Example: Scenario 11 Fire onboard aircraft

NLR Air Transport Safety Institute
Research & Consultancy



Accident type: fire/explosion.
Flight phase: take-off, initial climb, en route, approach, landing.
Initiating Event: fire onboard aircraft.

Fire onboard aircraft

$3.67 \cdot 10^{-6}$

yes

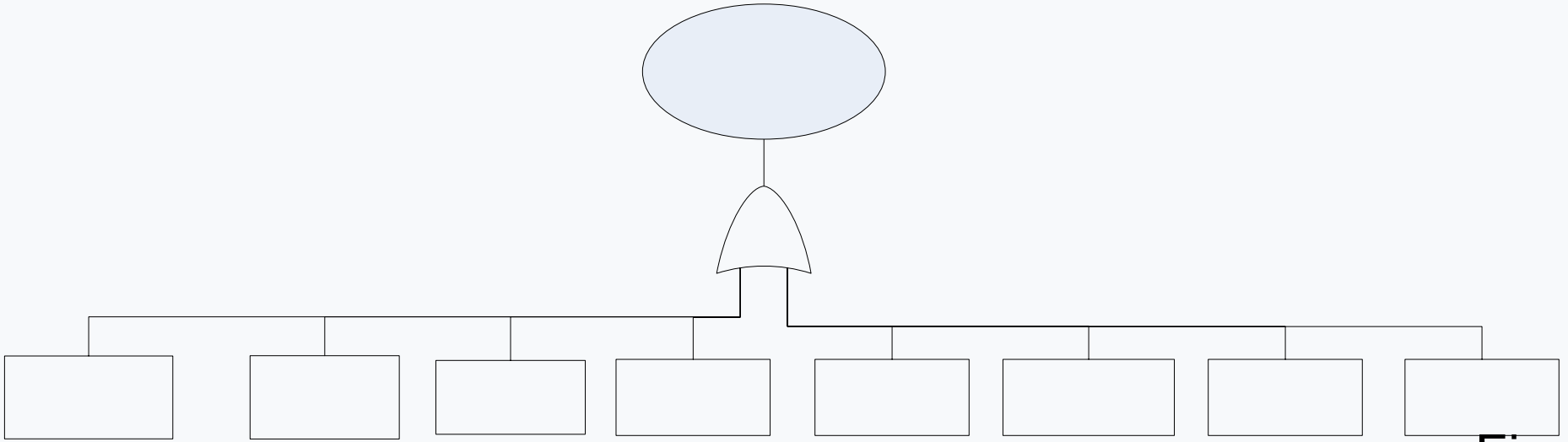
Flight crew fails to detect smoke/fire

0.0081

Fire propagates

Example: Scenario 11

NLR Air Transport Safety Institute
Research & Consultancy

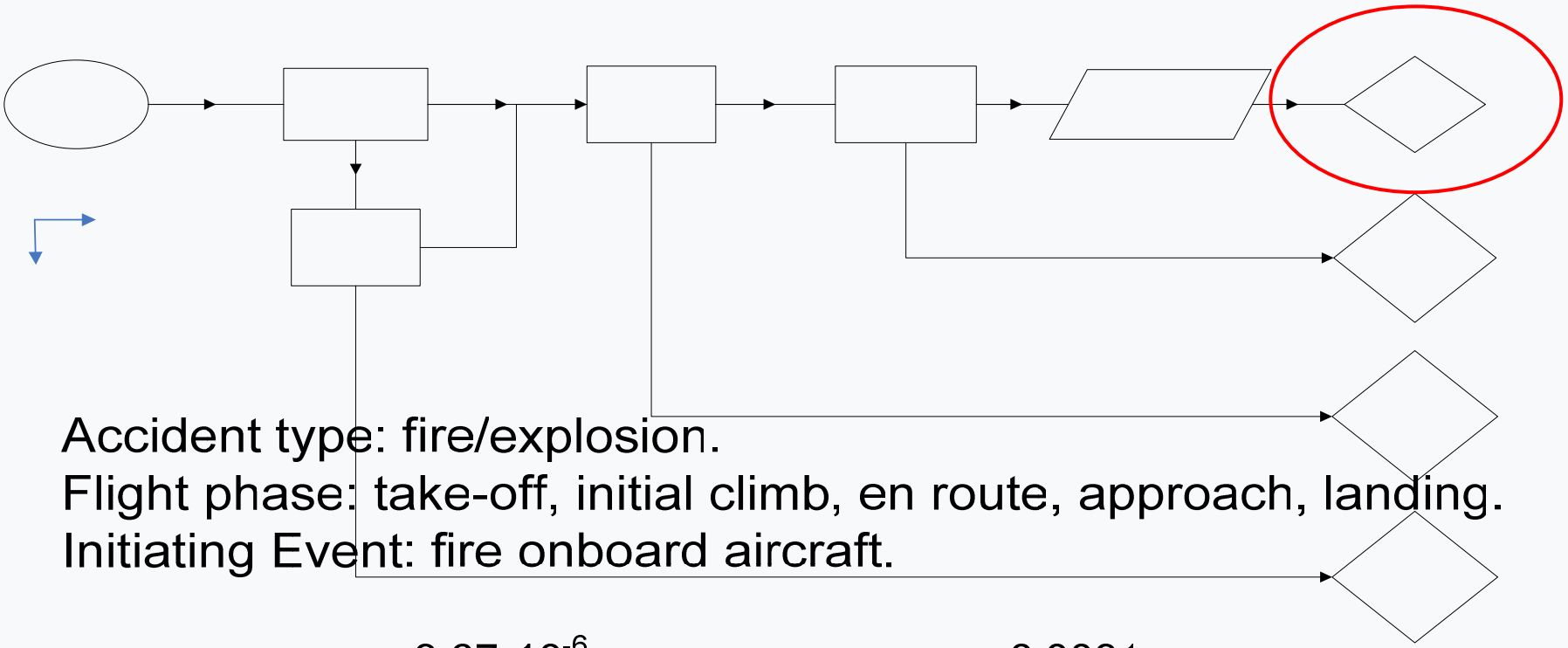


Fire onb
aircra

OR

Linking Risk & Cost model

NLR Air Transport Safety Institute
Research & Consultancy



Accident type: fire/explosion.
Flight phase: take-off, initial climb, en route, approach, landing.
Initiating Event: fire onboard aircraft.

Fire onboard aircraft

$3.67 \cdot 10^{-6}$

Flight crew fails to detect smoke/fire

0.0081

Fire propagates

$1.73 \cdot 10^{-1}$

Linking Risk & Cost model

NLR Air Transport Safety Institute
Research & Consultancy

	Direct			Indirect		
	Aircraft	Occupants	Operation aircraft involved	Other airlines	Airport	Third party
4	>75% damage (beyond economical repair)	=>80% killed or seriously injured.	>4hrs delay (Flight aborted)	Many flights cancelled	Airport closed for 12 hours and runway closed for 10 days	>10 killed or seriously injured
3	50% damage	40 % killed or seriously injured (i.e. 10 to 80%)	2 hrs < delay < 4 hrs	Many delays	Airport closed for 2 hours and runway closed for 2 days	1 <= killed or seriously injured < 10
2	15% damage	5% killed or seriously injured (i.e. 1 to 10%)	30min < delay < 2hour	Less than many delays	Airport closed for 30 minutes and runway closed for 12 hours	Some property damage and/or minor injuries
1	1% damage	<1% killed (and/or <5% seriously injured)	15min < delay < 30min	Little delays	Runway closed for 3 hours	Some property damage
0	No Impact	No impact (no fatalities or seriously injured but could have a few minor injuries	No Impact (less than 15min delay)	No Impact	No Impact	No Impact

Scenario 11: Result

NLR Air Transport Safety Institute
Research & Consultancy

End State	Severity						Before	After
Collision with ground	4	4	4	0	0	1	$2.64 \cdot 10^{-8}$	$1.32 \cdot 10^{-8}$
Aircraft continues flight damaged	1	1	4	0	0	0	0	0
Aircraft continues flight damaged	1	1	4	0	0	0	$1.50 \cdot 10^{-6}$	$1.51 \cdot 10^{-6}$
Aircraft continues flight damaged	1	1	4	0	0	0	$2.14 \cdot 10^{-6}$	$2.14 \cdot 10^{-6}$

Example costs (aircraft)

NLR Air Transport Safety Institute
Research & Consultancy

Aircraft Severity level	Heads of costs		
	Physical damage	Loss of resale value	Loss of use
4	€ 32 m	€ 0 m	€ 0 m
3	€ 16 m	€ 4.8 m	€ 3 m
2	€ 5 m	€ 2.4 m	€ 1.5 m
1	€ 0.3 m	€ 1.3 m	€ 0.4 m
0	€ 0 m	€ 0 m	€ 0 m

CBA computation

NLR Air Transport Safety Institute
Research & Consultancy

- Measure » change in probability » **Safety value**
- Investment costs
- Operational costs
- Operational benefits (if any)
- Trade off
  - Airline / airport / ...
  - Society

» Internal Rate of Return / Net Present Value

Conclusion

NLR Air Transport Safety Institute
Research & Consultancy

- CBA is a useful tool for understanding gains and losses of safety investments
- CBA should be one of the inputs in decision making process
- Safety benefits often disregarded in CBA
- ASICBA method offers opportunity to include safety benefits in CBA

Thank you for your attention!

Questions?