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## **How to deal with Equivalent Level of Safety provisions**

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# NLR – Netherlands Aerospace Centre

## Aerospace Operations Division – applied R&D and consultancy on Safety, Capacity, Efficiency, Environment

### Examples

- SESAR SEAC support (airport operations optimisation)
- SESAR – validate multiple remote tower concept (with LVNL, SAAB)
- H2020 FutureSky Safety coordinator
- RPAS test and training centre, regulations
- Belgocontroll: Runway allocation advisory system (up to 30hrs ahead)
- Schiphol: validation of dynamic vehicle traffic sign (LED) for RWY crossings
- EASA RESA safety study (partner ECORYS)



# ELoS - Contents

Certification basis

ELoS and Special Conditions

What is equivalent safety?

When to go for an ELoS provision?

RESA example

Conclusions



# Certification Basis for Aerodromes

## **ADR.AR.C.020: Certification Basis consists of**

- a) Agency Certification Specifications (CS)
- b) Equivalent Level of Safety** provisions, accepted by the authority
- c) Special Conditions, cf. ADR.AR.C.025, that the authority finds necessary

## **ADR.AR.C.025: Special Condition**

- a) CS cannot be met due due to physical, topographical or similar limitations related to the location of the aerodrome;
- b) novel or unusual design features; or
- c) Experience from other airports



# Definition of ELoS

## **ELoS, mentioned, but not defined in:**

- Implementing rules: (EU) No 139/2014
- Acceptable Means of Compliance to Part-ADR-AR (describes only acceptance process)
- Guidance Material to Part-ADR-AR (C.020 (b)) (mainly acceptance process of by the competent authority)

## **Conclusion:**

- Current aerodrome certification regulations describe ELoS as a potential aerodrome certification mechanism, without specifying what it entails exactly!



# Origin of ELoS and Special Condition provisions

## ELoS and SC are established mechanisms in Aircraft certification

General ELoS definition:

**ELoS:** when **literal compliance** with certification **specification cannot be shown**, and **equivalency to** the level of **safety intended** by the regulations can be demonstrated.



# ELoS for Aerodromes – NLR interpretation

## ELoS can be applied when:

- applicable **certification specifications** are **adequate**
- **literal compliance** with certification **specification cannot be shown**
- **equivalency to** the level of **safety intended** by the regulations can be demonstrated

## ELOS does not require (as opposed to SC):

- technical specifications, including limitations or procedures, unless necessary for demonstration of equivalency of level of safety



# When is safety equivalent?

## GM1 ADR.AR.C.020(b):

a level of safety, which is effectively **not lower than** that associated with the relevant Agency certification specifications (*i.e. **the intended safety level***).

## But.... What is:

- Not lower than?
- The intended safety level?



# How is safety assessed?

## Severity

| Severity     | Value    |
|--------------|----------|
| Catastrophic | <b>A</b> |
| Hazardous    | <b>B</b> |
| Major        | <b>C</b> |
| Minor        | <b>D</b> |
| Negligible   | <b>E</b> |



## Likelihood

| Likelihood           | Value    |
|----------------------|----------|
| Frequent             | <b>5</b> |
| Occasional           | <b>4</b> |
| Remote               | <b>3</b> |
| Improbable           | <b>2</b> |
| Extremely Improbable | <b>1</b> |



## Risk matrix

| Risk probability       | Risk severity     |                |            |            |                 |
|------------------------|-------------------|----------------|------------|------------|-----------------|
|                        | Catastrophic<br>A | Hazardous<br>B | Major<br>C | Minor<br>D | Negligible<br>E |
| Frequent 5             | <b>5A</b>         | <b>5B</b>      | <b>5C</b>  | <b>5D</b>  | <b>5E</b>       |
| Occasional 4           | <b>4A</b>         | <b>4B</b>      | <b>4C</b>  | <b>4D</b>  | <b>4E</b>       |
| Remote 3               | <b>3A</b>         | <b>3B</b>      | <b>3C</b>  | <b>3D</b>  | <b>3E</b>       |
| Improbable 2           | <b>2A</b>         | <b>2B</b>      | <b>2C</b>  | <b>2D</b>  | <b>2E</b>       |
| Extremely improbable 1 | <b>1A</b>         | <b>1B</b>      | <b>1C</b>  | <b>1D</b>  | <b>1E</b>       |



Risk Tolerability

# Not lower than the intended safety level?

## Considerations:

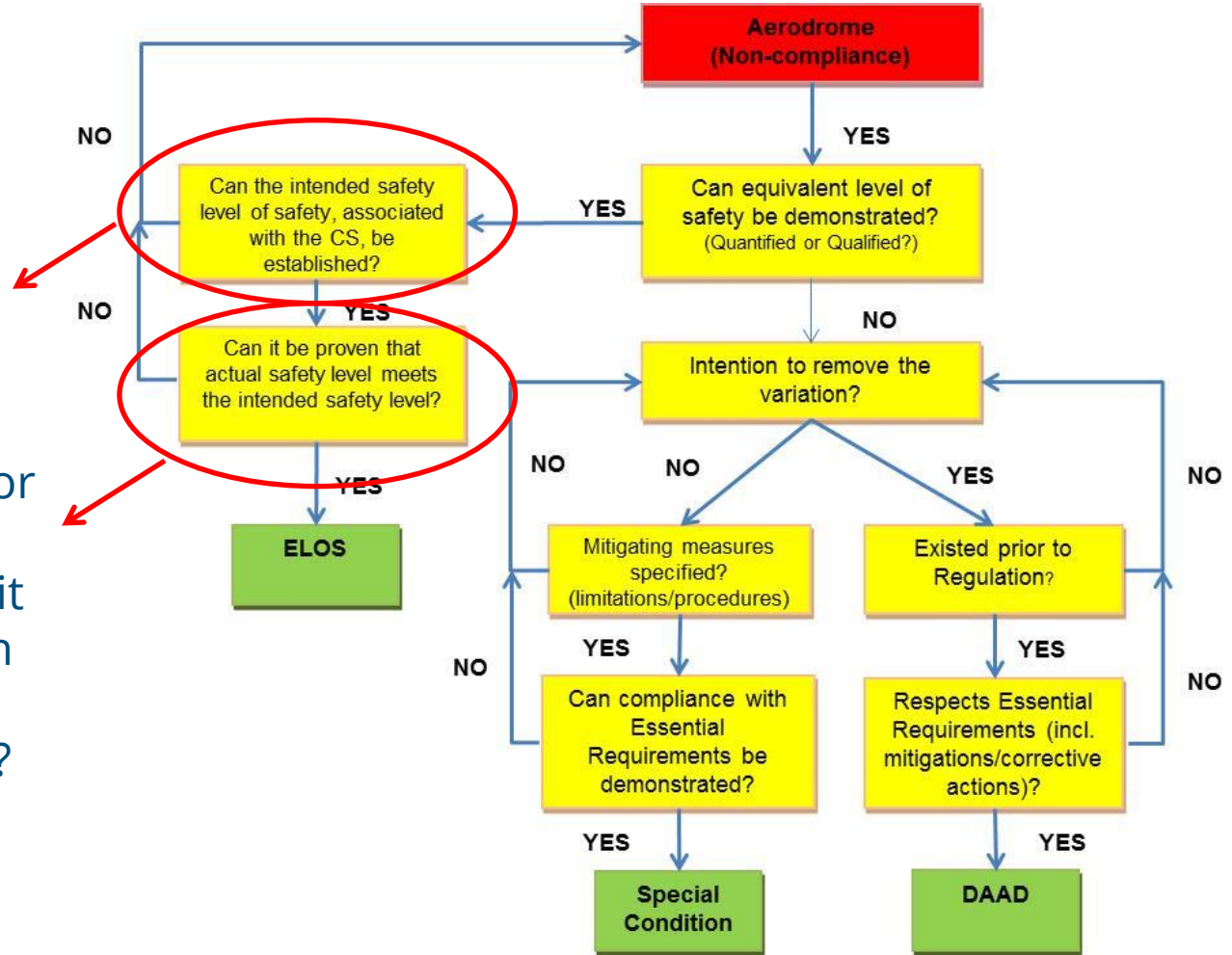
- Safety is not assessed on a continuous scale (see ICAO 9859 SMM)
- Granularity depends on the safety risk assessment matrix (usually 5x5)
- Risks with same risk index are considered as **equivalent**
- Equivalent safety is **not** “equal” safety
- Risks within the same risk index may differ slightly
- Safety differences within same risk index:
  - Do not affect risk tolerability
  - Are considered negligible
- **“Not lower than”** should be interpreted as:
  - In the same or lower risk index

| Risk probability       | Risk severity     |                |            |            |                 |
|------------------------|-------------------|----------------|------------|------------|-----------------|
|                        | Catastrophic<br>A | Hazardous<br>B | Major<br>C | Minor<br>D | Negligible<br>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              |

# ELoS or SC?

Can the TLS or risk index, associated with the CS be established?

Can the actual LoS or risk index be determined, and is it equal or better than the TLS or the intended risk index?





## The RESA example

### Many airports operate with RESA dimensions that:

- comply with **ICAO standard**: 90m length, (Annex 14, 3.5.3)
- **Not** comply with **ICAO recommendation** 240m length, (Annex 14, 3.5.4)

### EASA specifications do not discriminate between standards & recommendations.

CS ADR-DSN.C.215 requires:

- RESA shall be at least 90m, **and** wherever practicable, 240m

Many authorities consider **RESA 90m**, in light of EASA certification, **non-compliant**, because extension may be practicable, e.g. via land acquisition, reducing declared distances, or otherwise.



# ELoS approach to RESA non-compliance

## Intended safety level:

- Original dimensions of **RESA (90m)** defined by ICAO in the early 1970s; based on TLS of  **$6.6 \times 10^{-7}$**  per takeoff/landing
- Recommended Length increased to 240 meter in 1999; no TLS, but data shows 240m captures 83% of overruns vs. 61% for 90m RESA
- CAA UK derived TLS:  **$1.7 \times 10^{-7}$**  per takeoff/landing for **240m**

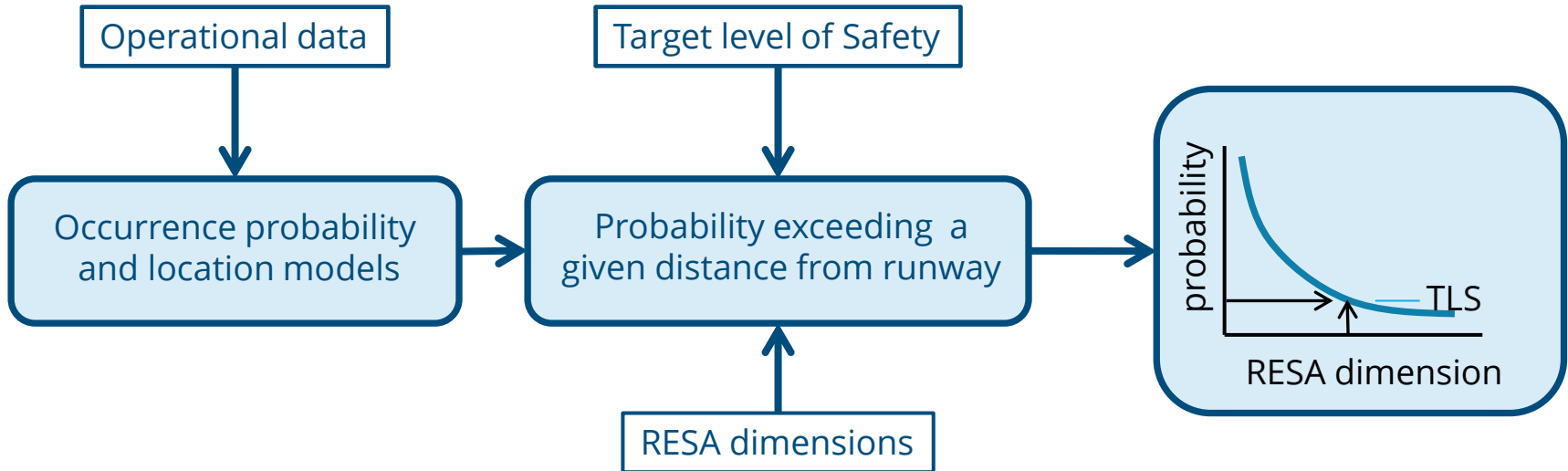
## Actual safety level:

- Can it be shown for a particular airport with 90 m RESA that –for given operations and conditions- actual level of safety meets the intended level of safety (i.e.  $1.7 \times 10^{-7}$ , corresponding with 240m)?

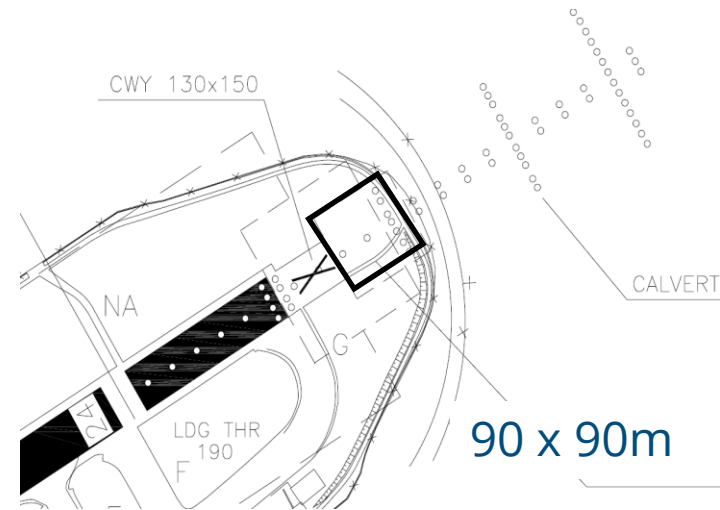
# How to assess actual safety?

Methodology described by EASA: report EASA\_REP\_RESEA\_2011\_12  
(by NLR as partner to ECORYS):

<https://www.easa.europa.eu/document-library/research-projects/easarepresea201112>



# Application to Naples Airport



| Runway   | Occurrence type               | Probability | Probability ending outside RESA | Traffic distribution % | Weighted probability |
|--|-------------------------------|-------------|---------------------------------|------------------------|----------------------|
| 24   | Landing under shoot small a/c | 2.86E-06    | 1.42E-06                        | 1.47                   | 2.07E-08             |
| 24   | Landing undershoot large a/c  | 1.60E-07    | 3.20E-08                        | 57.96                  | 1.85E-08             |
| 06   | Take-off overrun small a/c    | 7.26E-07    | 4.50E-07                        | 0.35                   | 1.55E-09             |
| 06   | Take-off overrun large a/c    | 9.57E-08    | 5.93E-08                        | 25.83                  | 1.53E-08             |
| 06   | Landing overrun small a/c     | 3.07E-06    | 1.27E-06                        | 0.22                   | 2.86E-09             |
| 06   | Landing overrun large a/c     | 3.92E-07    | 1.62E-07                        | 14.19                  | 2.30E-08             |
| <b>Total probability ending outside (90x90) RESA runway 06</b> |                               |             |                                 |                        | <b>8.20E-08</b>      |



## Equivalent Level of Safety

Intended level of safety of 240 meter RESA, by ICAO/EASA:

**$1.7 \times 10^{-7}$  per takeoff/landing**

Actual achieved level of safety at Naples with 90 meter RESA:

**$0.8 \times 10^{-7}$  per takeoff/landing**



Level of safety is effectively not lower than than associated with the relevant Agency certification specifications; thus

- **ELOS has been demonstrated**
- **Extension of RESA is not cost-effective and impracticable**





# Conclusions

- ELoS provisions can be part of the Certification basis, but....
- Are not clearly defined in EU regulation, AMC, GM or CS
- ELoS can be used – analogous to Aircraft certification – when:
  - literal compliance with certification specification cannot be shown
  - applicable certification specifications are adequate
- ELoS requires:
  - Assessment of the intended level of safety
  - Assessment of the actual level of safety
- ELoS can be successfully applied to RESA non-compliances, when local operational conditions are favourable



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# Fully engaged

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