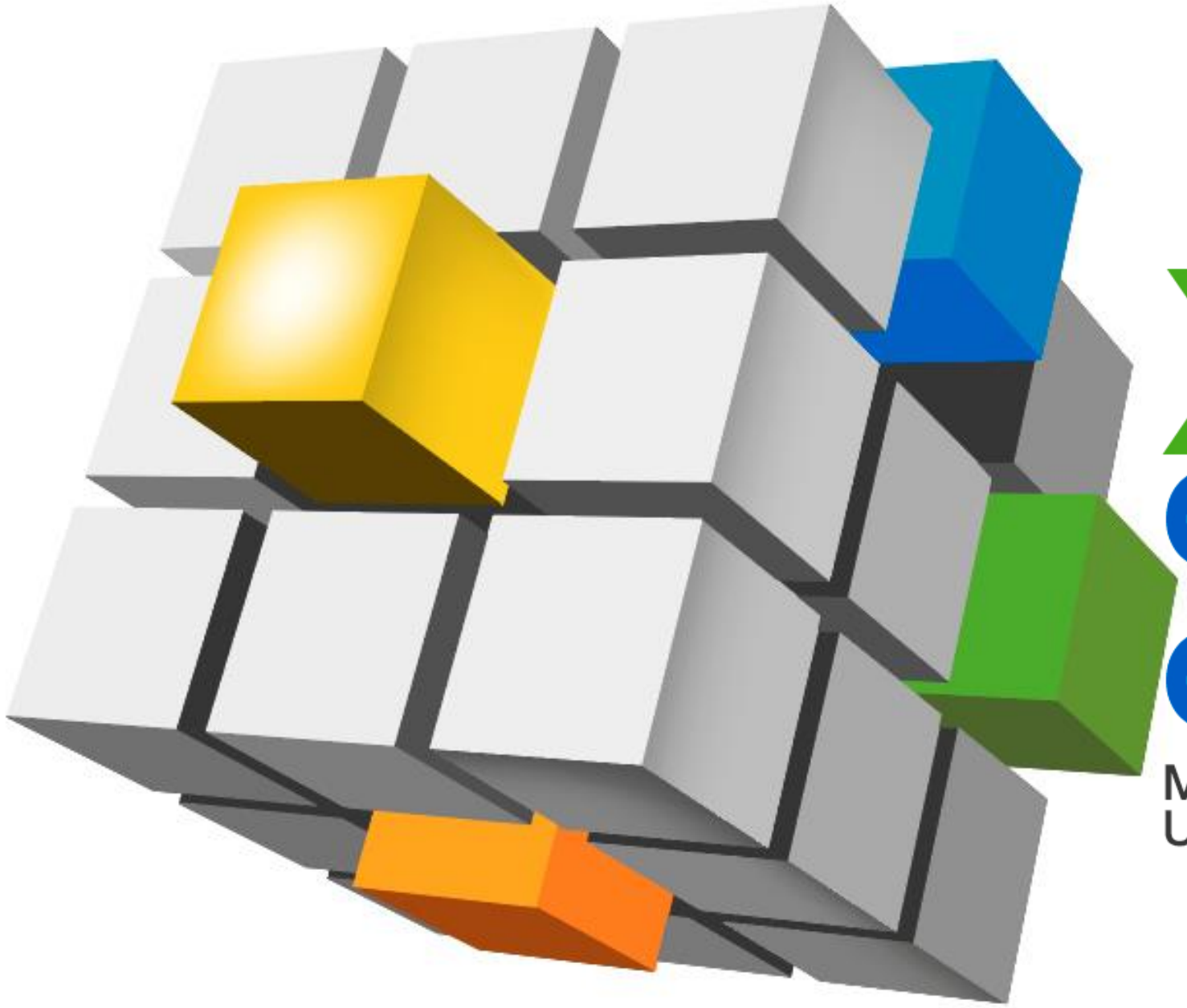

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XIX Congreso de Confiabilidad

Madrid, 22 de noviembre de 2017.
Universidad Europea de Madrid

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REACTION TIME EVALUATION FOR EVENTS GOVERNED BY WEAR OUT PROCESSES

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Continued Airworthiness Process

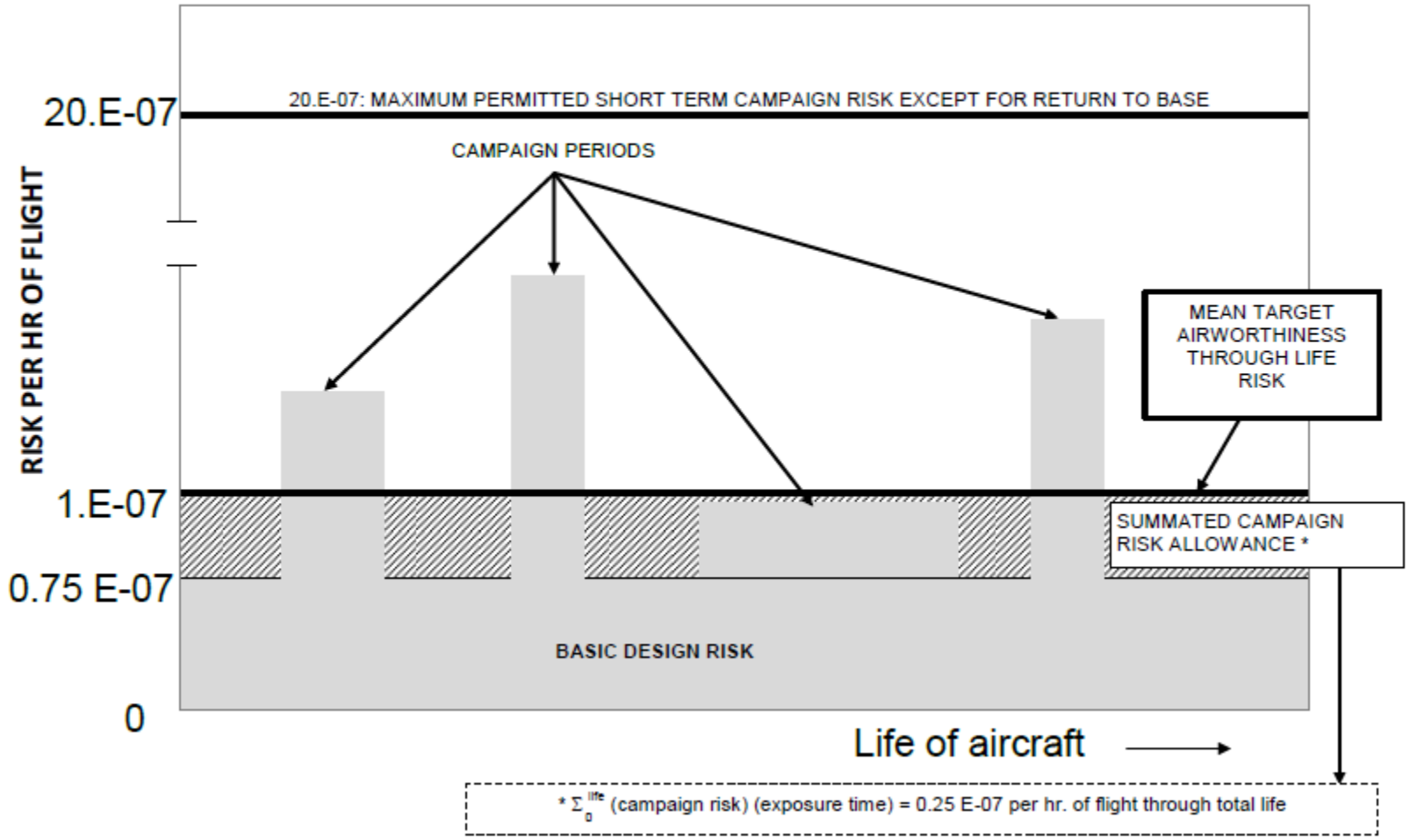
- Continued Airworthiness definition (ICAO)
- European regulations:
  - Collection and analysis of Data
  - Report of occurrences
  - Investigate the reason for the deficiency
  - Corrective Actions and Reaction Time
  - Airworthiness Directive (AD)

AMC GM Part 21

- Main Purpose of this GM is:
  - To define basic principles to be considered to maintain an adequate level of airworthiness risk after a defect detection
  - To define the criteria to asses the residual increase in risk and to limit it to an appropriate small fraction of the aircraft life
  - Reaction Time Evaluation

AMC GM Part 21

Figure 1 - Visualisation Chart for CS-25



AMC GM Part 21

- Reaction Time Evaluation
  - Failure modelization based on exponential distribution (λ = Cte)
  - Boundary areas proposed for CAT Failure Conditions
    - Risk Allowance

$$\sum(\boldsymbol{Campaign\ Risk}) \times (\boldsymbol{Exposure\ Time}) < \boldsymbol{K}$$

    - Upper Boundary ⇒ 2E-6 / FH

AMC GM Part 21

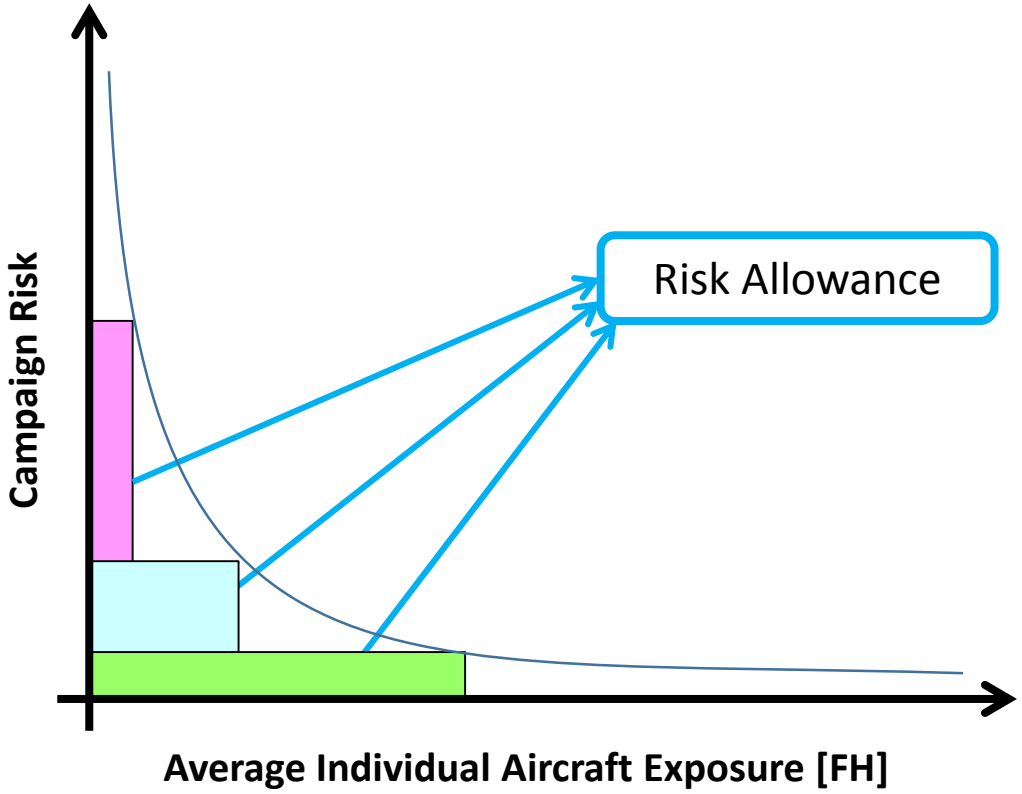
- Risk Allowance
  - A/C CAT events due to airworthiness reasons: 1E-07/FH
  - Acceptable through life risk of an A/C: ¼ of the A/C life
  - 10 Emergency periods along the life of an individual A/C

$$K = 1 \cdot 10^{-7} \cdot \frac{25}{100} \cdot \frac{1}{10} \cdot 30.000 = 7,5 \cdot 10^{-5}$$

[Risk allowance evaluated for an A/C life of 30.000 FH]

AMC GM Part 21

- Risk Allowance: Graphic Interpretation for Random Failures



$$(Campaign\ Risk) \times (Exposure\ Time) < 7,5 \cdot 10^{-5}$$

AMC GM Part 21

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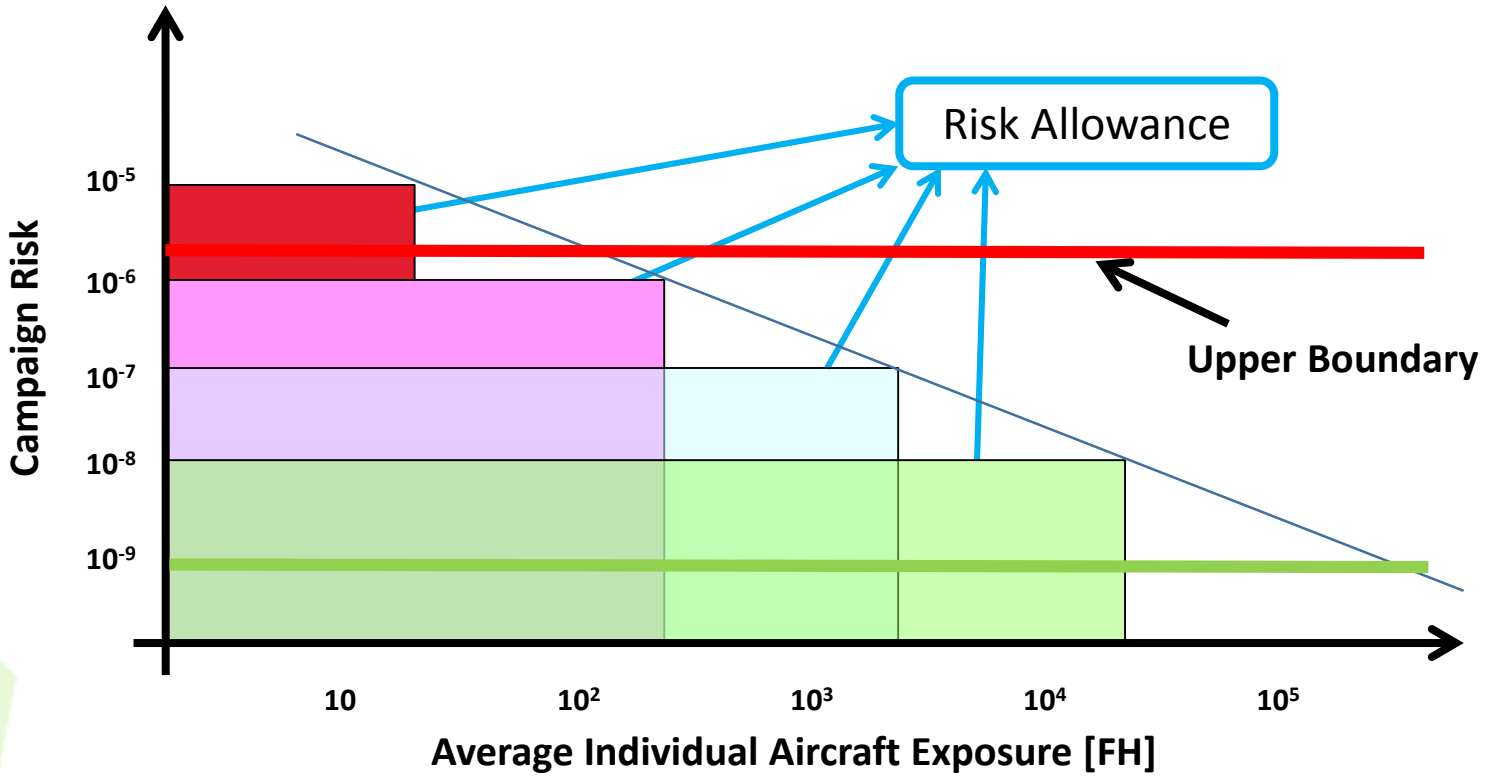

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AMC GM Part 21

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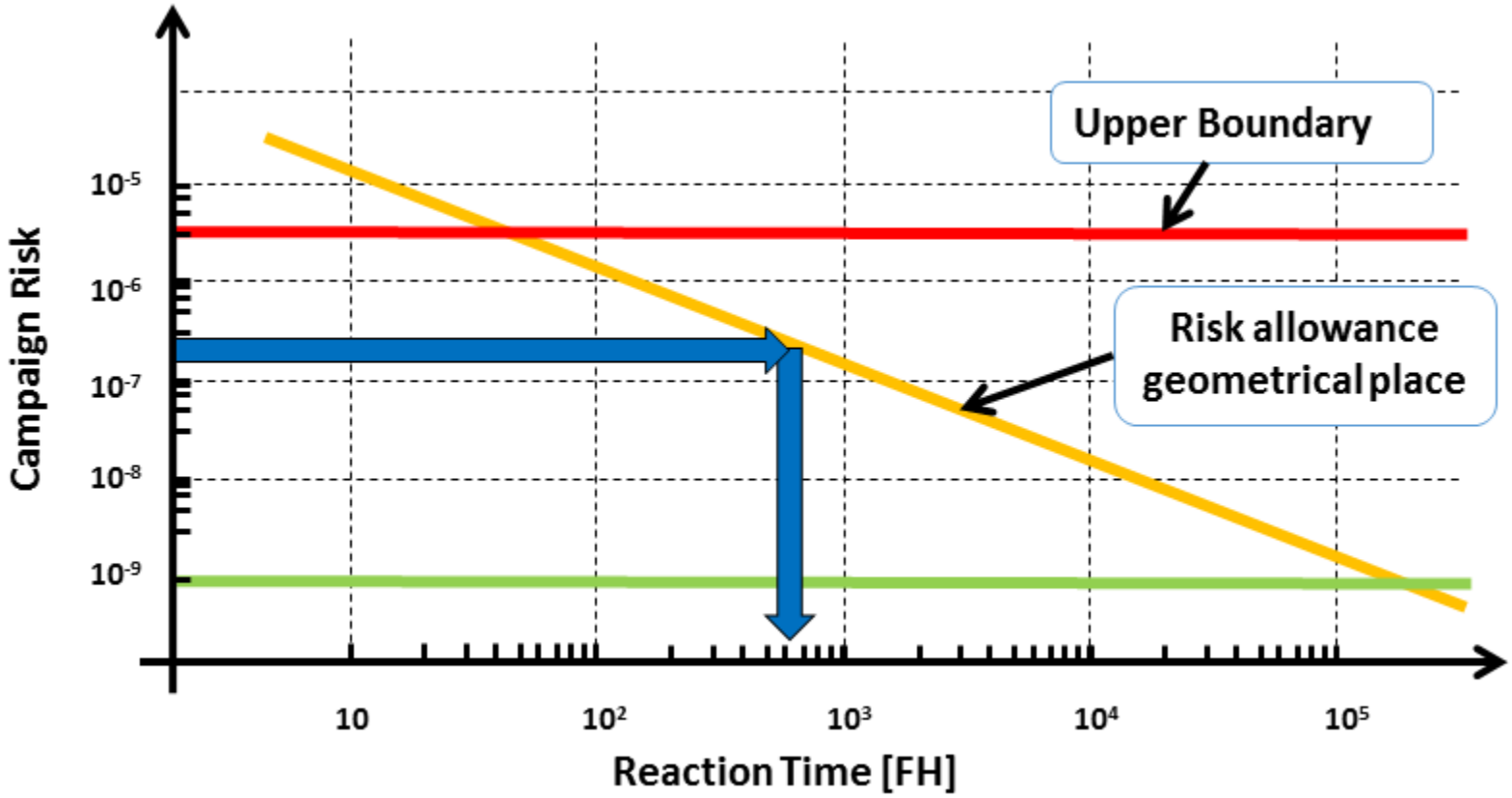
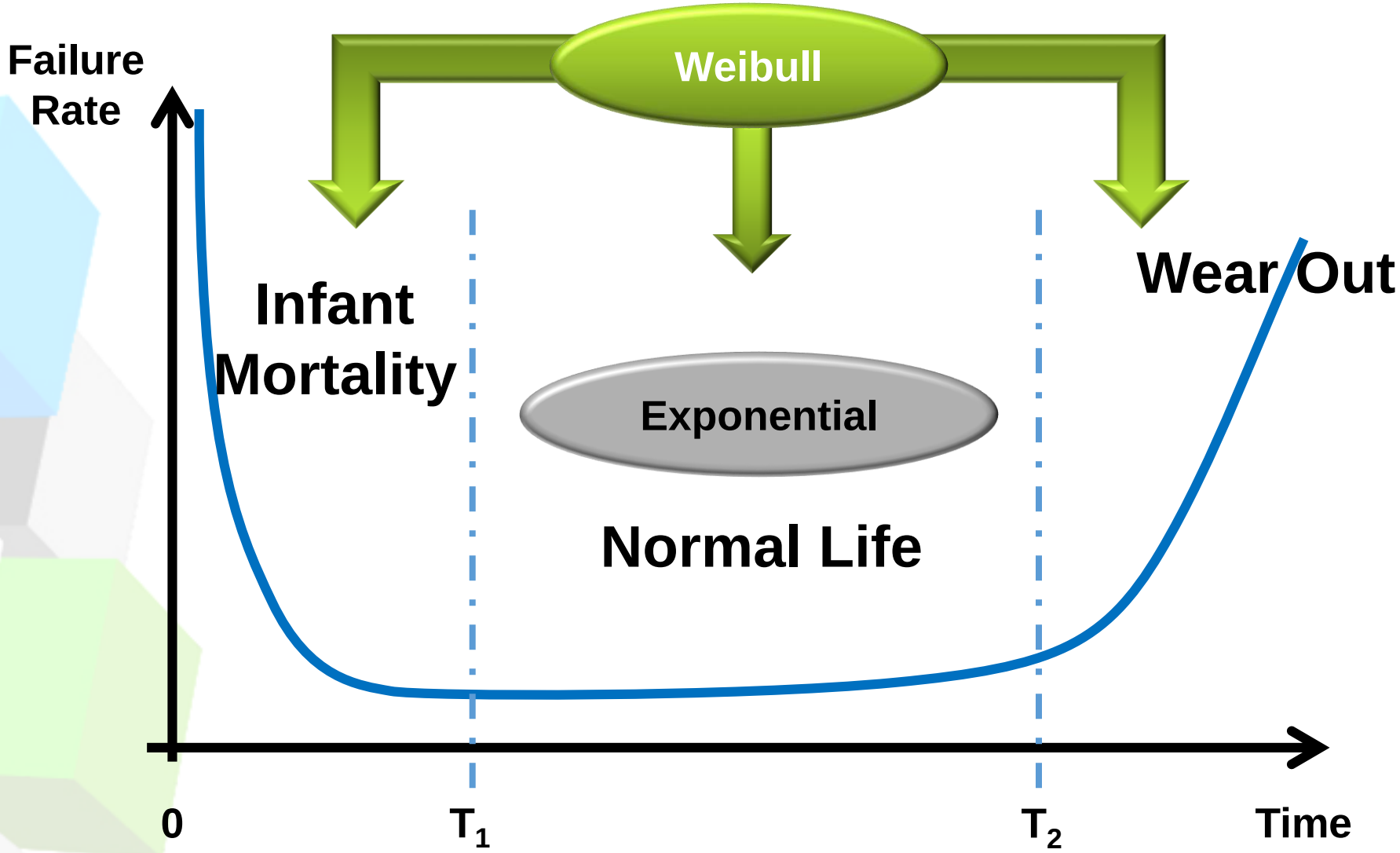


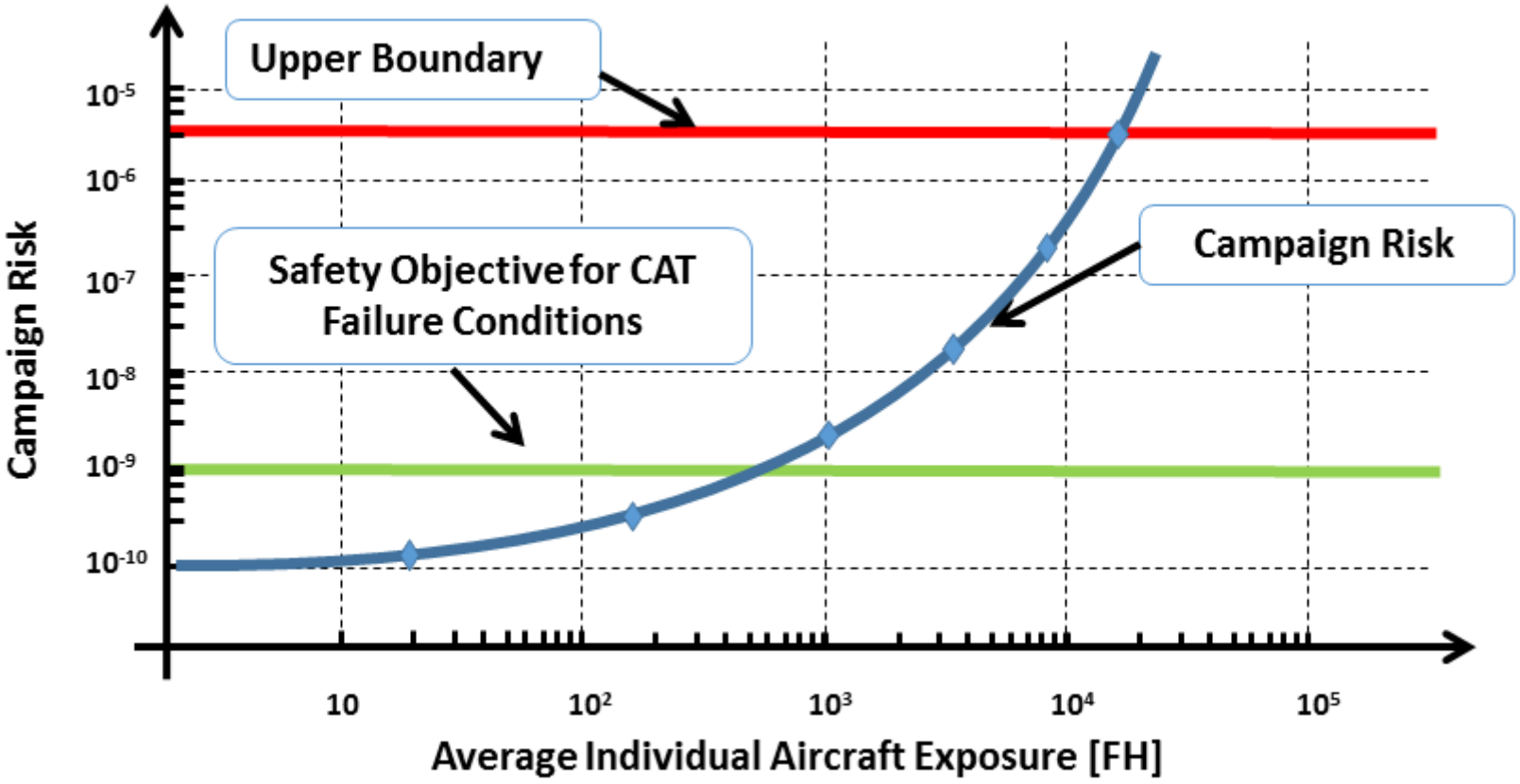
$$(Campaign\ Risk) \times (Exposure\ Time) < 7,5 \cdot 10^{-5}$$

Failure Mode Analysis



Alternative Methodology

- Campaign Risk for Wear Out failure modes



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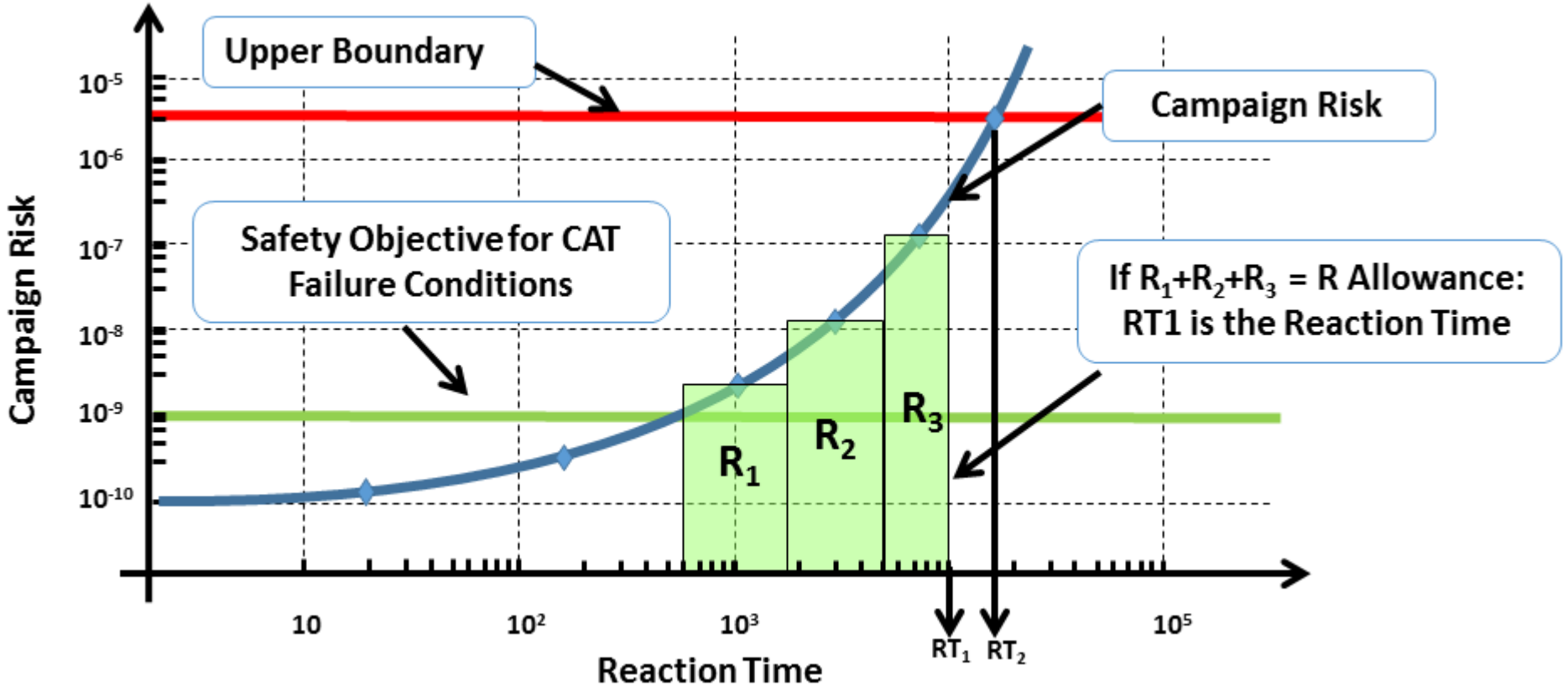
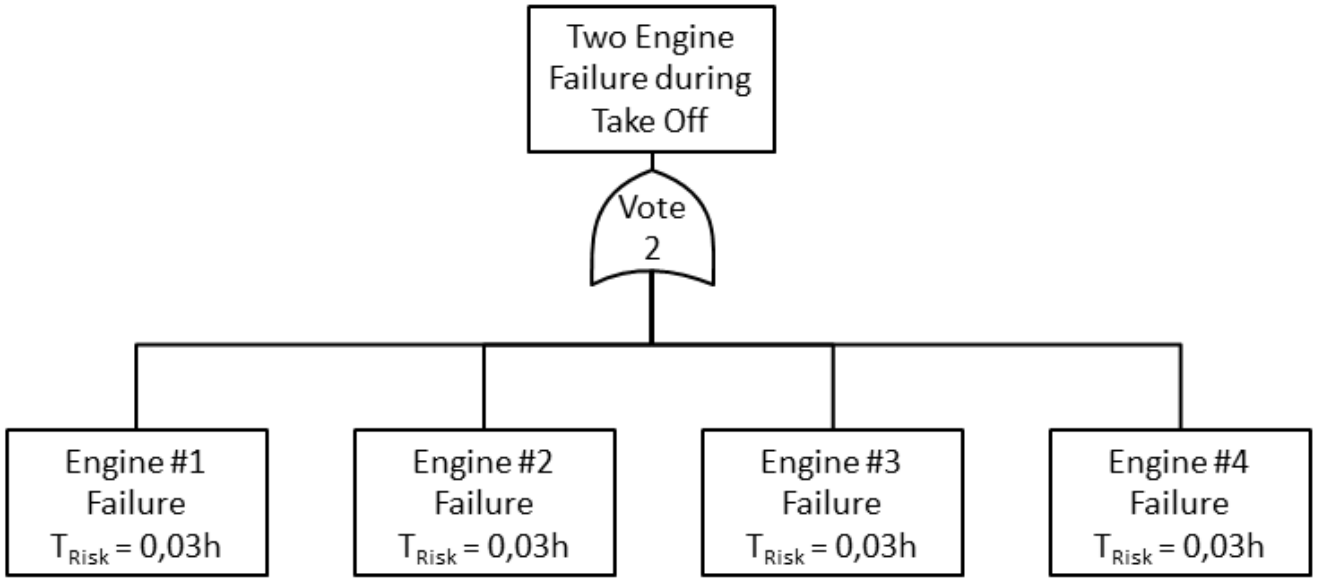


$$\sum(\boldsymbol{Campaign\ Risk}) \times (\boldsymbol{Exposure\ Time}) < \mathbf{7,5 \cdot 10^{-5}}$$

Application

- Engine equipment failure
  - Weibull approach: $\beta = 2,9 – \eta = 470$ FH
  - Campaign Risk: Two engine Failure During Take Off



Application

Time Reference [FH]	Failure Rate [1/FH]	Average Campaign Risk [1/FH]	Time Frame Risk [-]	Total Cumulative Risk [-]
20	1,51E-05	1,55E-13		
160	7,87E-04	6,69E-10		
180	9,84E-04	1,07E-09	2,14E-08	2,14E-08
300	2,60E-03	8,06E-09	1,61E-07	5,44E-07
400	4,49E-03	2,48E-08	4,95E-07	2,24E-06
500	6,86E-03	5,89E-08	1,18E-06	6,59E-06
600	9,69E-03	1,19E-07	2,38E-06	1,58E-05
800	1,67E-02	3,61E-07	7,22E-06	6,31E-05
820	1,75E-02	3,97E-07	7,94E-06	7,10E-05
840	1,84E-02	4,35E-07	8,71E-06	7,97E-05
1240	3,85E-02	1,94E-06		
1260	3,97E-02	2,06E-06		

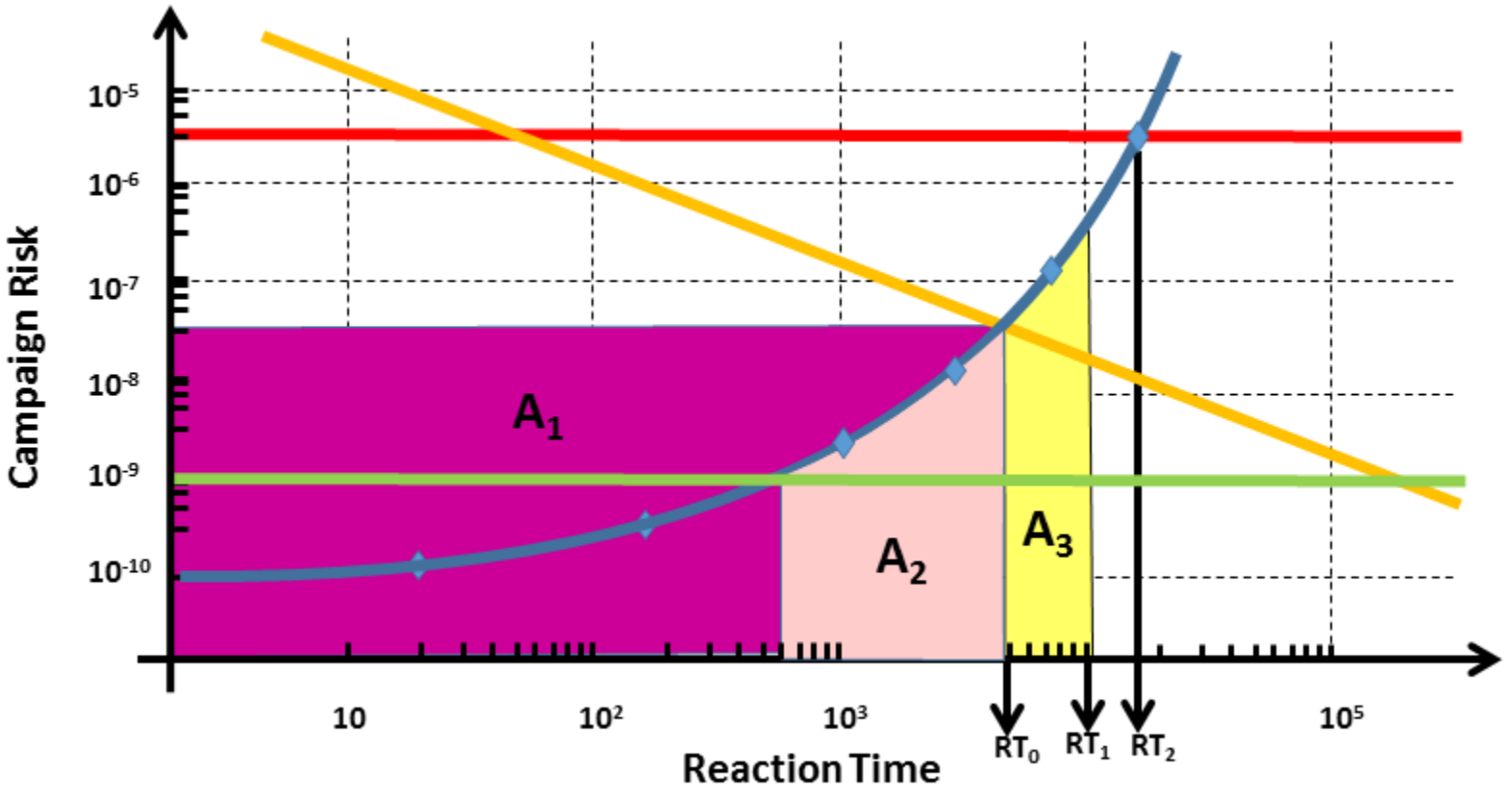
Average Campaign Risk above Catastrophic safety objective (1E-9/FH)

Total cumulative Risk just below Risk Allowance of 7,5E-5

Average Campaign Risk above upper limit of 2E-06/FH

Alternative Methodology

- Campaign Risk for Wear Out failure modes



$$\sum(\boldsymbol{Campaign\ Risk}) \times (\boldsymbol{Exposure\ Time}) < \mathbf{7,5 \cdot 10^{-5}}$$

Summary

- AMC/GM Part 21 provides guidelines to evaluate the reaction time for random failures with constant failure rates.
- This study presents an alternative to the evaluation of the reaction time for failures ruled out by wear out processes
- This new methodology let:
  - Being more precise with the evaluation of the time to impose corrective actions
  - Minimizing the disturbance to the operator
  - Ensuring a minimum level of Airworthiness

Thank you