



EASA
European Aviation Safety Agency

Risk Matrix customisation

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- Concept of Frequency and severity
- Why should an operator customize the matrix?
- Examples





SAFETY RISK PROBABILITY: Safety risk probability is the likelihood that a safety consequence or outcome will occur. It is important to envisage a variety of scenarios so that all potential consequences can be considered.

<i>Likelihood</i>	<i>Meaning</i>	<i>Value</i>
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely improbable	Almost inconceivable that the event will occur	1

Note.— This is an example only. The level of detail and complexity of tables and matrices should be adapted to the particular needs and complexities of each organization. It should also be noted that organizations might include both qualitative and quantitative criteria.



Discussion on probability

WHAT ARE THE CHANCES OF ROLLING 5 WITH A GREEN DICE?

$$\begin{aligned} \mathcal{L} &= \oint E_{\text{ext}} \\ f(w) &= \int_{-\infty}^{\infty} f(x) e^{-2\pi i x w} dx \frac{dt}{d\omega} \\ \rho \left(\frac{\partial v}{\partial t} + v \cdot \nabla v \right) &= -\nabla p + \nabla \cdot T + f \\ H &= -\sum p(x) \log p(x) \\ \nabla \cdot E &= 0 \quad \nabla \times E = -\frac{1}{c} \frac{\partial H}{\partial t} \quad \nabla \cdot H = 0 \quad \nabla \times H = \frac{1}{c} \frac{\partial E}{\partial t} \\ (-i\hbar \frac{\partial}{\partial t} \Psi) &= H \Psi \\ + \sum_{i=1}^n \frac{q_i}{2} H_i^M + c_s \frac{D}{Q} + c_o D + \\ &+ \frac{Q(p-D)}{2p} H^M + F_o N + \\ &+ F_o N + \sum_{i=1}^n D_i w_i d_i (1+w_i) \\ T(\rho, \mu, m) &= \sum_{i=1}^n \left[\frac{D_i}{m_i} S_i + \frac{q_i H_i}{2} \left(m_i \left(1 - \frac{D_i}{P_i} \right) - 1 + 2 \frac{D_i}{P_i} \right) \right] + \\ \left[\frac{d \Delta p(s, \phi)}{d\phi} \right] &= \begin{bmatrix} \gamma & -\mathcal{L} \\ -\beta & 0 \end{bmatrix} \begin{bmatrix} \Delta p(s, \phi) \\ \Delta M(s, \phi) \end{bmatrix} \\ \int_0^{\frac{\pi}{2}} (\log \sin x)^2 dx &= \int_0^{\frac{\pi}{2}} (\log \cos x)^2 dx = \frac{\pi}{2} \left\{ \frac{\pi^2}{12} + (\log 2)^2 \right\} \end{aligned}$$



Severity - ICAO Doc 9859 Ed 4

Safety risk severity: is defined as the extent of harm that might reasonably be expected to occur as a consequence or outcome of the identified hazard.

<i>Severity</i>	<i>Meaning</i>	<i>Value</i>
Catastrophic	<ul style="list-style-type: none">• Aircraft / equipment destroyed• Multiple deaths	A
Hazardous	<ul style="list-style-type: none">• A large reduction in safety margins, physical distress or a workload such that operational personnel cannot be relied upon to perform their tasks accurately or completely• Serious injury• Major equipment damage	B
Major	<ul style="list-style-type: none">• A significant reduction in safety margins, a reduction in the ability of operational personnel to cope with adverse operating conditions as a result of an increase in workload or as a result of conditions impairing their efficiency• Serious incident• Injury to persons	C
Minor	<ul style="list-style-type: none">• Nuisance• Operating limitations• Use of emergency procedures• Minor incident	D
Negligible	<ul style="list-style-type: none">• Few consequences	E



Risk MATRIX



Risk Matrix - ICAO Doc 9859 Ed 4

Safety Risk		Severity				
Probability		Catastrophic A	Hazardous B	Major C	Minor D	Negligible 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

Note.— In determining the safety risk tolerability, the quality and reliability of the data used for the hazard identification and safety risk probability should be taken into consideration.

Safety Risk Index Range	Safety Risk Description	Recommended Action
5A, 5B, 5C, 4A, 4B, 3A	INTOLERABLE	Take immediate action to mitigate the risk or stop the activity. Perform priority safety risk mitigation to ensure additional or enhanced preventative controls are in place to bring down the safety risk index to tolerable.
5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C, 1A	TOLERABLE	Can be tolerated based on the safety risk mitigation. It may require management decision to accept the risk.
3E, 2D, 2E, 1B, 1C, 1D, 1E	ACCEPTABLE	Acceptable as is. No further safety risk mitigation required.



Examples from the industry



Medium fix wing operator country A

SEVERITY OF OCCURRENCE	MEANING				VALUE
	PERSONNEL	ENVIRONMENT	MATERIAL VALUES & ASSETS	REPUTATION	
CATASTROPHIC (Very Large)	Multiple fatalities	Massive effects (pollution, destruction, etc.)	Catastrophic financial loss Damage > 1 M€	International impact	E
HAZARDOUS (Large)	Fatality	Effects difficult to repair	Severe financial loss with long term effects Damage < 1 M€	National impact	D
MAJOR (Medium)	Serious injuries	Noteworthy local effects	Substantial financial loss Damage < 250K€	Considerable impact	C
MINOR (Small)	Light injuries	Little impact	Financial loss with little impact Damage < 50K€	Limited impact	B
NEGLIGIBLE (Very Small)	Superficial or no injuries	Negligible or no effects	Financial loss with negligible impact Damage < 10K€	Light or no impact	A

RISK LIKELIHOOD	MEANING	VALUE
FREQUENT	Likely to occur many times. Has already occurred in [REDACTED] (Freq. > 3 times per year). Has occurred frequently in the history of the aviation industry.	5
OCCASIONAL	Likely to occur sometimes. Has already occurred in [REDACTED] (Freq. < 3 times per year). Has occurred infrequently in the history of the aviation industry.	4
REMOTE	Unlikely to occur, but possible. Has already occurred in [REDACTED] at least once or. Has seldom occurred in the history of the aviation industry.	3
IMPROBABLE	Very unlikely to occur. Not known to have occurred in [REDACTED] but has already occurred at least once in the history of the aviation industry.	2
EXTREMELY IMPROBABLE	Almost inconceivable that the event will occur. It has never occurred in the history of the aviation industry. ⁶	1



Big Heli Operator country B

SEVERITY OF OCCURRENCE	MEANING				VALUE
	PERSONNEL	ENVIRONMENT	MATERIAL VALUES & ASSETS	REPUTATION	
CATASTROPHIC	Multiple fatalities	Massive effects (pollution, destruction, etc.)	Catastrophic financial loss Damage > 1 M€	International impact	E
HAZARDOUS	Fatality	Effects difficult to repair	Severe financial loss with long term effects Damage < 1 M€	National impact	D
MAJOR	Serious injuries	Noteworthy local effects	Substantial financial loss Damage < 250K€	Considerable impact	C
MINOR	Light injuries	Little impact	Financial loss with little impact Damage < 50K€	Limited impact	B
NEGLIGIBLE	Superficial or no injuries	Negligible or no effects	Financial loss with negligible impact Damage < 10K€	Light or no impact	A

RISK LIKELIHOOD	MEANING	VALUE
FREQUENT	Likely to occur many times. Has already occurred in the company (Freq. > 3 times per year – indicative). Has occurred frequently in the history of the aviation industry.	5
OCCASIONAL	Likely to occur sometimes. Has already occurred in the company (Freq. < 3 times per year – indicative). Has occurred infrequently in the history of the aviation industry.	4
REMOTE	Unlikely to occur, but possible. Has already occurred in the company at least once. Has seldom occurred in the history of the aviation industry.	3
IMPROBABLE	Very unlikely to occur. Not known to have occurred in the company but has already occurred at least once in the history of the aviation industry.	2
EXTREMELY IMPROBABLE	Almost inconceivable that the event will occur. It has never occurred in the history of the aviation industry.	1



Medium Operator country A + B + C + ...

Severity	Meaning	Value
Catastrophic	Equipment destroyed Multiple deaths	A
Hazardous	A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely Serious injury Major equipment damage	B
Major	A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency Serious incident Injury to persons	C
Minor	Nuisance Operating limitations Use of emergency procedures Minor incident	D
Negligible	Little consequences	E

Occurrence	Meaning	Value
Frequent	Likely to occur many times (has occurred frequently)	5
Occasional	Likely to occur sometimes (has occurred infrequently)	4
Remote	Unlikely to occur, but possible (has occurred rarely)	3
Improbable	Very unlikely to occur (not known to have occurred)	2
Extremely Improbable	Almost inconceivable that the event will occur	1



Risk Acceptability country A & B (not close border countries)

COUNTRY A

Unacceptable Risk Level: the red zone in the matrix: risk is too high to continue operating.

Action required: Prohibit/suspend the operation. Operation may be resumed only when risk level is returned to tolerable or acceptable.

Management levels who have the authority to make decisions regarding risk tolerability:

- For the risk evaluation validation: The assumptions made for the determination of the risk level and its tolerability are to be validated by the SM.
- For the authorisation of operations: Management level which has the authority to authorise operations at this level of risk: not applicable: operations cannot be authorised.

Tolerable Risk Level: the yellow zone in the matrix: the risk level can be tolerated for the operation, providing that appropriate mitigation measures are in place.

Action required: Introduce appropriate mitigation measures.

Management levels who have the authority to make decisions regarding risk tolerability:

- For the risk evaluation validation: The assumptions made for the determination of the risk level and its tolerability are to be validated by the SM.
- For the authorisation of operations: Management who have the authority to authorise operations at this level of risk: the Accountable Manager.

COUNTRY B

Unacceptable Risk Level: the red zone in the matrix: risk is too high to continue operating.

Action required: Prohibit/suspend the operation. Operation may be resumed only when risk level is returned to tolerable or acceptable.

Management levels who have the authority to make decisions regarding risk tolerability:

- For the risk evaluation validation: The assumptions made for the determination of the risk level and its tolerability is to be validated by the Safety Manager.
- For the authorisation of operations: Management level which has the authority to authorise operations at this level of risk: not applicable: operations cannot be authorised.

Tolerable Risk Level: the yellow zone in the matrix: the risk level can be tolerated for the operation, providing that appropriate mitigation measures are in place.

Action required: Introduce appropriate mitigation measures.

Management levels who have the authority to make decisions regarding risk tolerability:

- For the risk evaluation validation: The assumptions made for the determination of the risk level and its tolerability is to be validated by the Safety Manager.
- For the authorisation of operations: Management who have the authority to authorise operations at this level of risk: the Accountable Manager.



Risk Acceptability with defined time frame

High

Unacceptable Risk Level: the red zone in the matrix: risk is too high to continue operating.

Action required: Prohibit/suspend the operation. Operation may be resumed only when risk level is returned to acceptable.

Management levels who have the authority to make decisions regarding risk tolerability:

- For the risk evaluation validation: The assumptions made for the determination of the risk level and its tolerability are validated by the Safety Manager supported by the pertinent Department Manager and immediate communication is given to the Accountable Manager;
- For the authorisation of operations: Management level which has the authority to authorise operations at this level of risk: not applicable: operations cannot be authorised.

Maximum Response Time: Immediate.

Maximum Implementation Plan: Prior to the next flight or correction on the spot.

Investigation & Report Completion: High priority – 5 hrs

Medium

Moderate: Acceptable after review of the operation: the yellow bright zone in the matrix the risk level can be tolerated for the operation, providing continuous tracking and recorded action plans are in place.

Action required: Continuous tracking and record of action plans.

Management levels who have the authority to make decisions regarding risk tolerability:

- For the risk evaluation validation: The assumptions made for the determination of the risk level and its tolerability are to be validated by the Safety Manager supported by the pertinent Department Manager.
- For the authorisation of operations: Management who have the authority to authorise operations at this level of risk: the pertinent Department Manager.

Maximum Response Time: 14 days

Maximum Implementation Plan: 60 calendar days

Investigation & Report Completion: final 30 days



The standard layout

RISK LIKELIHOOD	RISK SEVERITY				
	NEGLIGIBLE (A)	MINOR (B)	MAJOR (C)	HAZARDOUS (D)	CATASTROPHIC (E)
FREQUENT (5)	5 A	5 B	5 C	5 D	5 E
OCCASIONAL (4)	4 A	4 B	4 C	4 D	4 E
REMOTE (3)	3 A	3 B	3 C	3 D	3 E
IMPROBABLE (2)	2 A	2 B	2 C	2 D	2 E
EXTREMELY IMPROBABLE (1)	1 A	1 B	1 C	1 D	1 E

Frequency / Statistical Probability				
Never happened in the industry	Very unlikely to occur	Possible to occur	Likely to occur some times	Likely to occur many times
Probability				
Remote	Occasional	Likely	Probable	Frequent

Severity	Meaning	Value
Catastrophic	Equipment destroyed Multiple deaths	A
Hazardous	A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely Serious injury Major equipment damage	B
Major	A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency Serious incident Injury to persons	C
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Different Approach



Different description of Severity

Severity LEVEL	S5	S4	S3	S2	S1
NATURE	Extreme	High	Medium	Low	Minor
INJURY					
NON ROUTINE INCIDENT (modified ICAO definition)	Total loss or hull loss	Accident with serious injuries or fatalities, or significant damage to aircraft	Serious incident with injuries and or substantial damage to aircraft	Incident with minor injury and or minor aircraft damage	Incident with discomfort and/or less than minor system damage
A/C DAMAGE	> 20 Mio EUR	400.000 EUR to 20 Mio EUR	10.000 EUR to 400.000 EUR	300 EUR to 10.000 EUR	< 300 EUR
REPUTATION AND PUBLIC CONFIDENCE	Fundamental change in public perception of EN as a quality airline	Extended nationwide negative media coverage or international negative media coverage	Short term nationwide negative media coverage	Negative local media coverage	None
CUSTOMER IMPACT	Extensive shut down of services for an extensive period. All customers affected	More than 40 flights cancelled, rescheduled or delayed. Thousands of customers affected	Between 1 and 40 flights cancelled, rescheduled or delayed. Hundreds of customers affected	Between 2 and 5 flights rescheduled or delayed. Dozen of customer affected	1 flight rescheduled or delayed. Small number of customers affected
OPERATIONAL IMPACT	Fleet grounding for extended period	Brief fleet grounding up to 2 days	Aircraft grounding more than 2 days	Aircraft grounding 4 to 48 hours	Aircraft delay less than 4 hours
EQUIPMENT	Loss of critical equipment, shut down of organization	Major damage results in major slowdown and/or downtime	Minor damage leads to organizational slowdown	Minor damage potential organizational slowdown	No adverse consequences
COMPLIANCE	Significant disruption to scheduled services over an extended period of time	Substantial fine and disruption to scheduled services	Substantial fine but no disruption to scheduled services	No fine and no disruption to scheduled services	Minor breaches by individual staff members
PROCESS BREACH	Several steps of flight critical process not followed or flight critical process non-existent	No steps of documented process followed or process non-existent	Majority of steps of documented process not followed or process unknown	Contiguous steps of documented process not followed or process partly unclear	Some single steps of documented process not followed
KNOW-HOW LOSS	Dramatic loss resulting in fully new build-up requiring more than 2 years	Heavy loss resulting in substantial build-up and/or renewal requiring 1-2 years	Worrying loss resulting in substantial build-up and/or renewal requiring up to 1 year	Loss resulting in noticeable build-up and/or renewal requiring 3/6 months	Slight loss that can be easily absorbed within the existing organization within 3 months
SAFETY AWARENESS IGNORANCE	Intolerable total absence of safety awareness demanding immediate dismissal	Unusually high level of safety awareness ignorance needing immediate correction or dismissal	Unacceptable attitude toward safety awareness needing immediate correction or dismissal warning	Generally acceptable attitude toward safety awareness with occasional blackout needing pronounced and lasting correction	Sound attitude toward safety awareness with occasional and isolated misjudgment needing clarification and lasting educational influence

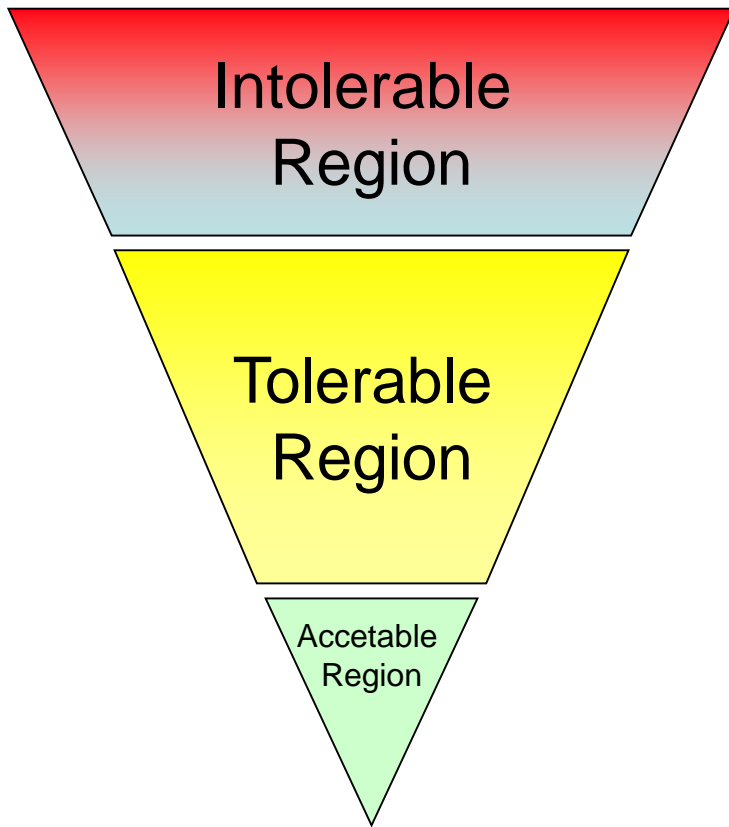


Probability customized

Probability LEVEL	Occurrences in XYZ			One out of _____ flights	Probability	Description
	Upper Boundary	Mean	Lower Boundary			
P5	Always	10 per day	3,5 per day	140	7,3E-03	Probability: Almost certain, very high History: Significant past history, has occurred many times and is considered most likely to happen in these circumstances Context: Has occurred innumerable times at XYZ
P4	3,5 per day	Once per day	2,9 per week	1.100	9,0E-04	Probability: Likely, high History: Past history and will probably occur in most circumstances Context: Has occurred many times at XYZ
P3	2,9 per week	Once per week	1,3 per month	10.000	1,0E-04	Probability: Possible, medium History: Some past history, has occurred occasional and is considered quite likely to happen in these circumstances Context: Has occurred several times at XYZ
P2	1,3 per month	Every two months	2,2 per year	100.000	1,0E-05	Probability: Low, possible under certain circumstances History: Some past history and considered possible in these circumstances Context: Has occurred at XYZ
P1	2,2 per year	Every year	Every 3,2 years	500.000	2,0E-06	Probability: Very low, unlikely History: Has occurred rarely, has happened, but a credible statistic frequency is hard to establish Context: Has occurred sporadic at XYZ
P0	Every 3,2 years	Every 10 years	Every 32 years	5.000.000	2,0E-07	Probability: Quite unlikely, rare History: In most circumstances no past history, but possible in exceptional circumstances Context: Has occurred in the aviation industry
Pe	Every 32 years	Every 100 years	Every 320 years	50.000.000	2,0E-08	Probability: Extremely unlikely, mishap basically impossible History: No past history and considered very unlikely to occur Context: Not yet heard of in the aviation industry



Different Matrix



	S5	S4	S3	S2	S1	S0
P5	A	A	B	C	D	E
P4	A	A	B	C	D	E
P3	A	B	C	D	E	E
P2	A	B	C	D	E	E
P1	B	C	D	E	E	E
P0	C	C	D	E	E	E
Pe	C	D	E	E	E	E



Risk Acceptability color grades

	Remote	Occasional	Likely	Probable	Frequent
Factor	3	4	6	8	10
10	30	40	60	80	100
7	21	28	42	56	70
5	15	20	30	40	50
3	9	12	18	24	30
2	6	8	12	16	20
	Accept 1-15	Monitor 16-23	Secure 24-39	Improve 40-69	Stop 70-100



- “Description of the dice”
- Clearly define Severity and Likelihood table
- Customisation of the Matrix



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Thanks for your attention

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