



Runway Safety NextGen

Financial analysis of runway safety

Rob van Eekeren
Safe-Runway GmbH
TRAINING and CONSULTANCY



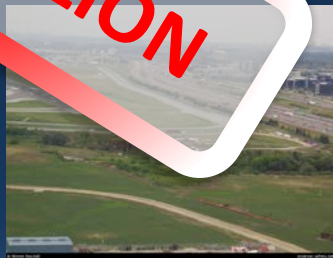
INSPIRATION: Two runway excursions



www.Safe-Runway.com

NO grooving and, NO standard RESA.....WHY NOT?

- AF 358; 2 aug 2005, A 340, CYYZ, runway excursion into Etobicoke creek, 12 injuries, 11 destroyed.



- TM354; 17 July 2007, A 320, SBSP, runway excursion into road fuel station, 199 fatalities (137 SOB, 12 others)



ALARP EASA NPA 2015-18(B)



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- EASA Safety Risk Management defines ALARP:
- “Showing that the safety risk is ALARP means that any further risk reduction is either *impracticable* or *grossly outweighed by the cost*”.



CYYZ

- Impracticable?
- NO
- Grossly outweighed by the costs?

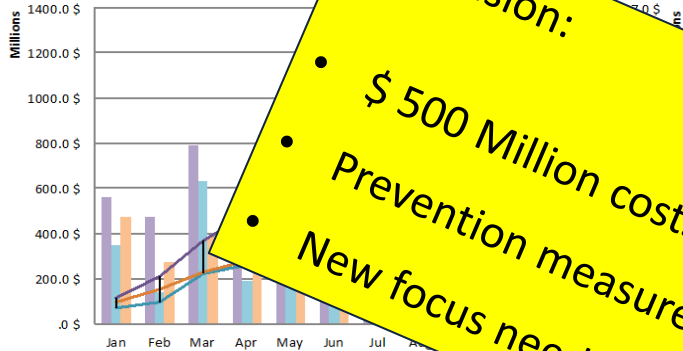
Cost estimates required



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Runway accidents / incidents COSTS 2015-2017

MONTHLY COSTS 2015-2017



Source: Safe-Runway GmbH

Risk:

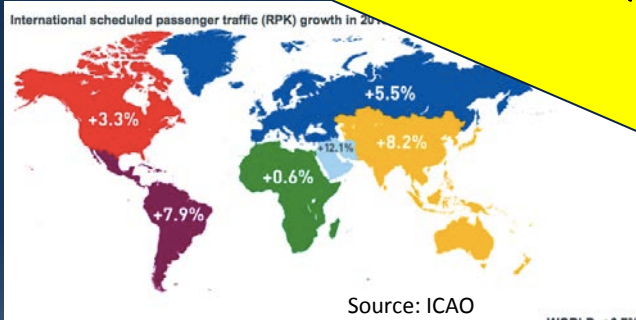
- Human Life & Injury
 - Damage
 - Disruption
 - Indirect effects
- Expressed in costs

Subject

- Runway Incursions
- Runway Excursions
 - Veer offs
 - Overruns
- Runway Underruns
- On Runway events



OMDB Emirates 521; 3 Aug 2016



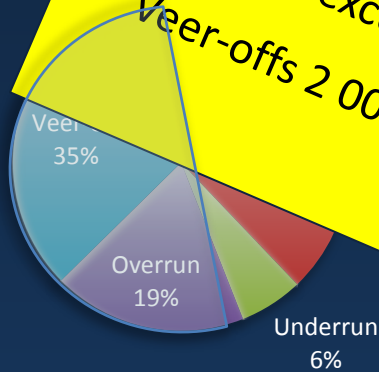
Source: ICAO



Conclusion:

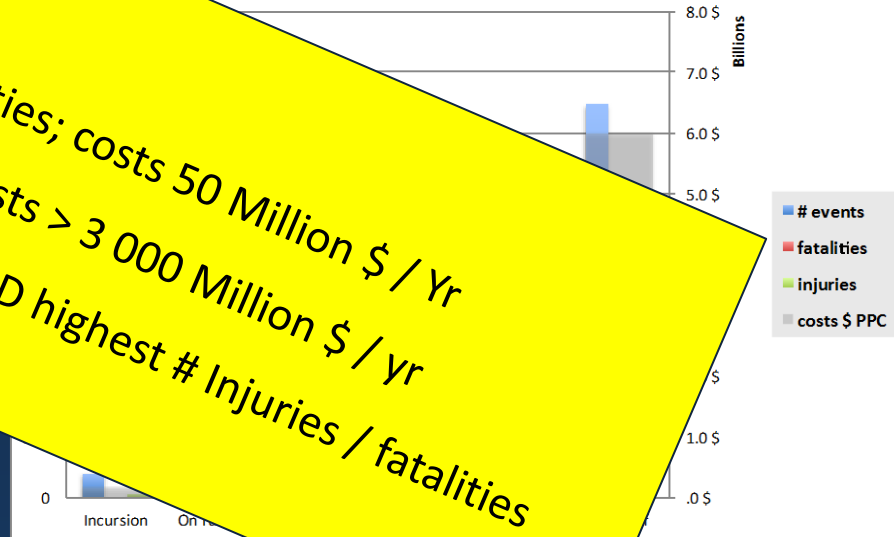
2015-2017

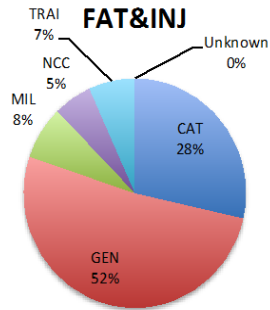
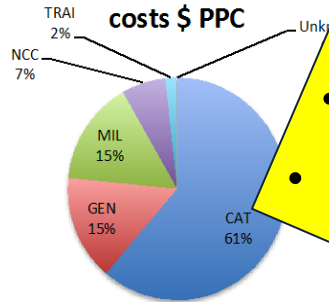
- Runway incursions: no fatalities; costs 50 Million \$ / Yr
- Runway excursions highest Costs > 3 000 Million \$ / yr
- Veer-offs 2 000 Million \$ / Yr AND highest # Injuries / fatalities



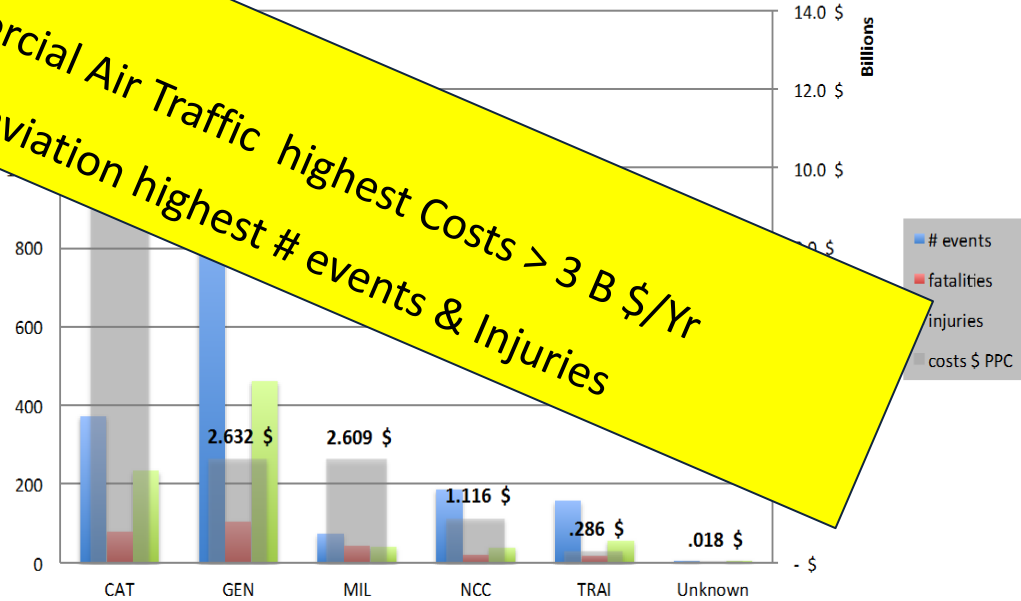
51% cost due to Excursions
1% due to Incursions

2015-2017 runway events
Costs; # events; # injuries; # fatalities
EVENTS





2015-2017 runway events Costs; # events; # injuries; # fatalities OPERATION

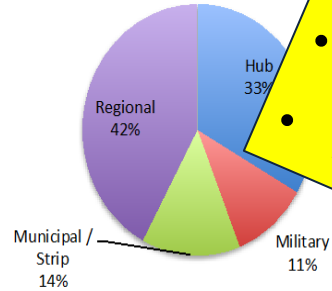


Conclusion:

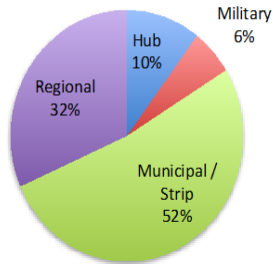
- Commercial Air Traffic highest Costs > 3 B \$/Yr
- General aviation highest # events & Injuries



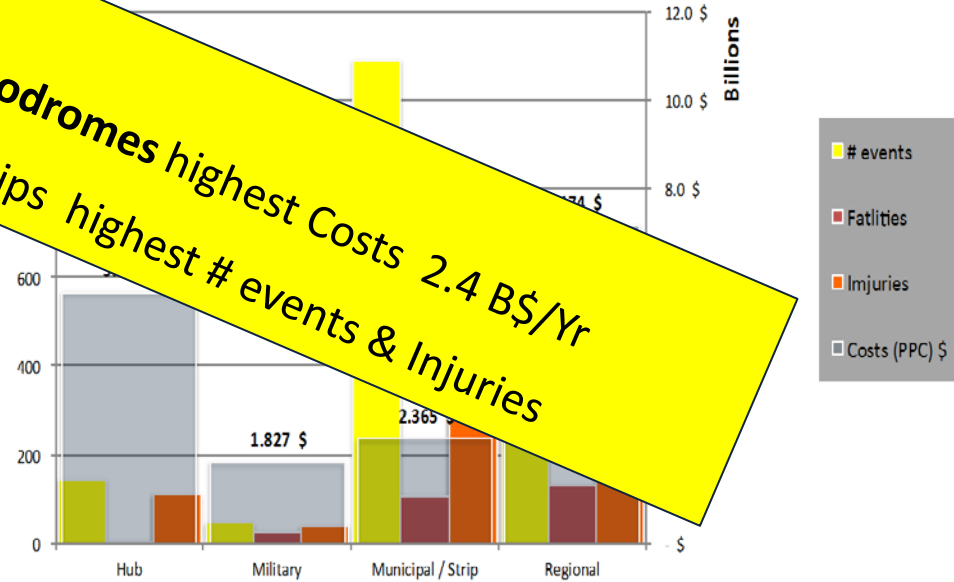
Costs (PPC) \$



FAT&INJ



2015-2017 runway events
Costs; # events; # injuries; # fatalities
AERODROME



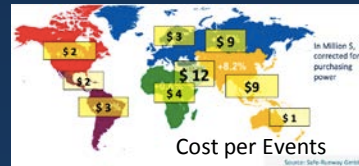
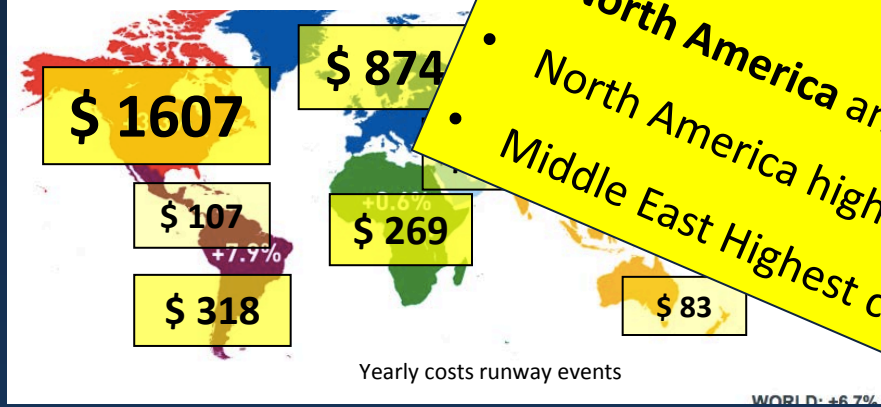
Conclusion:

- **Regional aerodromes** highest Costs 2.4 B\$/Yr
- **Municipal / strips** highest # events & Injuries



Annual runway accident, severe incident costs

In Million \$, corrected for purchasing power



Conclusion:

- North America and ASIA Highest runway event costs (4M\$ / day)
- North America highest # yearly events (1 per day)
- Middle East Highest costs per event (12M\$)

1 United States	3,690,919,647 \$
2 Japan	1,794,134,915 \$
3 Russian Federation	896,983,276 \$
4 Indonesia	872,134,681 \$
5 Canada	517,942,876 \$
6 United Kingdom	468,755,139 \$
7 France	466,051,646 \$
8 Germany	463,326,503 \$
9 China	426,832,840 \$
10 Australia	311,335,393 \$
11 India	312,077 \$
12 Italy	288,599,245 \$
13 Mexico	288,599,245 \$
14 South Korea	288,599,245 \$
15 Brazil	288,599,245 \$
16 Spain	288,599,245 \$
17 Netherlands	288,599,245 \$
18 Belgium	288,599,245 \$
19 Sweden	288,599,245 \$
20 Norway	288,599,245 \$
21 Switzerland	288,599,245 \$
22 Austria	288,599,245 \$
23 Denmark	288,599,245 \$
24 Finland	288,599,245 \$
25 Greece	288,599,245 \$
26 Portugal	288,599,245 \$
27 Ireland	288,599,245 \$
28 Luxembourg	288,599,245 \$
29 Slovenia	288,599,245 \$
30 Czech Republic	288,599,245 \$
31 Hungary	288,599,245 \$
32 Slovakia	288,599,245 \$
33 Poland	288,599,245 \$
34 Ukraine	288,599,245 \$
35 Belarus	288,599,245 \$
36 Latvia	288,599,245 \$
37 Lithuania	288,599,245 \$
38 Estonia	288,599,245 \$
39 Georgia	288,599,245 \$
40 Armenia	288,599,245 \$
41 Azerbaijan	288,599,245 \$
42 Kazakhstan	288,599,245 \$
43 Kyrgyzstan	288,599,245 \$
44 Uzbekistan	288,599,245 \$
45 Tajikistan	288,599,245 \$
46 Turkmenistan	288,599,245 \$
47 Mongolia	288,599,245 \$
48 Vietnam	288,599,245 \$
49 Laos	288,599,245 \$
50 Cambodia	288,599,245 \$

51 Belgium	56,734,683 \$
52 Madagascar	55,740,791 \$
53 Norway	54,221,218 \$
54 Uganda	52,819,294 \$
55 Sudan	51,969,610 \$
56 Ukraine and Moldova	50,058,015 \$
57 Syria	45,504,377 \$
58 Ghana	43,686,747 \$
59 Ecuador	41,885,360 \$
60 Austria	40,349,783 \$
61 Papua New Guinea	39,536,361 \$
62 Maldives	37,605,402 \$
63 Kenya	36,563,269 \$
64 Kazakhstan and Kyrgyz	36,407,888 \$
65 Alaska	35,594,466 \$
66 Mongolia	28,569,245 \$
67 Kazakhstan	28,540,695 \$
68 Uzbekistan	28,097,858 \$
69 Tajikistan	27,419,113 \$
70 Turkmenistan	25,938,066 \$
71 Zimbabwe	1,787,968 \$
72 Angola	1,199,199 \$
73 Malawi	1,152,115 \$
74 Mozambique	1,152,115 \$
75 Botswana	1,152,115 \$
76 Lesotho	1,152,115 \$
77 Namibia	1,152,115 \$
78 Zambia	1,152,115 \$
79 Maldives	1,152,115 \$
80 Maldives	1,152,115 \$
81 Maldives	1,152,115 \$
82 Maldives	1,152,115 \$
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97 Maldives	1,152,115 \$
98 Maldives	1,152,115 \$
99 Maldives	1,152,115 \$
100 Maldives	1,152,115 \$

101 Malta	4,654,486 \$
102 Zambia	4,615,811 \$
103 Honduras	4,351,532 \$
104 Aruba / Netherlands Antilles	4,135,407 \$
105 Mali	3,256,795 \$
106 Nigeria	3,045,179 \$
107 Antigua and Barbuda	2,727,645 \$
108 Sri Lanka	2,646,685 \$
109 Chile	2,638,413 \$
110 Germany - Military	2,546,816 \$
111 St. Lucia	1,824,706 \$
112 Iceland	1,763,418 \$
113 Luxembourg	1,706,808 \$
114 Saudi Arabia	1,652,557 \$
115 Cyprus	1,634,712 \$
116 Mauritania	1,427,697 \$
117 Namibia	1,149,122 \$
118 Zimbabwe	1,055,449 \$
119 India - East	767,160 \$
120 Angola	656,736 \$
121 Malawi	621,676 \$
122 Maldives	520,997 \$
123 Maldives	455,809 \$
124 Maldives	352,768 \$
125 Maldives	287,023 \$
126 Maldives	287,023 \$
127 Maldives	287,023 \$
128 Maldives	287,023 \$
129 Maldives	287,023 \$
130 Maldives	287,023 \$
131 Maldives	287,023 \$
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149 Maldives	287,023 \$
150 Maldives	287,023 \$

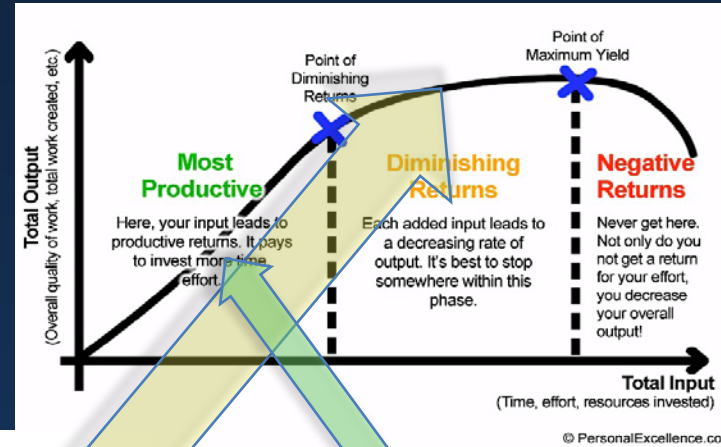
The Issue: (Safety) Return Of Investment



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Prevention has been successful for aviation accidents in general. Is this sustainable?

Risk=f [Probability, Severity]



Accident Overview

	2011	2012	2013	2014	2015	2016	Trend	Average 2011 - 2015
Yearly Flights (Millions)*	34.4	35.1	35.9	36.9	38.0	40.4		36.0
Total Accidents	96	78	87	77	68	55		80.2
Fatal Accidents	22	15	14	12	4	10		13.4
Fatalities**	490	414	175	641	136	268		271.2

Note: the trend is designed to indicate the performance for each category, therefore the scale has been adjusted for each category and cannot be compared with the other trend lines. The red dot(s) correspond to the highest value(s) and the blue dot(s) to the lowest one(s) during the period.

Runway accidents in principle survivable given the proper mitigations

Runway Safety NEXGEN:



A **cost-benefit** driven system aimed at reaching the **ALARP** level of safety.

		Severity				
		Negligible (1)	Marginal (2)	Moderate (3)	Critical (4)	Catastrophic (5)
Probability	Almost certain (5)	Medium (3)	High (10)	High (15)	High (20)	High (25)
	Fairly likely (4)	Low (4)	Medium (8)	High (12)	High (16)	High (20)
	Possible (3)	Low (3)	Medium (6)	Medium (9)	High (12)	High (15)
	Unlikely (2)	Low (2)	Low (4)	Medium (6)	Medium (8)	High (10)
	Rare (1)	Low (1)	Low (2)	Low (3)	Low (4)	Medium (5)



Cost-Benefit:

- Prioritize (Inc, Exc, Ur, Or)
- Adoptive mitigations
- Prevention AND Severity

$$\text{Risk} = f [\text{Probability, Severity}]$$

- Prediction of future costs
- Estimation runway accident likelihood (H2020)
- Estimation runway accident costs (Safe-Runway GmbH)
- Costs / Benefit of mitigation(s) (Manufacturers)

If the mitigation costs grossly outweigh the future accident costs, the risk is acceptable.

If not: Implement cost-effective mitigation(s).



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Overrun mitigations Aerodrome

Inadequate RESA/strip



Adequate RESA / strip



Alternatives for RESA





THE CHALLENGE and Recommendations

2015-2017 Cost distribution

Aerodrome operator 2%

Why would an aerodrome operator invest in risk reducing full RESA, runway strip or alternative if the aircraft operator would have the cost savings?

Solve **disproportional problem** aerodromes / aircraft operators (Mutual Fund?)

② Evolve to **Runway Safety NextGen**: ALARP by COST-BENEFIT

- ① Likelihood prediction (ACRP & H2020)
- ② Cost estimation (safe-Runway GmbH)
- ③ Mitigation(s) Costs-Benefit (Manufacturers)

③ Address **RISK**, thus costs

- a) **Runway Veer-offs**
- b) **Regional aerodromes**
- c) **GEN and CAT operations**

④ Adequate **oversight & Train staff**: excursions



Questions / Discussion



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A safe runway is THE core business

TRAINING and CONSULTANCY

Row Labels	costs \$ PPC	# events
Afghanistan	236.937.129 \$	3
Alaska	35.594.466 \$	17
Algeria	10.093.490 \$	2
Angola	76.342.878 \$	4
Anguilla	656.736 \$	1
Antigua and Barbuda	2.777.645 \$	2
Argentina	267.676.844 \$	10
Armenia and Georgia	14.129.893 \$	1
Aruba / Netherlands Ant	4.135.407 \$	4
Australia	223.704.807 \$	68
Austria	40.384.783 \$	7
Bahamas	23.188.777 \$	5
Bahrain	82.538.507 \$	1
Bangladesh	23.373.199 \$	4
Belarus, Latvia and Lithu	80.702.316 \$	2
Belgium	56.734.683 \$	4
Bolivia	62.546.685 \$	8
Brazil	178.746.094 \$	28
Brunei	66.725.429 \$	4
Bulgaria	76.209.263 \$	1
Canada	517.942.876 \$	60
Canary Islands	147.200.776 \$	6
Cayman Islands	352.768 \$	1
Chad	71.350.987 \$	1
Chile	2.638.413 \$	7
China	411.335.893 \$	10
Colombia	144.360.678 \$	22
Costa Rica	19.827.554 \$	12
Croatia	11.214.160 \$	3
Cyprus	1.634.712 \$	1
Czech Republic	111.940 \$	1
Denmark	6.861.203 \$	6
Dominica	7.912.359 \$	1
Dominican Republic	82.146.356 \$	2
Ecuador	41.885.360 \$	5
Ethiopia	13.659.867 \$	1
Finland	28.340.693 \$	6
France	392.797.077 \$	40
French Antilles	67.117.672 \$	2
Germany - Civil	283.565.483 \$	61
Germany - Military	2.546.816 \$	1
Ghana	43.686.742 \$	2
Greece	13.683.737 \$	1
Guam	124.832.826 \$	3
Guatemala	14.378.593 \$	4
Guinea	10.058.709 \$	1
Guyana	11.976.396 \$	6
Hawaii	24.787.968 \$	7
Honduras	4.351.532 \$	3
Hongkong	28.559.245 \$	2

51 Iceland	1.763.418 \$	1
52 India - East	767.160 \$	2
53 India - North	143.692.912 \$	6
54 India - South	6.582.434 \$	3
55 India - West	468.755.319 \$	12
56 Indonesia	822.134.683 \$	45
57 Iran	228.405.371 \$	10
58 Iraq	11.086.991 \$	1
59 Ireland	621.676 \$	1
60 Israel	19.016.651 \$	2
61 Italy	213.145.824 \$	27
62 Japan	1.294.134.935 \$	43
63 Jordan	86.599.684 \$	3
64 Kazakhstan and Kyrgyzst	36.407.888 \$	2
65 Kenya	36.563.269 \$	7
66 Korea	266.132.971 \$	2
67 Kosovo	22.076.217 \$	1
68 Laos	27.419.113 \$	1
69 Latvia	23.047.525 \$	3
70 Lithuania	223.500 \$	2
71 Luxembourg	1.706.808 \$	1
72 Madagascar	55.968.791 \$	5
73 Malawi	1.152 \$	1
74 Malaysia	75.279.244 \$	6
75 Maldives	37.603.402 \$	4
76 Mali	3.256.795 \$	1
77 Malta	4.654.486 \$	4
78 Mauritania	1.427.697 \$	1
79 Mexico	143.174.481 \$	13
80 Moldova	128.670 \$	1
81 Mongolia	520.997 \$	1
82 Morocco	287.023 \$	1
83 Mozambique	4.836.680 \$	1
84 Myanmar	11.415.118 \$	2
85 Namibia	1.149.122 \$	1
86 Nepal	463.326.503 \$	7
87 Netherlands	116.460.680 \$	21
88 New Zealand	25.938.066 \$	24
89 Nigeria	3.045.179 \$	1
90 Norway	54.221.218 \$	2
91 Okinawa Islands	98.345.591 \$	6
92 Pakistan	82.425.294 \$	4
93 Panama	20.495.182 \$	4
94 Papua New Guinea	39.536.361 \$	1
95 Paraguay	20.266.700 \$	4
96 Peru	152.560.807 \$	10
97 Philippines	213.862.483 \$	10
98 Poland	104.404.142 \$	7
99 Portugal	166.905.629 \$	5
100 Puerto Rico	11.587.182 \$	4

101 Romania	18.693.845 \$	5
102 Russian Federation	896.963.276 \$	31
103 Sao Tome	13.327.908 \$	1
104 Saudi Arabia	1.652.557 \$	2
105 Senegal	455.809 \$	2
106 Singapore	147.955 \$	1
107 Slovakia	20.556.785 \$	3
108 Somalia	16.286.757 \$	2
109 South Africa	188.827.193 \$	14
110 Spain	466.051.646 \$	16
111 Sri Lanka	2.646.685 \$	1
112 St. Lucia	1.824.706 \$	1
113 Sudan	51.969.610 \$	9
114 Sweden	18.376.926 \$	8
115 Switzerland	13.401.847 \$	14
116 Syria	45.504.377 \$	1
117 Taiwan	72.612.814 \$	4
118 Tanzania	28.097.838 \$	3
119 Thailand	171.047.898 \$	2
120 Turkey	236.248.918 \$	6
121 Uganda	52.819.294 \$	1
122 Ukraine and Moldova	50.058.015 \$	4
123 United Arab Emirates	382.010.050 \$	4
124 United Kingdom	266.188.606 \$	66
125 United States	3.690.919.647 \$	694
126 United States - small	426.832.840 \$	240
127 Venezuela	60.731.493 \$	16
128 Zaire	116.352.434 \$	7
129 Zambia	4.615.811 \$	1
130 Zimbabwe	1.055.449 \$	1
131		
Grand Total	17.033.858.821 \$	1942



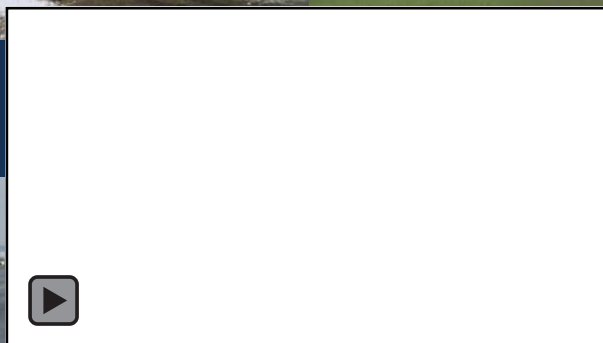
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Veer-off mitigations success



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Runway strip successful: Risk low





www.Safe-Runway.com

Veer-off mitigations DONT's



Inadequate runway strip: Risk High

Ranking

per estimated runway
occurrence **COSTS**

High-Low

All costs estimates are in absolute size, corrected for purchasing power and based on open source data.

1	United States	3.690.919.647 \$
2	Japan	1.294.134.935 \$
3	Russian Federation	896.963.276 \$
4	Indonesia	822.134.683 \$
5	Canada	517.942.876 \$
6	India - West	468.755.319 \$
7	Spain	466.051.646 \$
8	Nepal	463.326.503 \$
9	United States - small	426.832.840 \$
10	China	411.335.893 \$
11	France	392.797.077 \$
12	United Arab Emirates	382.010.050 \$
13	Germany - Civil	283.565.483 \$
14	Argentina	267.676.844 \$
15	United Kingdom	266.188.606 \$
16	Korea	266.132.971 \$
17	Afghanistan	236.937.129 \$
18	Turkey	236.248.918 \$
19	Iran	228.405.371 \$
20	Australia	223.704.807 \$
21	Philippines	213.862.483 \$
22	Italy	213.145.824 \$
23	South Africa	188.827.193 \$
24	Brazil	178.746.094 \$
25	Thailand	171.047.898 \$
26	Portugal	166.905.629 \$
27	Peru	152.560.807 \$
28	Canary Islands	147.200.776 \$
29	Colombia	144.360.678 \$
30	India - North	143.692.912 \$
31	Mexico	143.174.481 \$
32	Guam	124.832.826 \$
33	Netherlands	116.460.680 \$
34	Zaire	116.352.434 \$
35	Poland	104.404.142 \$
36	Okinawa Islands	98.345.591 \$
37	Jordan	86.599.684 \$
38	Bahrain	82.538.907 \$
39	Pakistan	82.425.294 \$
40	Dominican Republic	82.146.356 \$
41	Belarus, Latvia and Lith	80.702.316 \$
42	Angola	76.342.878 \$
43	Bulgaria	76.209.263 \$
44	Malaysia	75.279.244 \$
45	Taiwan	72.612.814 \$
46	Chad	71.350.987 \$
47	French Antilles	67.117.672 \$
48	Brunei	66.725.429 \$
49	Bolivia	62.546.685 \$
50	Venezuela	60.731.493 \$

51	Belgium	56.734.683 \$
52	Madagascar	55.968.791 \$
53	Norway	54.221.218 \$
54	Uganda	52.819.294 \$
55	Sudan	51.969.610 \$
56	Ukraine and Moldova	50.058.015 \$
57	Syria	45.504.377 \$
58	Ghana	43.686.742 \$
59	Ecuador	41.885.360 \$
60	Austria	40.384.783 \$
61	Papua New Guinea	39.536.361 \$
62	Maldives	37.603.402 \$
63	Kenya	36.563.269 \$
64	Kazakhstan and Kyrgyz	36.407.888 \$
65	Alaska	35.594.466 \$
66	Hongkong	28.559.245 \$
67	Finland	28.340.693 \$
68	Tanzania	28.097.838 \$
69	Laos	27.419.113 \$
70	New Zealand	25.938.066 \$
71	Hawaii	24.787.968 \$
72	Bangladesh	23.373.199 \$
73	Bahamas	23.188.772 \$
74	Latvia	23.047.525 \$
75	Kosovo	22.076.217 \$
76	Slovakia	20.556.785 \$
77	Panama	20.495.182 \$
78	Paraguay	20.266.700 \$
79	Costa Rica	19.827.554 \$
80	Israel	19.016.651 \$
81	Romania	18.693.845 \$
82	Sweden	18.326.926 \$
83	Somalia	16.286.757 \$
84	Guatemala	14.378.593 \$
85	Armenia and Georgia	14.129.893 \$
86	Greece	13.683.737 \$
87	Ethiopia	13.659.862 \$
88	Switzerland	13.401.847 \$
89	Sao Tome	13.327.908 \$
90	Guyana	11.976.396 \$
91	Puerto Rico	11.587.182 \$
92	Myanmar	11.415.118 \$
93	Croatia	11.214.160 \$
94	Iraq	11.086.991 \$
95	Algeria	10.093.490 \$
96	Guinea	10.058.709 \$
97	Dominica	7.912.359 \$
98	Denmark	6.861.203 \$
99	India - South	6.582.434 \$
100	Mozambique	4.836.680 \$

101	Malta	4.654.486 \$
102	Zambia	4.615.811 \$
103	Honduras	4.351.532 \$
104	Aruba / Netherlands Ar	4.135.407 \$
105	Mali	3.256.795 \$
106	Nigeria	3.045.179 \$
107	Antigua and Barbuda	2.727.645 \$
108	Sri Lanka	2.646.685 \$
109	Chile	2.638.413 \$
110	Germany - Military	2.546.816 \$
111	St. Lucia	1.824.706 \$
112	Iceland	1.763.418 \$
113	Luxembourg	1.706.808 \$
114	Saudi Arabia	1.652.557 \$
115	Cyprus	1.634.712 \$
116	Mauritania	1.427.697 \$
117	Namibia	1.149.122 \$
118	Zimbabwe	1.055.449 \$
119	India - East	767.160 \$
120	Anguilla	656.736 \$
121	Ireland	621.676 \$
122	Mongolia	520.997 \$
123	Senegal	455.809 \$
124	Cayman Islands	352.768 \$
125	Morocco	287.023 \$
126	Lithuania	223.500 \$
127	Singapore	147.955 \$
128	Moldova	120.670 \$
129	Czech Republic	111.940 \$
130	Malawi	1.152 \$



Source: Safe-Runway GmbH

Ranking

per **NUMBER** of reported runway occurrences.

High-Low

All costs estimates are in absolute size, corrected for purchasing power and based on open source data.

1	United States	694
2	United States - small	240
3	Australia	68
4	United Kingdom	66
5	Germany - Civil	61
6	Canada	60
7	Indonesia	45
8	Japan	43
9	France	40
10	Russian Federation	31
11	Brazil	28
12	Italy	27
13	New Zealand	24
14	Colombia	22
15	Netherlands	21
16	Alaska	17
17	Spain	16
18	Venezuela	16
19	South Africa	14
20	Switzerland	14
21	Mexico	13
22	India - West	12
23	Costa Rica	12
24	China	10
25	Argentina	10
26	Iran	10
27	Philippines	10
28	Peru	10
29	Sudan	9
30	Bolivia	8
31	Sweden	8
32	Nepal	7
33	Zaire	7
34	Poland	7
35	Austria	7
36	Kenya	7
37	Hawaii	7
38	Chile	7
39	Turkey	6
40	Canary Islands	6
41	India - North	6
42	Okinawa Islands	6
43	Malaysia	6
44	Finland	6
45	Guyana	6
46	Denmark	6
47	Portugal	5
48	Madagascar	5
49	Equador	5
50	Bahamas	5

51	Romania	5
52	United Arab Emirates	4
53	Pakistan	4
54	Angola	4
55	Taiwan	4
56	Brunei	4
57	Belgium	4
58	Ukraine and Moldova	4
59	Maldives	4
60	Bangladesh	4
61	Panama	4
62	Paraguay	4
63	Guatemala	4
64	Puerto Rico	4
65	Malta	4
66	Aruba / Netherlands Ar	4
67	Afghanistan	3
68	Guam	3
69	Jordan	3
70	Tanzania	3
71	Latvia	3
72	Slovakia	3
73	Croatia	3
74	India - South	3
75	Honduras	3
76	Korea	2
77	Thailand	2
78	Dominican Republic	2
79	Belarus, Latvia and Lith	2
80	French Antilles	2
81	Norway	2
82	Ghana	2
83	Kazakhstan and Kyrgyz	2
84	Hongkong	2
85	Israel	2
86	Somalia	2
87	Myanmar	2
88	Algeria	2
89	Antigua and Barbuda	2
90	Saudi Arabia	2
91	India - East	2
92	Senegal	2
93	Lithuania	2
94	Bahrain	1
95	Bulgaria	1
96	Chad	1
97	Uganda	1
98	Syria	1
99	Papua New Guinea	1
100	Laos	1

101	Kosovo	1
102	Armenia and Georgia	1
103	Greece	1
104	Ethiopia	1
105	Sao Tome	1
106	Iraq	1
107	Guinea	1
108	Dominica	1
109	Mozambique	1
110	Zambia	1
111	Mali	1
112	Nigeria	1
113	Sri Lanka	1
114	Germany - Military	1
115	St. Lucia	1
116	Iceland	1
117	Luxembourg	1
118	Cyprus	1
119	Mauritania	1
120	Namibia	1
121	Zimbabwe	1
122	Anguilla	1
123	Ireland	1
124	Mongolia	1
125	Cayman Islands	1
126	Morocco	1
127	Singapore	1
128	Moldova	1
129	Czech Republic	1
130	Malawi	1



Source: Safe-Runway GmbH

Ranking

Average COSTS per runway EVENT

COSTS in \$

runway occurrences

High-Low

All costs estimates are in absolute size,
corrected for purchasing power and based
on open source data.

1	Korea	133.066.486 \$
2	United Arab Emirates	95.502.513 \$
3	Thailand	85.523.949 \$
4	Bahrain	82.538.907 \$
5	Afghanistan	78.979.043 \$
6	Bulgaria	76.209.263 \$
7	Chad	71.350.987 \$
8	Nepal	66.189.500 \$
9	Uganda	52.819.294 \$
10	Syria	45.504.377 \$
11	Guam	41.610.942 \$
12	China	41.133.589 \$
13	Dominican Republic	41.073.178 \$
14	Belarus, Latvia and Lithuania	40.351.158 \$
15	Papua New Guinea	39.536.361 \$
16	Turkey	39.374.820 \$
17	India - West	39.062.943 \$
18	French Antilles	33.558.836 \$
19	Portugal	33.381.126 \$
20	Japan	30.096.161 \$
21	Spain	29.128.228 \$
22	Russian Federation	28.934.299 \$
23	Jordan	28.866.561 \$
24	Laos	27.419.113 \$
25	Norway	27.110.609 \$
26	Argentina	26.767.684 \$
27	Canary Islands	24.533.463 \$
28	India - North	23.948.819 \$
29	Iran	22.840.537 \$
30	Kosovo	22.076.217 \$
31	Ghana	21.843.371 \$
32	Philippines	21.386.248 \$
33	Pakistan	20.606.324 \$
34	Angola	19.085.720 \$
35	Indonesia	18.269.660 \$
36	Kazakhstan and Kyrgyzst	18.203.944 \$
37	Taiwan	18.153.204 \$
38	Brunei	16.681.357 \$
39	Zaire	16.621.776 \$
40	Okinawa Islands	16.390.932 \$
41	Peru	15.256.081 \$
42	Poland	14.914.877 \$
43	Hongkong	14.279.623 \$
44	Belgium	14.183.671 \$
45	Armenia and Georgia	14.129.893 \$
46	Greece	13.683.737 \$
47	Ethiopia	13.659.862 \$
48	South Africa	13.487.657 \$
49	Sao Tome	13.327.908 \$
50	Malaysia	12.546.541 \$

51	Ukraine and Moldova	12.514.504 \$
52	Madagascar	11.193.758 \$
53	Iraq	11.086.991 \$
54	Mexico	11.013.422 \$
55	Guinea	10.058.709 \$
56	France	9.819.927 \$
57	Israel	9.508.326 \$
58	Maldives	9.400.851 \$
59	Tanzania	9.365.946 \$
60	Canada	8.632.381 \$
61	Ecuador	8.377.072 \$
62	Somalia	8.143.379 \$
63	Dominica	7.912.359 \$
64	Italy	7.894.290 \$
65	Bolivia	7.818.336 \$
66	Latvia	7.682.508 \$
67	Slovakia	6.852.262 \$
68	Colombia	6.561.849 \$
69	Brazil	6.383.789 \$
70	Bangladesh	5.843.300 \$
71	Sudan	5.774.401 \$
72	Austria	5.769.255 \$
73	Myanmar	5.707.559 \$
74	Netherlands	5.545.747 \$
75	United States	5.318.328 \$
76	Kenya	5.223.324 \$
77	Panama	5.123.796 \$
78	Paraguay	5.066.675 \$
79	Algeria	5.046.745 \$
80	Mozambique	4.836.680 \$
81	Finland	4.723.449 \$
82	Germany - Civil	4.648.614 \$
83	Bahamas	4.637.754 \$
84	Zambia	4.615.811 \$
85	United Kingdom	4.033.161 \$
86	Venezuela	3.795.718 \$
87	Romania	3.738.769 \$
88	Croatia	3.738.053 \$
89	Guatemala	3.594.648 \$
90	Hawaii	3.541.138 \$
91	Australia	3.289.777 \$
92	Mali	3.256.795 \$
93	Nigeria	3.045.179 \$
94	Puerto Rico	2.896.796 \$
95	Sri Lanka	2.646.685 \$
96	Germany - Military	2.546.816 \$
97	Sweden	2.290.866 \$
98	India - South	2.194.145 \$
99	Alaska	2.093.792 \$
100	Guyana	1.996.066 \$

St. Lucia	1.824.706 \$
United States - small	1.778.470 \$
Iceland	1.763.418 \$
Luxembourg	1.706.808 \$
Costa Rica	1.652.296 \$
Cyprus	1.634.712 \$
Honduras	1.450.511 \$
Mauritania	1.427.697 \$
Antigua and Barbuda	1.363.823 \$
Malta	1.163.622 \$
Namibia	1.149.122 \$
Denmark	1.143.534 \$
New Zealand	1.080.753 \$
Zimbabwe	1.055.449 \$
Aruba / Netherlands Ant	1.033.852 \$
Switzerland	957.275 \$
Saudi Arabia	826.279 \$
Anguilla	656.736 \$
Ireland	621.676 \$
Mongolia	520.997 \$
India - East	383.580 \$
Chile	376.916 \$
Cayman Islands	352.768 \$
Morocco	287.023 \$
Senegal	227.905 \$
Singapore	147.955 \$
Moldova	120.670 \$
Czech Republic	111.940 \$
Lithuania	111.750 \$
Malawi	1.152 \$



COUNTRIES

ALPHABETICAL

All costs estimates are in absolute size,
corrected for purchasing power and
based on open source data.

Row Labels	costs \$ PPC	# events
Afghanistan	236.937.129 \$	3
Alaska	35.594.466 \$	17
Algeria	10.093.490 \$	2
Angola	76.342.878 \$	4
Anguilla	656.736 \$	1
Antigua and Barbuda	2.727.645 \$	2
Argentina	267.676.844 \$	10
Armenia and Georgia	14.129.893 \$	1
Aruba / Netherlands Ant	4.135.407 \$	4
Australia	223.704.807 \$	68
Austria	40.384.783 \$	7
Bahamas	23.188.772 \$	5
Bahrain	82.538.907 \$	1
Bangladesh	23.373.199 \$	4
Belarus, Latvia and Lithu	80.702.316 \$	2
Belgium	56.734.683 \$	4
Bolivia	62.546.685 \$	8
Brazil	178.746.094 \$	28
Brunei	66.725.429 \$	4
Bulgaria	76.209.263 \$	1
Canada	517.942.876 \$	60
Canary Islands	147.200.776 \$	6
Cayman Islands	352.768 \$	1
Chad	71.350.987 \$	1
Chile	2.638.413 \$	7
China	411.335.893 \$	10
Colombia	144.360.678 \$	22
Costa Rica	19.827.554 \$	12
Croatia	11.214.160 \$	3
Cyprus	1.634.712 \$	1
Czech Republic	111.940 \$	1
Denmark	6.861.203 \$	6
Dominica	7.912.359 \$	1
Dominican Republic	82.146.356 \$	2
Ecuador	41.885.360 \$	5
Ethiopia	13.659.867 \$	1
Finland	28.340.693 \$	6
France	392.797.077 \$	40
French Antilles	67.117.672 \$	2
Germany - Civil	283.565.483 \$	61
Germany - Military	2.546.816 \$	1
Ghana	43.686.742 \$	2
Greece	13.683.737 \$	1
Guam	124.832.826 \$	3
Guatemala	14.378.593 \$	4
Guinea	10.058.709 \$	1
Guyana	11.976.396 \$	6
Hawaii	24.787.968 \$	7
Honduras	4.351.532 \$	3
Hongkong	28.559.245 \$	2

51 Iceland	1.763.418 \$	1
52 India - East	767.160 \$	2
53 India - North	143.692.912 \$	6
54 India - South	6.582.434 \$	3
55 India - West	468.755.319 \$	12
56 Indonesia	822.134.683 \$	45
57 Iran	228.405.371 \$	10
58 Iraq	11.086.991 \$	1
59 Ireland	621.676 \$	1
60 Israel	19.016.651 \$	2
61 Italy	213.145.824 \$	27
62 Japan	1.294.134.935 \$	43
63 Jordan	86.599.684 \$	3
64 Kazakhstan and Kyrgyzst	36.407.888 \$	2
65 Kenya	36.563.269 \$	7
66 Korea	266.132.971 \$	2
67 Kosovo	22.076.217 \$	1
68 Laos	27.419.113 \$	1
69 Latvia	23.047.525 \$	3
70 Lithuania	223.500 \$	2
71 Luxembourg	1.706.808 \$	1
72 Madagascar	55.968.791 \$	5
73 Malawi	1.152 \$	1
74 Malaysia	75.279.244 \$	6
75 Maldives	37.603.402 \$	4
76 Mali	3.256.795 \$	1
77 Malta	4.654.486 \$	4
78 Mauritania	1.427.697 \$	1
79 Mexico	143.174.481 \$	13
80 Moldova	120.670 \$	1
81 Mongolia	520.997 \$	1
82 Morocco	287.023 \$	1
83 Mozambique	4.836.680 \$	1
84 Myanmar	11.415.118 \$	2
85 Namibia	1.149.122 \$	1
86 Nepal	463.326.503 \$	7
87 Netherlands	116.460.680 \$	21
88 New Zealand	25.938.066 \$	24
89 Nigeria	3.045.179 \$	1
90 Norway	54.221.218 \$	2
91 Okinawa Islands	98.345.591 \$	6
92 Pakistan	82.425.294 \$	4
93 Panama	20.495.182 \$	4
94 Papua New Guinea	39.536.361 \$	1
95 Paraguay	20.266.700 \$	4
96 Peru	152.560.807 \$	10
97 Philippines	213.862.483 \$	10
98 Poland	104.404.142 \$	7
99 Portugal	166.905.629 \$	5
100 Puerto Rico	11.587.182 \$	4

101 Romania	18.693.845 \$	5
102 Russian Federation	896.963.276 \$	31
103 Sao Tome	13.327.908 \$	1
104 Saudi Arabia	1.652.557 \$	2
105 Senegal	455.809 \$	2
106 Singapore	147.955 \$	1
107 Slovakia	20.556.785 \$	3
108 Somalia	16.286.757 \$	2
109 South Africa	188.827.193 \$	14
110 Spain	466.051.646 \$	16
111 Sri Lanka	2.646.685 \$	1
112 St. Lucia	1.874.706 \$	1
113 Sudan	51.969.610 \$	9
114 Sweden	18.326.926 \$	8
115 Switzerland	13.401.847 \$	14
116 Syria	45.504.377 \$	1
117 Taiwan	72.612.814 \$	4
118 Tanzania	28.097.838 \$	3
119 Thailand	171.047.898 \$	2
120 Turkey	236.748.918 \$	6
121 Uganda	52.819.294 \$	1
122 Ukraine and Moldova	50.058.015 \$	4
123 United Arab Emirates	382.010.050 \$	4
124 United Kingdom	266.188.606 \$	66
125 United States	3.690.919.647 \$	694
126 United States small	426.832.840 \$	240
127 Venezuela	60.731.493 \$	16
128 Zaire	116.352.434 \$	7
129 Zambia	4.615.811 \$	1
130 Zimbabwe	1.055.449 \$	1
131		
Grand Total	17.033.858.821 \$	1942

