Birdstrike probability calculation

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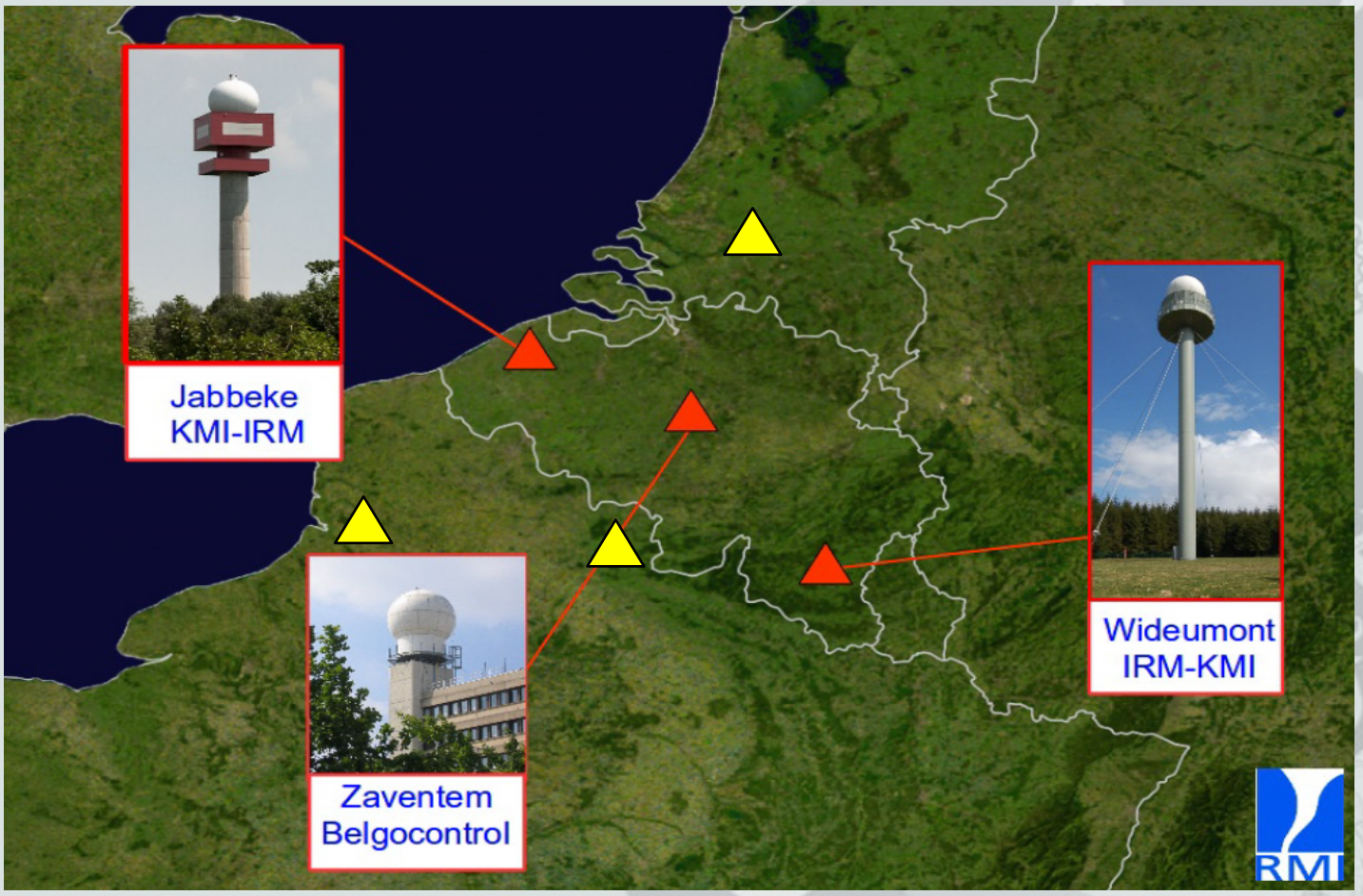
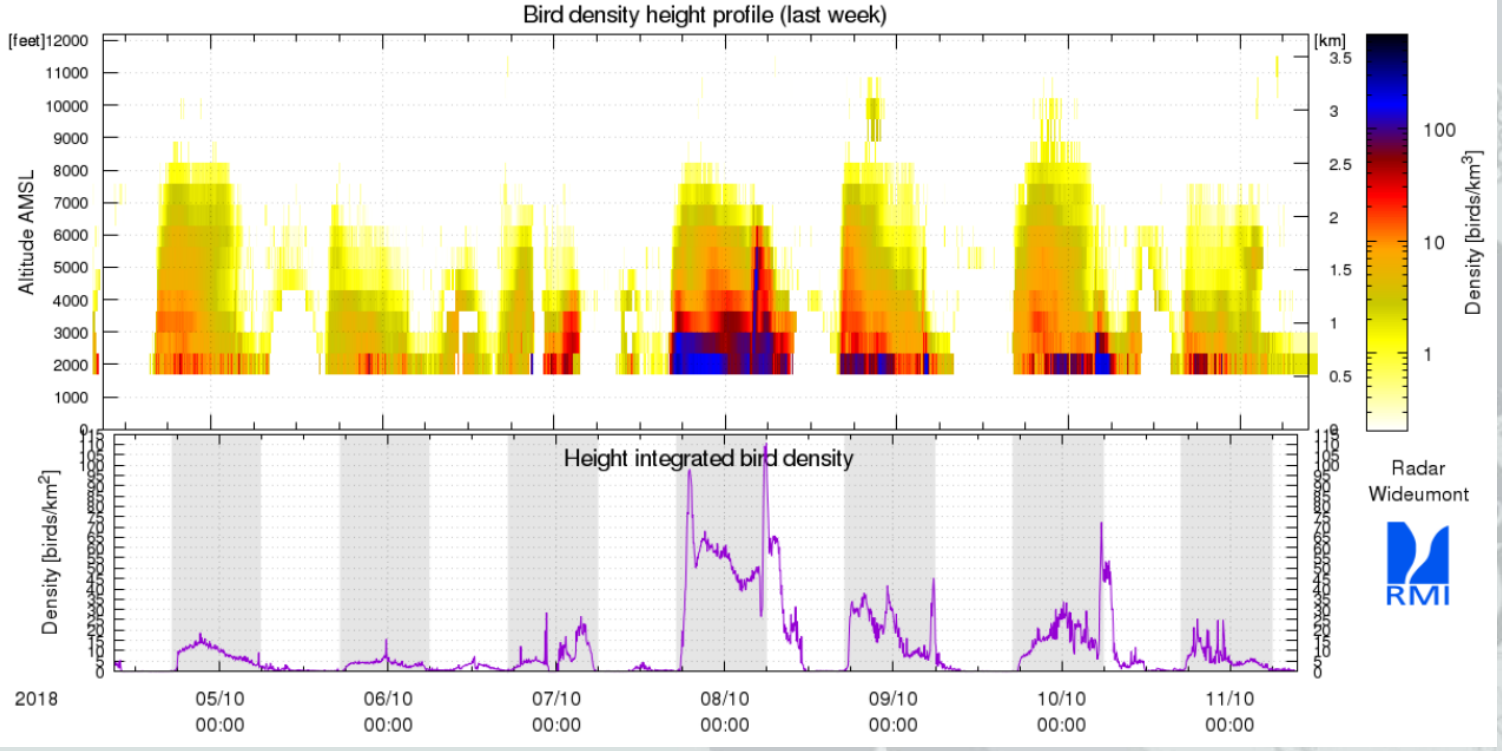
Weather radar

3 BE radars used: Coast/Center/Ardennes area



Weather radar

Bird intensity determination based on real-time data and graphs analysis



Birdstrike probability

Question: birdstrike probability?

- Aircraft flying a certain speed
- 1 hour
- Airspace populated by given bird density

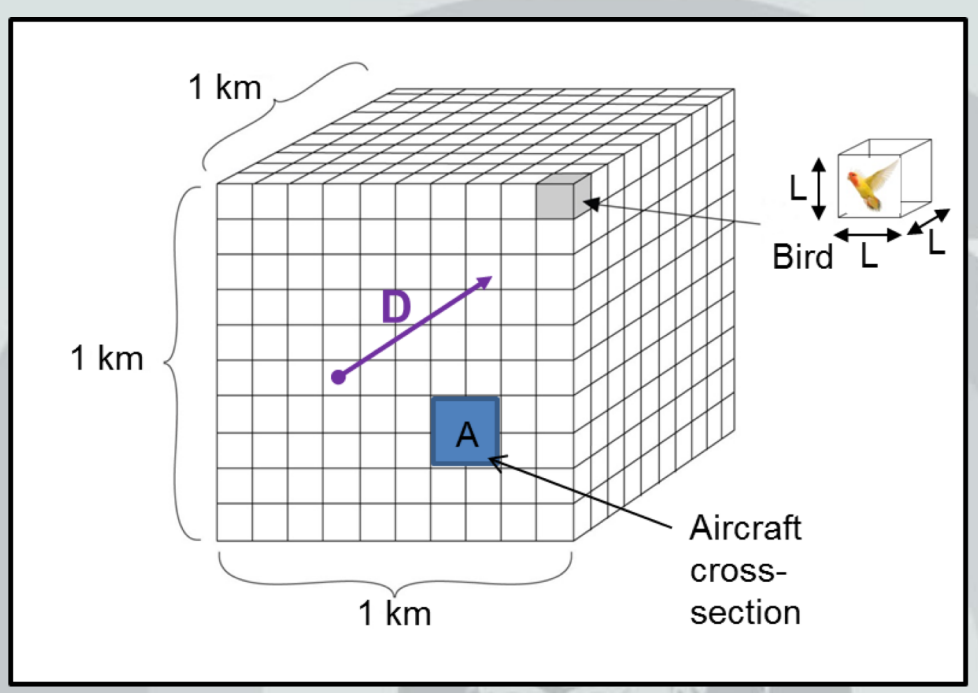
BIRDTAM

- Generated based on probability
- Mitigation procedures / flight restrictions
- Decrease risk -> acceptable/accepted level

Model

Given data:

- Cube of reference : 1 km³
- Aircraft frontal cross section (m²)
- Distance travelled by the aircraft
- Number of birds (birds / km³)
- L = size of the bird (cm)



Assumptions:

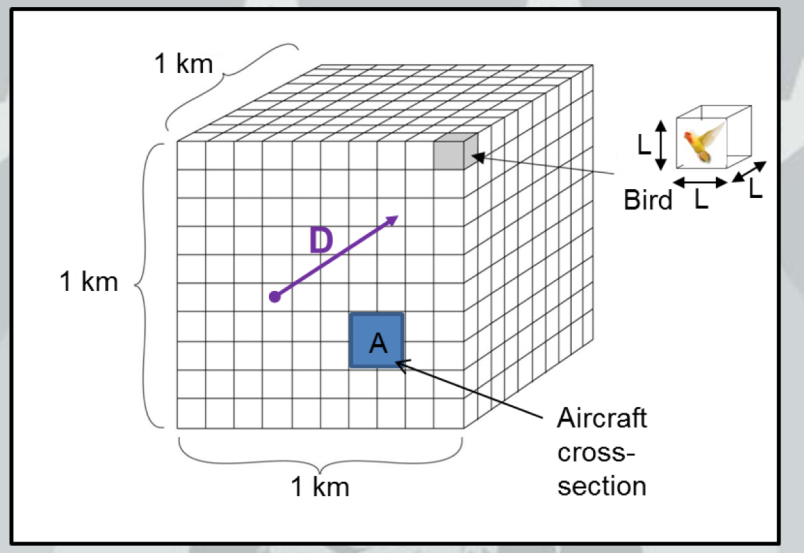
- Birds uniformly spread in the cube
- Speed of birds considered as nil

Model

Step 1: divide reference cube in sub-cubes of length L

Step 2: determine number of crossed sub-cubes for distance “D” -> calculate probability of entering occupied sub-cube

Step 3: express the A/C cross section as a number of cross-sections of a sub-cube

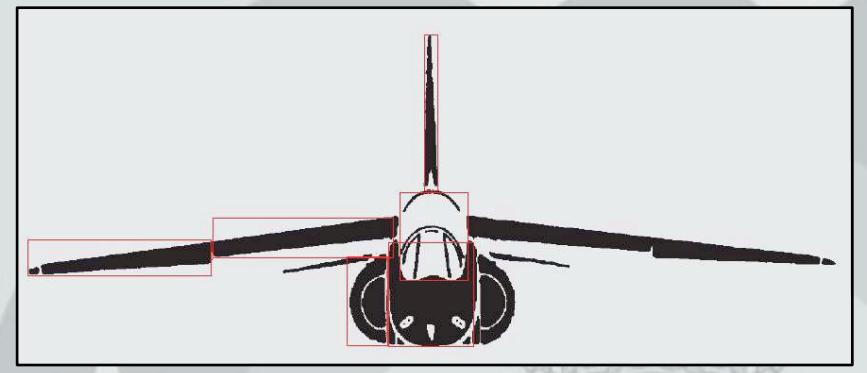


$$P(birdstrike) = N.L^2.D\,\frac{1}{10^{10}}\,.\frac{A}{L^2}\,.10^4 \Rightarrow N.D.A\,.\frac{1}{10^6}$$

Model

Example:

- A : 10 m²
- D : 1 km
- N: 500 birds / km³



$$P(birdstrike) = N.D.A.\frac{1}{10^6}$$

$$= 500 \,.\, 1 \,.\, 10 \,.\, \frac{1}{10^6}$$

$$= 0{,}005\ (0{,}5\%)$$

Model

Step 4: Calculation for longer distances + probability “for the next hour”

- Birds uniformly spread -> *P(birdstrike)* same in each 1 km³ cube
- Crossing more reference cubes ≠ adding *P(birdstrike)*
- Calculate probability of a single bird strike through total distance

$$Pn\ km(birdstrike) = Pn{-}1\ km(birdstrike) + (1 - Pn{-}1\ km(birdstrike)).\ P1km(birdstrike)$$

Birdstrike probability

Excel tool

Example:

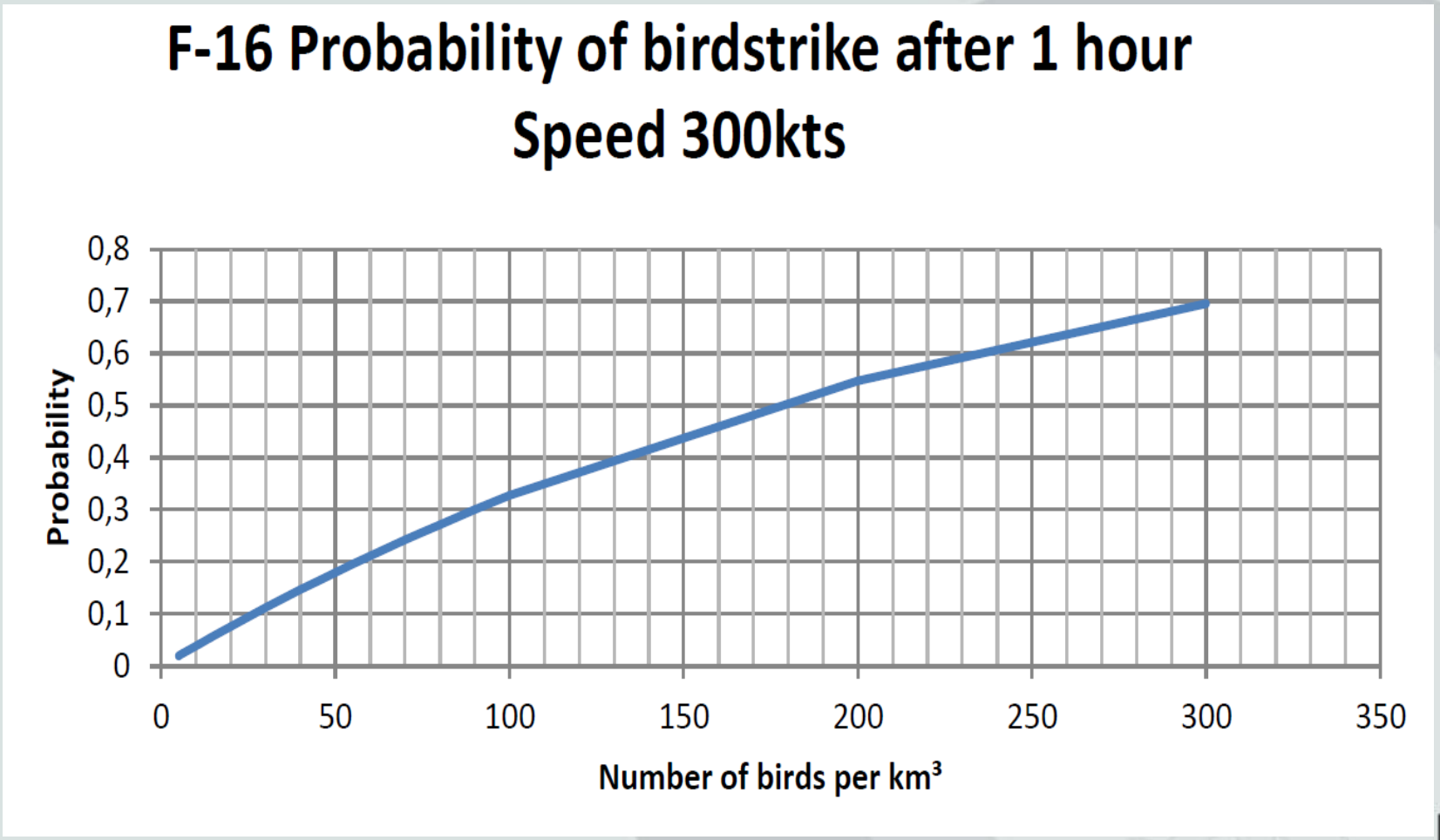
- A : 6,6 m² (F16)
- N: 200 birds / km³
- Speed: 600 km/h

-> P(birdstrike) = 0,5473 = **54% after one hour**

N:	Number of birds per Km³	200	V:	Aircraft speed (km/h)	600
D:	Distance (km)	1			
A:	Aircraft cross section (m²)	6,6		Probability of birdstrike after 1 hour:	**0,5473**

P(birdstrike) = N*D*A/10^6

Result

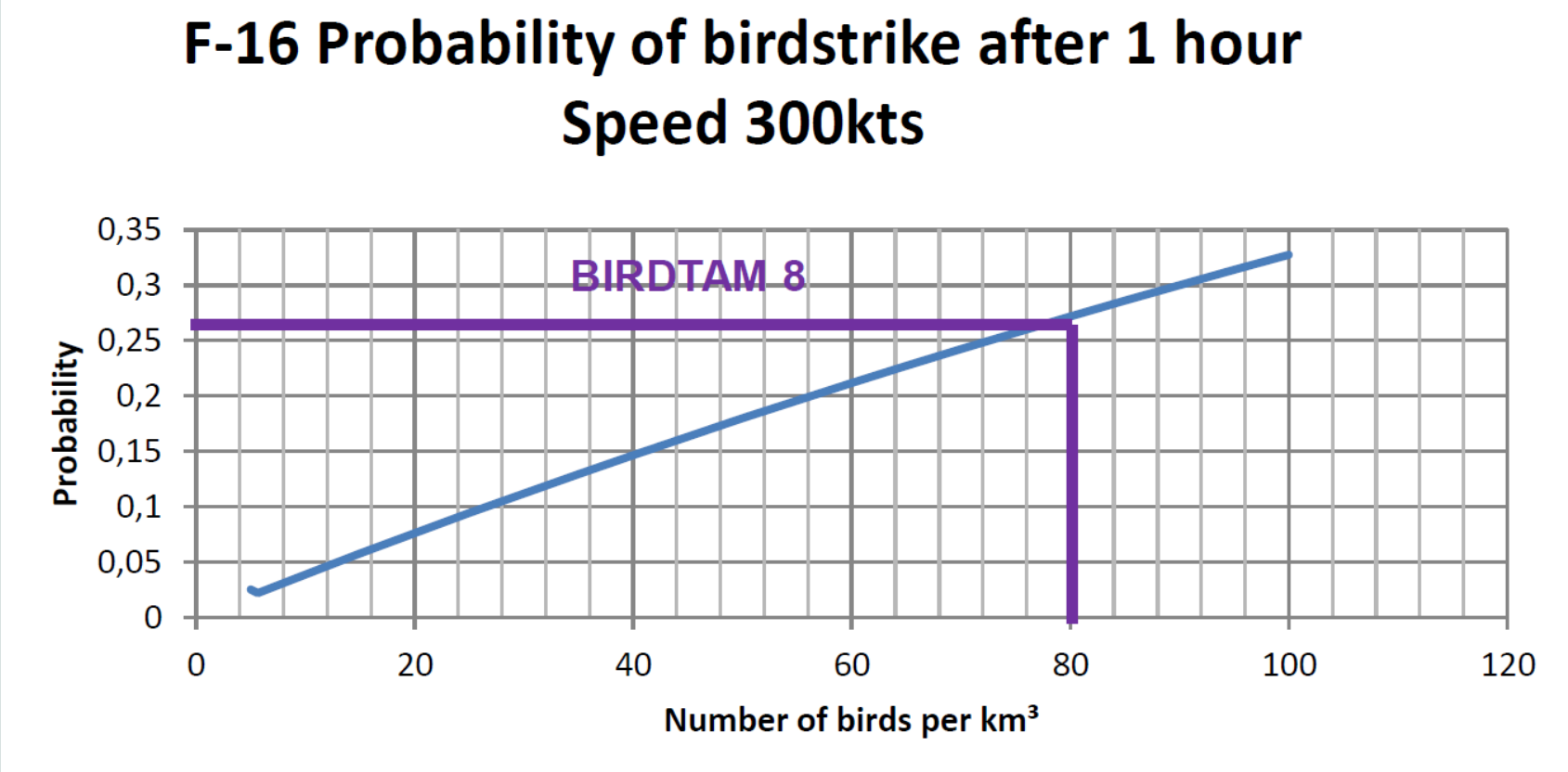

F-16 Probability of birdstrike after 1 hour
Speed 300kts
Probability
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
0
50
100
150
200
250
300
350
Number of birds per km³

BIRDTAM

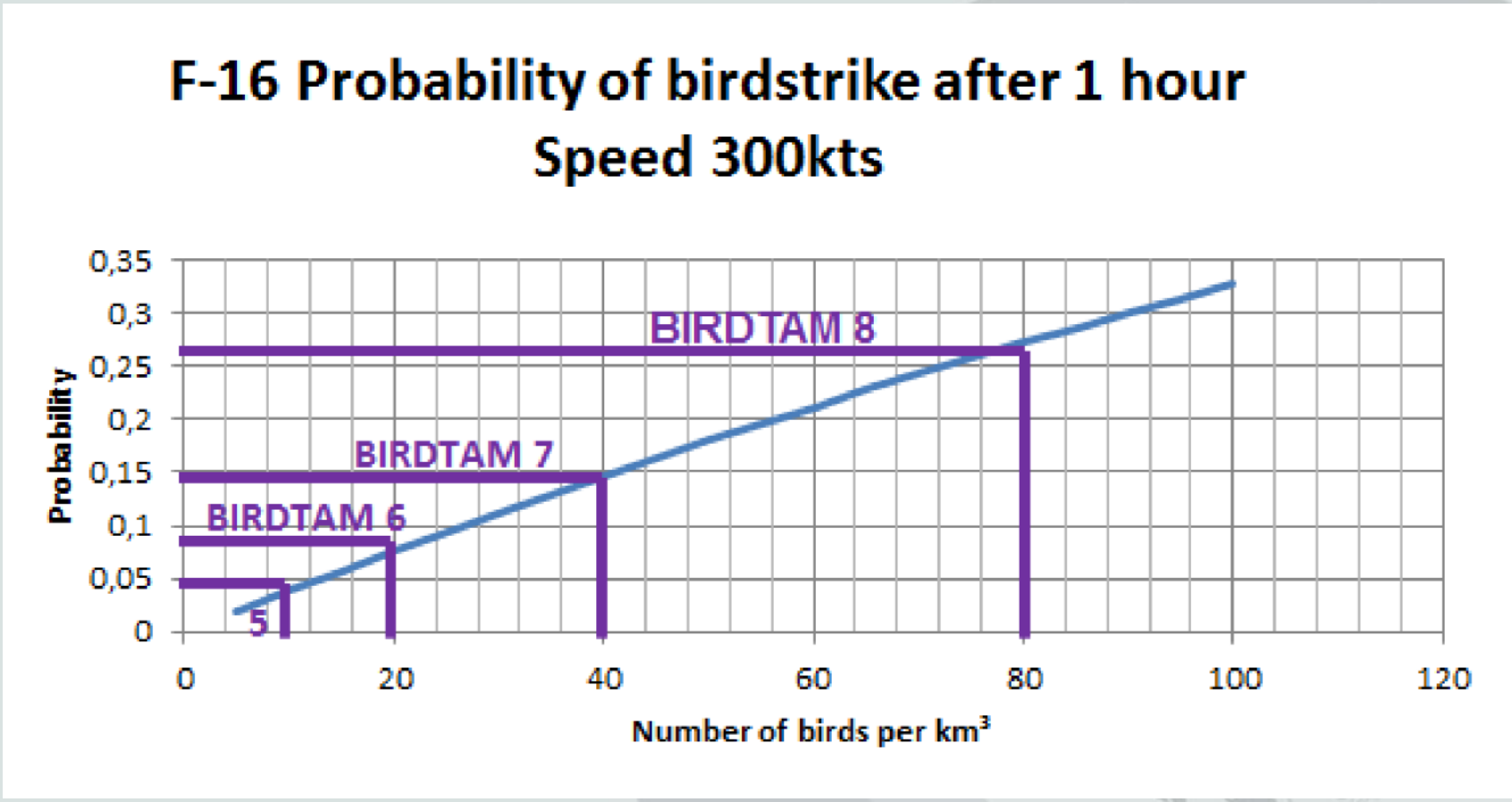
- STANAG 3879 - Wildlife strike prevention

Intensity	Bird strike Risk
0	Nil
1	Extremely small
2	Very small
3	Small
4	Fairly small
5	Fairly great
6	Great
7	Very great
8	Extremely great

BIRDTAM level determination



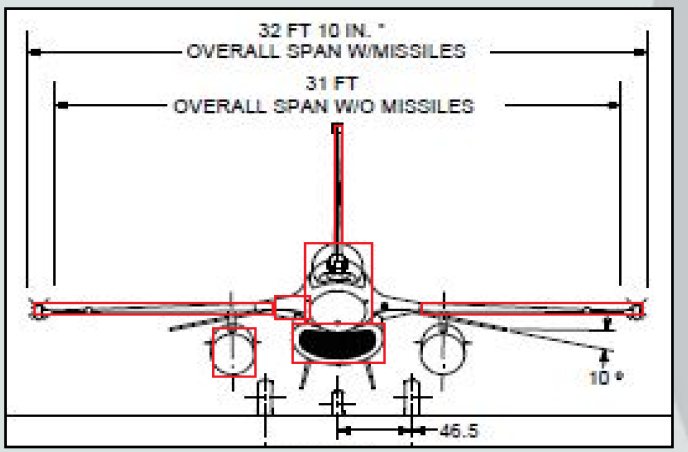
BIRDTAM level determination



BIRDTAM level determination

F-16 Probability of birdstrike after 1 hour Speed 300kts

BIRDTAM	Bird Strike Probability Definition	Number of birds per km³	Bird Strike Probability
5	Fairly great	10	3,6%
6	Great	20	7,0%
7	Very great	40	13,6%
8	Extremely great	80	25,4%

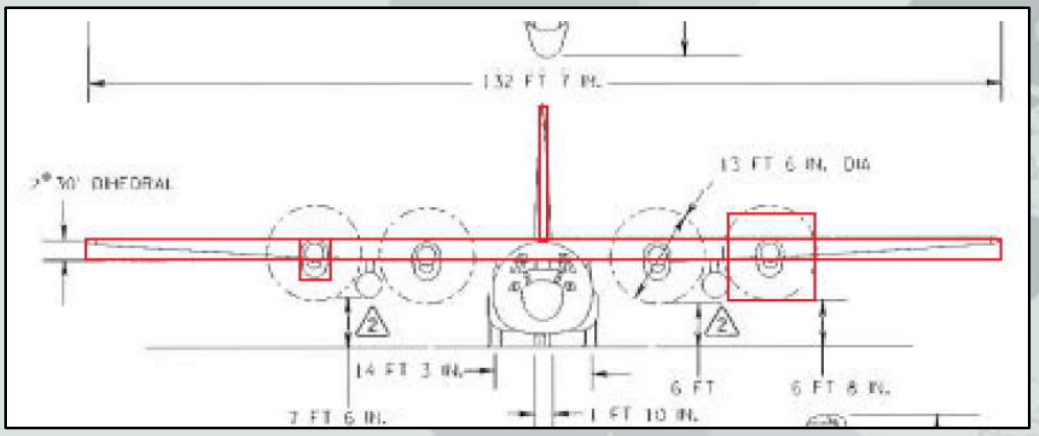


- Multiple aircraft
≠
- Longer period

BIRDTAM level determination

C-130 Probability of birdstrike after 1 hour Speed 250kts

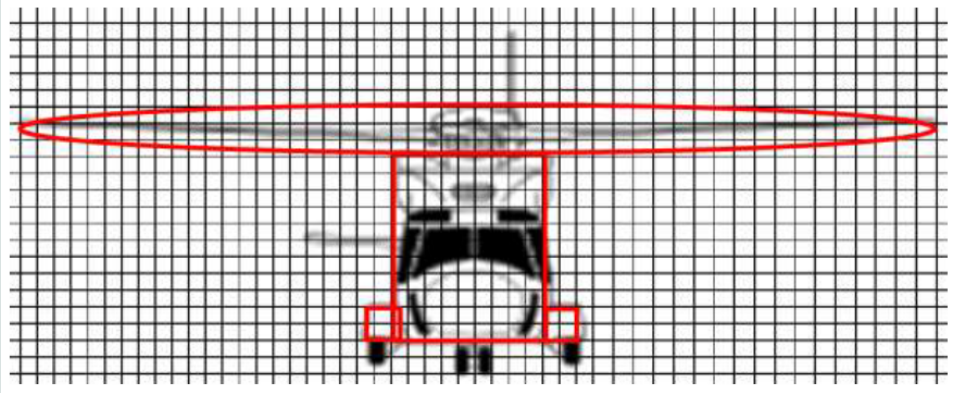
BIRDTAM	Bird Strike Probability Definition	Number of birds per km³	Bird Strike Probability
5	Fairly great	10	24,9%
6	Great	20	43,7%
7	Very great	40	68,3%
8	Extremely great	80	90,0%



BIRDTAM level determination

NH-90 Probability of birdstrike after 1 hour Speed 120kts

BIRDTAM	Bird Strike Probability Definition	Number of birds per km³	Bird Strike Probability
5	Fairly great	10	5,4%
6	Great	20	10,4%
7	Very great	40	19,8%
8	Extremely great	80	35,7%



Flying limitations

BIRDTAM > 5 ⏩ Ops influences

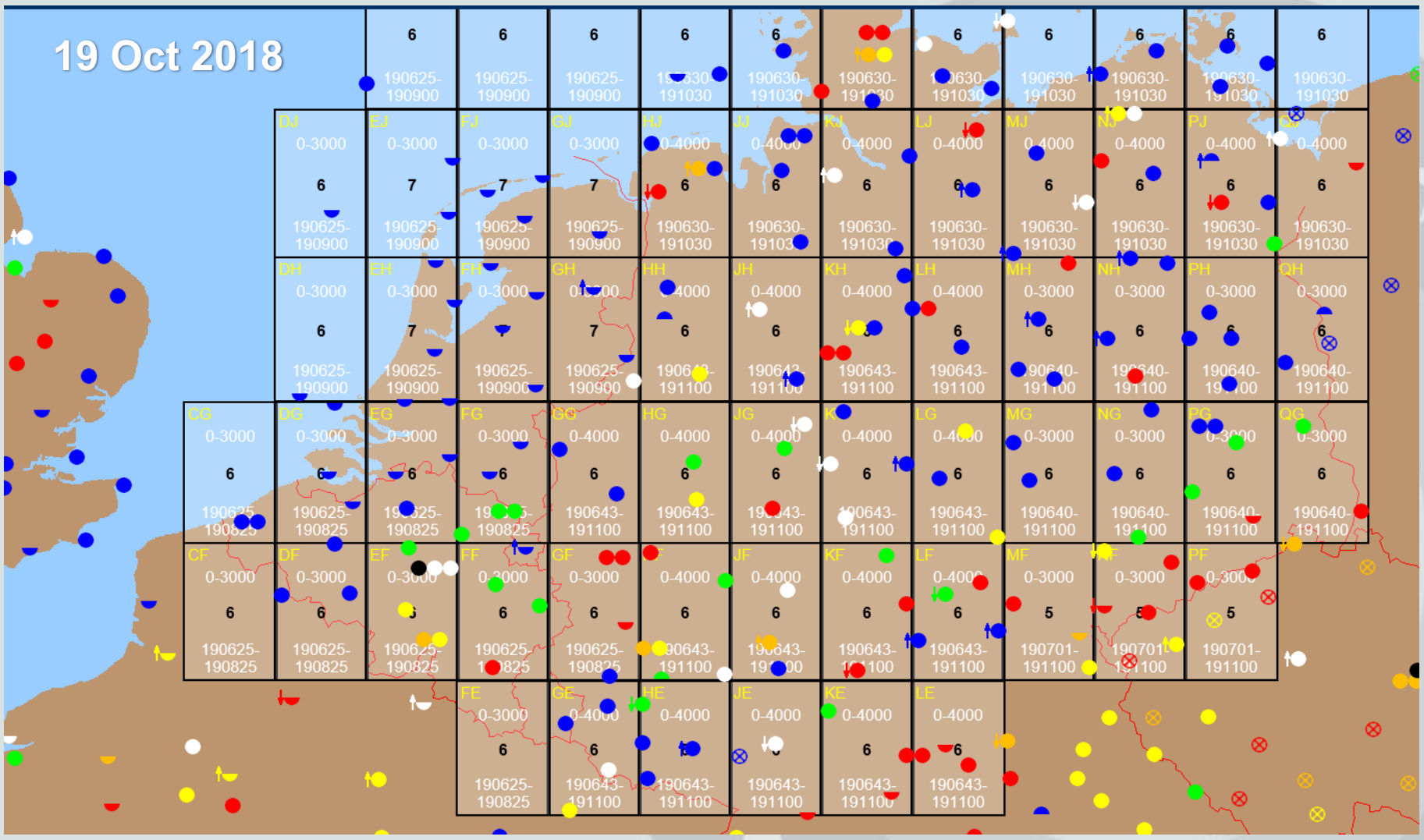
Local Bird Intensity (LBI) Matrix			
BIRDTAM / BCU Obs	<5	5-7	8
High	H	H	H
Medium	M	M	H
Low	L	M-	M
Not available	L	M	H

Combining (BCU obs) & BIRDTAM
L - M – H
collision probability

Operations		Fighter Aircraft F-16
Applicable to Enroute / OPS Area BIRDTAM - GeorefSquare Matrix	< 5	• Normal Ops
	5-8	• Fly at least 1000 Ft above or below layer concerned by the BIRDTAM • No crossing of the BIRDATM layer except in emergency
Applicable to Departure / Recovery / Local patterns LBI	L LBI not available and BIRDTAM < 5	• Normal Ops.
	M- Not applicable if LBI not available	• High - no formation – T/O • Straight in recovery (both VFR and IFR) - standard IFR penetration in the BIRDTAM layer. • RATR limited to 2 singletons • No VFR outer circuit allowed. Close patterns with Touch & Go's allowed. SFO's allowed if BIRDTAM up to max 2000' • No practice IFR patterns (Tacan, GCA, ILS) • No formation LDG (except in emergency)
	M LBI not available and BIRDTAM 5-7	• No T/O if BIRDTAM 8 except for QRA A-scramble • High - no formation - T/O & vectored departures to pass through the BIRDTAM layer (if applicable) ASAP and as close to the base as possible. In IMC, use standard IFR climb out parameters, • RATR limited to 2 singletons, • No practice VFR/IFR patterns allowed • Straight in recovery (both VFR and IFR) - standard IFR penetration in the BIRDTAM layer. • No formation LDG (except in emergency)
	H or LBI not available and BIRDTAM 8	• No T/O except for QRA A-scrambles • Landing only allowed after QRA A-scrambles, in emergency or after Risk Management analysis by SOF with approval of COA A3 in very particular situations (eg: recoveries of aircraft after CCD return, night flight no more diversions etc…) • No practice VFR/IFR patterns allowed

DEFENSIE
LA DÉFENSE

BIRDTAM



Conclusion

$$P(birdstrike) = N.L^2.D\frac{1}{10^{10}}.\frac{A}{L^2}.10^4 = N.D.A.\frac{1}{10^6}$$

A mathematical tool to help calculate the bird strike probability and determine BIRDTAM levels

Acknowledgements:

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Thank you