DEVELOPMENT VERSUS FLIGHT SAFETY ZONES

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Airports can be classified as a system. In certain aspects airports function as a closed system seeing that various developments and activities within the boundaries of an airport are restricted from external liaison. Airports can also function as an open system seeing that some activities that are executed within its boundaries have interactions with the immediate surrounding environment.

The purpose of this paper is to present a model designed to optimise development that falls within the flight safety zones of an airport through height restrictions. The model is first and foremost a guideline document relating to those matters over which planning has control and influence. The model will initiate, encourage and control development. It will be clear on aims, guidelines and proposals. It will follow a process of participation with stakeholders with the purpose of identifying key issues. It will give an indication of the needs and priorities of an airport and its surrounding environment.

1. BACKGROUND

Airfields can be classified as systems. In certain cases airfields functions as a closed system seeing that various developments and activities within the boundaries of an airfield are restricted from external liaison. Airfields can also function as an open system seeing that some activities that are executed within its boundaries have interactions with the immediate surrounding environment.

The question remains how to define these activities that interacts with the immediate surrounding environment and how to control these activities to optimize development that falls within these activities.

One way of defining and controlling these activities is through a height restriction model.

2. ACTIVITIES

The model is designed around three activities:

2.1 Type of runway

As defined by the International Civil Aviation Organization (ICAO) there are two types of runways:

- **None-Instrumental runway**

  Runway meant for Aircrafts using approaching procedures.

- **Instrumental runway**

  Runway meant for Aircrafts not using approaching procedures.

A runway is classified according to its length and width and aircraft type meant for that runway. Table 1 shows the different codes of runways with standards.

TABLE 1: RUNWAY

CODE	LENGTH	WIDTH	WING-SPAN	WHEEL-SPAN
1	800m and <	18-23m	< 15m	<4.5m
2	800-1200m	23-30m	15m to <24m	4.5m to <6m
3	1200-1800m	30-45m	24m to <36m	6m to <9m
4	1800m and >	45m	36m to <52m	9m to <14m

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2.2 Hindrance levels

As defined by the International Civil Aviation Organization (ICAO) there are five types of hindrance levels:

- **Approach and Take-off level**

  The approach and take-off level is a slope extending upwards from the safety level.

- **Safety level**

  The safety level is a defined area around the runway that includes the runway, meant to minimize damage to an aircraft during take-off or landing.

- **Transitional level**

  The transitional level is the level alongside the safety area and parts of the approach and take-off level that stretches up- and outwards to the inner horizontal level.

- **Inner Horizontal level**

  The inner horizontal level is that level that defines an area safe to be used by an aircraft before commencing landing procedures.

- **Conical level**

  The conical level is that level that stretches up- and outwards from the periphery of the inner horizontal level to a specific height.

Table 2 shows the different standards for each hindrance level. Table 3 and 4 shows the distances and heights for each hindrance level according to the different runway types. Figure 1 shows the different hindrance levels graphically.

TABLE 2: HINDRANCE LEVELS

	NONE-INSTRUMENTAL				INSTRUMENTAL		
CODE	**1**	**2**	**3**	**4**	**1**	**2**	**3/4**
CONICAL LEVEL							
Slope	5%	5%	5%	5%	5%	5%	5%
Height	55m	55m	75m	100m	60m	60m	100m
INNER HORIZONTAL LEVEL							
Height	45m	45m	45m	45m	45m	45m	45m
Radius	2000m	2500m	4000m	4000m	3500m	3500m	4000m
APPROACH LEVEL							
Variation	10%	10%	10%	10%	15%	15%	15%
Length	1600m	2500m	3000m	3000m	3000m	3000m	3000m
Slope	5%	4%	3,3%	2,5%	2,5%	2,5%	2%
TAKE-OFF LEVEL							
Variation	10%	10%	12,5%	12,5%	10%	10%	12,5%
Length	1600m	2500m	15000m	15000m	1600m	2500m	15000m
Slope	5%	4%	2%	2%	5%	4%	2%
TRANSITIONAL LEVEL							
Slope	20%	20%	14,3%	14,3%	14,3%	14,3%	14,3%
SAFETY LEVEL							
Length	30m	60m	60m	60m	30m	60m	60m
Width	40m	75m	75m	75m	150m	150m	150m

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TABLE 3: INSTRUMENTAL RUNWAY

Distance from runway	Safety level	Transitional level	Inner Horizontal level	Conical level	Approach level	Take-off level
	Height per level					
Code 1						
150m	0m					
150m-465m		0m-45m				
465m-3965m			45m			
3965m-4265m				45m-60m		
30m	0m					
30m-3030m					0m-74m	
30m-1630						0m-79m
Code 2						
150m	0m					
150m-465m		0m-45m				
465m-3965m			45m			
3965m-4265m				45m-60m		
60m	0m					
60m-3060m					0m-74m	
60m-2560m						0m-98m
Code 3 / 4						
150m	0m					
150m-465m		0m-45m				
465m-4465m			45m			
4465m-5565m				45m-100m		
60m	0m					
60m-3060m					0m-59m	
60m-15060m						0m-299m

TABLE 4: NONE-INSTRUMENTAL RUNWAY

Distance from runway	Safety level	Transitional level	Inner Horizontal level	Conical level	Approach level	Take-off level
	Height per level					
Code 1						
40m	0m					
40m-265m		0m-45m				
265m-2265m			45m			
2265m-2465m				45m-55m		
30m	0m					
30m-1630m					0m-80m	
30m-1630m						0m-80m
Code 2						
75m	0m					
75m-300m		0m-45m				
300m-2800m			45m			
2800m-3000m				45m-55m		
60m	0m					
60m-2560m					0m-98m	
60m-2560m						0m-98m
Code 3						
75m	0m					
75m-390m		0m-45m				
390m-4390m			45m			
4390m-4990m				45m-75m		
60m	0m					
60m-3060m					0m-97m	
60m-15060m						0m-299m
Code 4						
75m	0m					
75m-390m		0m-45m				
390m-4390m			45m			
4390m-5490m				45m-100m		
60m						
60m-3060m					0m-74m	
60m-15060						0m-299m

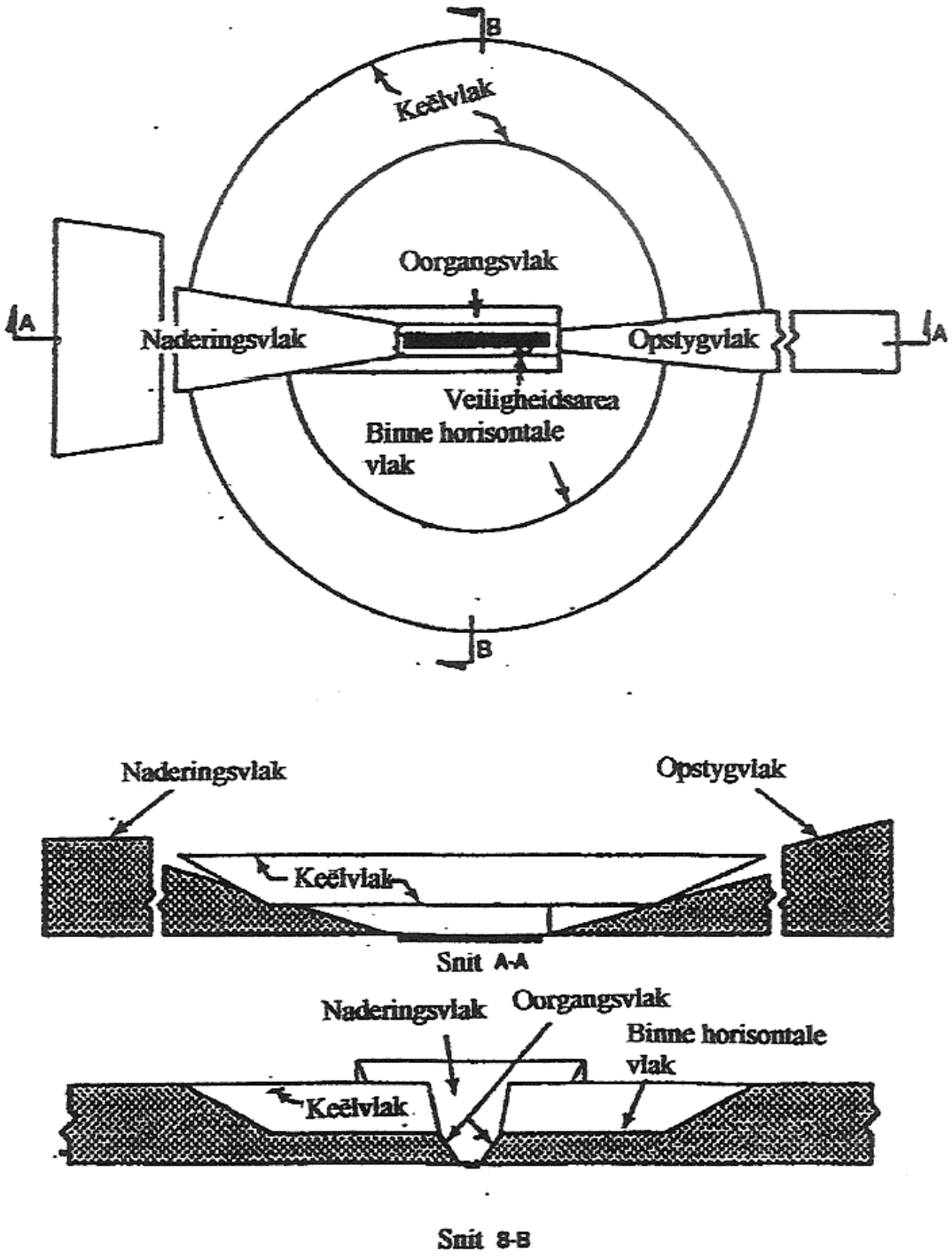

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FIGURE 1: HINDRANCE LEVELS

2.3 Environment

The calculation of hindrance levels is based on the height of a runway above sea level. Topography, considering all types of hindrance levels and that hindrance levels stretches up-and outwards, is the only physical entity that has an impact on the calculation of height restrictions for each hindrance level. Topography can be defined as contour values defining the height of a structure or area above sea level.

3. HEIGHT RESTRICTION MODEL

The height restriction model is based on the calculation of height restrictions for a structure or an area using the following formula:

$$\text{Hindrance} = (((\text{y-distance}) \times (\text{slope})) + \text{height}) + (\text{runway-topography}) \quad [1]$$

3.1 Y

Equal to the distance of a structure or area from the runway. There are two aspects to consider:

- **Locality**

  Locality of a structure or area to enable the identification of the relevant hindrance level.

- **Distance**

  Distance to differentiate between the different hindrance levels.

3.2 Distance

Equal to the minimum distance of the different hindrance levels from a runway.

3.3 Slope

Equal to the percentage slope of each hindrance level. For the approach and take-off level the smallest value should be considered.

3.4 Height

Equal to the minimum height of each hindrance level. There are only two heights to be considered:

- 0m - relevant to the following hindrance levels: safety, transitional, approach and take-off level.

- 45m – relevant to the following hindrance levels: inner horizontal and conical level.

3.5 Runway

Equal to the height above sea level.

3.6 Topography

Equal to the highest contour value where the structure or area are located.

4. METHOD CALCULATING HEIGHT RESTRICTIONS

Hindrance levels ensure that the operation of an aircraft is done safely and that the impact of development is kept to the minimum. There are two methods to consider when calculating height restrictions:

4.1 Distance

The calculation of height restrictions is based on distance. The following information is required when calculating height restrictions based on distance:

- Type of runway
- Locality of structure or area according to runway
- Contour value
- Runways height above sea level
- Distance of structure or area from runway

Example

- Type of runway – **Code 4 Instrumental**
- Locality of structure or area according to runway – **Parallel to runway**
- Contour value – **1503m**
- Runways height above sea level – **1500m**
- Distance of structure or area from runway – **350m**

Hindrance = (((y-distance) x (slope))+height)+(runway-topography)
= (((350-150) x (14.3/100))+0)+(1500-1503)
= ((200 x 0.143)+0)+(-3)
= (28.6+0)-3
= 28.6-3
= 25.6

The above calculation indicates that a structure should not exceed a height of 25.6m.

4.2 Distance interval

The calculation of height restrictions is generalized according to different distance intervals. The following information is required when calculating height restrictions based on distance intervals:

- Maximum contour values for each hindrance level
- Runways height above sea level
- Locality of structure or area according to runway
- Distance of structure or area from runway
- Hindrance level where structure or area is located
- Minimum height restriction for a structure according to hindrance levels
- Height restrictions according to distance intervals for each hindrance level

Example

- Area earmarked for development is located approximately 300m parallel from the runway. According to the planning the highest structure to be erected will be 15m in height.

- Type of runway – **Code 4 Instrumental**

- Maximum contour values as shown by Table 5:

TABLE 5: CONTOUR VALUES

Safety level	Na
Transitional level	1508
Inner Horizontal level	1512
Conical level	1520
Approach level	1514
Take-off level	1520

- Maximum height restrictions for each hindrance level according to distance intervals as shown by Tables 6-10:

TABLE 6: TRANSITIONAL LEVEL

Code 4 Instrumental		Code 4 None-Instrumental	
Distance	**Maximum**	**Distance**	**Maximum**
150	-8	75	-10
200	0	125	-2.85
220	2.1	150	0
250	6.3	160	2.1
300	13.45	175	4.3
350	20.6	225	11.45
400	27.75	275	18.6
465	37.05	325	25.75
		390	35.05

	No development

TABLE 7: INNER HORIZONTAL LEVEL

Code 4 Instrumental		Code 4 None-Instrumental	
Distance	**Maximum**	**Distance**	**Maximum**
465-4465	33	390-4390	35

TABLE8: CONICAL LEVEL

Code 4 Instrumental		Code 4 None-Instrumental	
Distance	**Maximum**	**Distance**	**Maximum**
4465	25	4390	25
4565	30	4490	30
4665	35	4590	35
4765	40	4690	40
4865	45	4790	45
4965	50	4890	50
5065	55	4990	55
5165	60	5090	60
5265	65	5190	65
5365	70	5290	70
5465	75	5390	75
5565	80	5490	80

TABLE 9: APPROACH LEVEL

Code 4 Instrumental		Code 4 None-Instrumental	
Distance	**Maximum**	**Distance**	**Maximum**
60	-14	60	-16
800	0	700	0
875	2	780	2
1060	6	1060	9
2060	26	2060	34
3060	46	3060	59

	No development

TABLE 10: TAKE-OFF LEVEL

Code 4 Instrumental		Code 4 None-Instrumental	
Maximum	**Distance**	**Maximum**	**Maximum**
60	-20	60	-18
1060	0	1000	0
1160	2	1060	2
2060	20	2060	22
3060	40	3060	42
4060	60	4060	62
5060	80	5060	82
6060	100	6060	102
7060	120	7060	122
8060	140	8060	142
9060	160	9060	162
10060	180	10060	182
11060	200	11060	202
12060	220	12060	222
13060	240	13060	242
14060	260	14060	262
15060	280	15060	282

	No development

According to the above distance intervals, if a runway is classified as code 4 Instrumental than the proposed development cannot be supported because the highest structure of 15m exceeds the maximum height allowed of 13.45m.

But, if a runway is classified as code 4 None-Instrumental than the proposed development can be supported because the highest structure of 15m doesn't exceed the maximum height allowed of 25.75m.

5. GUIDELINES

To calculate the maximum height restriction the following guidelines can be used for each hindrance level:

- **Safety level:** height restriction of 0m not to be exceeded.
- **Transitional level:** height restriction stretches upwards against a slope – should be calculated according to distance from runway and maximum contour value.
- **Inner Horizontal level:** height restriction stretches horizontal – should be calculated considering maximum contour value.
- **Conical level:** height restriction stretches upwards against a slope – should be calculated considering distance from runway and maximum contour value.
- **Approach and Take-off level:** height restriction stretches upwards against a slope – should be calculated considering distance from runway and maximum contour value.

6. CONTROL MEASURES

The following measures are proposed to control development within hindrance levels:

- Define hindrance level as height restrictions in Deed of Transport during registration of property.

- Define hindrance levels as restrictive conditions in Town Planning Scheme.

- Define hindrance levels as restrictive conditions in Building Regulations.

7. CLOSURE

The model is a guideline document relating to those matters over which planning has control and influence. The model initiate, encourage and control development. It is clear on aims, guidelines and proposals. It follows a process of participation with stakeholders with the purpose of identifying key issues. It gives an indication of the needs and priorities of an airfield and its surrounding environment.

REFERENCES

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO). 1990. Aerodrome design and options. Volume 1: annex 14.