ADVISORY CIRCULAR

CAA-AC-AGA101
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GUIDANCE ON ESTABLISHMENT OF AERODROMES

1.0 PURPOSE

This Advisory Circular provides methods, acceptable to the Authority, for showing compliance with the Establishment and Development of Aerodrome requirements of Civil Aviation (Aerodromes) Regulations as well as explanatory and interpretative material to assist in showing compliance.

The Advisory Circular serves as a guide to new proponent other than military intending to establish an aerodrome in Uganda.

The contents of the Advisory Circular are only guides to advise airport consultants, engineers, and planners on aerodrome development. Detail planning, facilities' design and construction rest with the aerodrome owner.

However, to achieve the desired objectives of a viable aerodrome, planning is key to identifying all the requirements needed to economically design the airport facilities. Other factors too are equally important when planning an aerodrome.

2.0 REFERENCE

2.1 The Civil Aviation (Aerodromes) Regulations
2.2 ICAO Annex 14 Volume 1 – Aerodromes
2.3 ICAO Doc 9157- Aerodrome Design Manual
2.3 ICAO Doc 9184– Airport Planning Manual

3.0 APPLICATION

The material contained in this Advisory Circular mainly applies to applicants seeking approval to establish and operate aerodromes as well as aerodrome operators intending to transfer, amend or surrender aerodrome certificates

4.0 REQUIREMENTS FOR DESIGN AND CONSTRUCTION OF AERODROMES

4.1 REQUIREMENTS FOR APPLICATION FOR AERODROME CONSTRUCTION PERMIT

An operator shall not construct an aerodrome unless that operator has a valid aerodrome construction permit

The application for an aerodrome construction permit to the authority in the prescribed form and the application shall be accompanied by—

a) a proof of ownership of the proposed aerodrome site and a master plan

b) a detailed design of the proposed construction including related architectural requirements for approval by the relevant authority;

c) aerodrome data in accordance with the characteristics of the aircraft for which the aerodrome is intended;

d) a topographical map of the proposed aerodrome site as specified by the authority; and

e) an environmental impact assessment report approved by the National Environment Management Authority.

An application for an aerodrome construction permit should be considered for approval by the authority, where the application is accompanied by an environmental impact assessment report approved by the National Environment Management Authority.

Assessment of the suitability of the place proposed for construction shall take into consideration;

a) the proximity of the place to other aerodromes and landing areas including military aerodromes;

b) obstacles, terrain and existing airspace restrictions; and

c) that it is not against public interest that the place where the aerodrome is to be constructed shall be used as such.

4.2 DESIGN AND CONSTRUCTION

The design and construction of the aerodrome is undertaken by a person registered by the relevant professional body.

An aerodrome design should indicate the following;

a) the physical characteristics in accordance with these Regulations;

b) the obstacle limitation surfaces;

c) visual aids for navigation; and
d) the appropriate equipment and installations.

The design of an aerodrome should also take into account existing land use and environmental control measures.

The physical characteristics, obstacle limitation surfaces, visual aids and equipment and installations should;

a) be appropriate to the critical aircraft characteristics for which the aerodrome intends to serve;
b) be at the lowest meteorological minima for each runway;
c) provide ambient light conditions during the operations of aircraft; and
d) comply with the appropriate aerodrome design requirements as prescribed by the authority.

4.3 INTEGRATION OF SECURITY MEASURES

Architectural and infrastructure-related requirements for the optimum implementation of the Civil Aviation (Security) Regulations, 2022 should be integrated into the design and construction of new facilities and alterations to existing facilities at an aerodrome.

An aerodrome operator should provide a fence or a suitable barrier on the aerodrome—

a) to prevent the entrance into the movement area, by any animal likely to be a hazard to aircraft; and
b) to deter the inadvertent or premeditated access of an unauthorized person onto a non-public areas of the aerodrome.

An aerodrome operator should provide suitable means of protection for an aerodrome to deter the inadvertent or premeditated access of unauthorized persons into ground installations and facilities essential for the safe operation of aircraft.

The fence or barrier should be located in such away that separates the movement area and other facilities or zones on the aerodrome which are vital to the safe operation of aircraft, from areas open to public use.

Where greater security is needed, a cleared area should be provided on both sides of the fence or barrier to facilitate the work of patrols and to make trespassing more difficult.

Provision for a perimeter road along the aerodrome fencing for the use of both maintenance personnel and security patrols may be made.

Where the authority considers it necessary for security reasons, a fence or other barrier provided for the protection of international civil aviation and its facilities shall be illuminated at a minimum essential level and the security lighting shall be located in such a way that the ground area on both sides of the fence or barrier, particularly at access points, is illuminated.

4.4 AERODROME MASTERPLAN

An aerodrome master plan containing detailed plans for the development of aerodrome infrastructure should be established for Category A aerodromes, and other aerodromes as determined by the authority from time to time.

A master plan shall represent the development plan of a specific aerodrome and shall be developed by the aerodrome operator based on economic feasibility, traffic forecasts, and current and future requirements provided by aircraft operators among others.

A master plan may be required where the lack of capacity at an airport, due to conditions such as, but not limited to expected traffic growth, changing weather and climatic conditions or major works to address safety or environmental concerns, would put the connectivity of a geographical area at risk or cause severe disruption to the air transport network.

The master plan shoud;

a) contain a schedule of priorities including a phased implementation plan; and
b) be reviewed periodically to take into account current and future aerodrome traffic.

Aerodrome stakeholders, particularly aircraft operators, may be consulted in order to facilitate the master planning process using a consultative and collaborative approach.

An aerodrome operator shall when applying for a Category A aerodrome certificate, submit to the authority a master plan for the aerodrome.

5.0 AIRPORT PLANNING

Planning provides the sound foundation necessary for realisation of the maximum advantages of good design, prudent investment and efficient operation and management.

Planning of airports is complicated by the diversity of facilities (i.e. runways and taxiways, aircraft aprons, buildings where aircraft operators deliver and receive passengers, where government control authorities undertake their inspections and amenities for passengers' comfort and assistance are provided) and services which are necessary for the movement of aircraft, passengers and cargo and the ground vehicles associated with them, and the necessity to integrate their planning.

Additional requirements are terminal buildings, control tower, perimeter fence and access gates, AIS and briefing rooms, meteorological stations, firefighting station, utilities building and parking areas for aircraft maintenance, roads and parks for vehicles used by passengers and visitors, aircraft operators and all occupants of the airport, and buildings for the dispatch and receipt of air cargo.

The type of operations at a particular aerodrome dictate the size and facilities needed to be provided.

5.1 PLANNING PROCEDURES

Planning procedures for the individual facilities which make up an airport are the same for any airport master plan.

The major stages for any airport plan are:

5.1.1 Forecasts

Develop long-term forecasts covering aviation operational, economic and other factors on which future planning of the proposed aerodrome can be based, by carrying out appropriate survey to acquire statistical data of people that have travelled by air and extent of cargo movement for at least in the last two (2) years or more and those that are interested in travelling by air. Estimating the population and economic viability that will aid the forecast should be done to justify the need and capacity required and any other information that may be needed.

5.1.2 System concepts

Develop concepts for the basic systems of operation and identify the developments that will be required to meet the forecast needs of all airport users. In addition, stating the type of operation (day light only or including night operations) will determine the extent and type of facilities required to support the desired system.

5.1.3 Airport master plan

Determine an ultimate over-all layout that will best exploit the potential of the site, making the fullest use of any natural features, bearing in mind the physical characteristics of every element involved in the intended aerodrome. Priority should be given to the location of the control tower with respect to 360 azimuth view, security and related services

5.1.4 Airspace evaluation:

Critical examination of the airspace over the proposed aerodrome to ensure safe and economical flight operations is required; this can be achieved considering the designed critical aircraft, topography of the supposed control area or terminal area, adjacent aerodrome, determining the visual segment surface (VSS) to determine flyability into the aerodrome, as well aid determination of location in which the NAVAIDs and type(s) to be recommended for operations

6.0 AIRPORT SITE SELECTION

The starting point in selection of an airport site or the assessment of the suitability of an existing site is the definition of the purpose for which the airport is required. This requires consideration of forecast future demands and the quantity and type of traffic to be accommodated. It is then necessary to define the type of airport and the operational systems for the forecast passenger and/or cargo traffic. Based on this information, the actual process of site selection falls into several major steps commencing with an assessment of the shape and size of the area required for the airport, the location of sites with potential for development, followed by examination and evaluation of these sites.

6.1 MAJOR STEPS IN THE SITE EVALUATION AND SELECTION PROCESS

The major steps involved in any site evaluation or selection process for new aerodrome include:

6.1.1 Broad determination of the land area required

Before inspection of any potential sites, including existing sites, it is necessary to make a broad assessment of the land area likely to be required. This can be achieved by considering the space necessary for runway development which generally forms the major proportion of land required for an airport.

This requires consideration of the following factors: runway length; - runway orientation; - number of runways; - combination of length, number and orientation of runways, suitability and siting of NAVAIDS/Landing aids and standard spacing between facilities most especially runway-taxiway where taxiway is parallel, runway-apron where taxiway is perpendicular to the runway to form an outline runway scheme for rough assessment of the order of magnitude of land required. Evaluation of topography within the control area and or terminal area covering E-TOD area 2c should also be considered.

6.1.2 Evaluation of factors affecting airport location:

While considering airport development, the following factors should be considered and documented in the operator’s manual.

a) Development of surrounding area

Contact planning authorities and agencies to obtain plans of existing and future land use.

b) Atmospheric conditions

Obtain data on presence of fog, haze, smoke, etc., which may consequently reduce visibility and the capacity of an airport. List any special local weather factors; for example, variations in weather pattern, prevailing winds, fog, low cloud, rainfall, turbulence, etc.

c) Accessibility to ground transport

Note the location of roads, railways, and public transport routes.

d) Availability of land for expansion of an existing airport or for a new airport

Availability of suitable land for the future expansion of an airport is necessary. Study aeronautical, land, road and topographical maps and aerial photographs, etc. Study topographical maps to ascertain areas with suitable slopes and drainage. Review geological maps showing distribution of soil and rock types. Ascertain location and availability of construction materials, quarries, etc. Ascertain general land values for various areas and usage residential, agricultural, pastoral, and industrial.

e) Topography

Note significant factors affecting cost of construction such as the need for excavation or filling, drainage and poor soil conditions.

f) Environment

Note locations of wildlife reserves and migratory areas. Also note noise- sensitive areas such as schools and hospitals.

g) Presence of other airports

Note locations of existing airports and ATS routes together with their associated airspace and any future plans to change them.

h) Availability of utilities

Note locations of main power and water supplies, sewage and gas mains, telephone services, fuel, etc.);

6.1.3 Preliminary office study of possible sites:

After the approximate size and type of airport has been determined as in (a) and locational factors have been tabulated as in (b) above, the next step is to analyse these factors, and having done so, to plot possible new airport sites or additional land requirements for an existing airport, on charts and maps. This preliminary study should eliminate undesirable sites or determine the adequacy of an existing site before costly site inspections are undertaken.

6.1.4 Site inspection:

After listing all the potential sites considered worthy of further investigation, a thorough field and aerial inspection is required to provide a basis for assessment of the advantages and disadvantages of each site.

6.1.5 Environmental Study:

Environmental factors should be carefully considered in the development of a new airport or the expansion of an existing one. Studies of the impact of the construction and operation of a new airport or the expansion of an existing one upon acceptable levels of air and water quality, noise levels, ecological processes, and demographic development of the area must be conducted to determine how the airport requirements can best be accommodated.

6.1.6 Review of potential sites:

At this stage, sufficient information should be available to reduce the number of sites to those meriting detailed consideration. At this point the planner should review the results of the office study and field investigation. Based on this review, sites which are unsuitable and do not warrant further examination should be omitted;

6.1.7 Preparation of outline plans and estimates of costs and revenues:

Detailed site surveys, including obstacle surveys;

a) Preparation of outline airport layouts for each site;
b) Preparation of broad cost estimates covering the total capital and operating expenditure required including all associated off-airport items such as access roads, communications to population centres, planning control of surrounding areas and

estimates of annual percentage changes in land values for the probable life of the airport; and the anticipated phasing of expenditure;

c) When expansion or abandonment of existing sites is in question, the determination of the depreciated and current values of any existing installations together with the value of all other off-airport associated assets including easements, public utilities, noise zones, etc.

6.1.8 Final evaluation and selection:

This stage when a number of alternative sites are under consideration, the question of cost plays a large part in the final choice. If all potential sites were of equal merit, logical decisions would be possible on the basis of least cost. Unfortunately, a clear- cut situation does not normally arise in practice and it is usually necessary for varying degrees of advantage and disadvantage to be weighed before reaching a decision. Economic factors are of great importance because the rate and pattern of growth of an economy are influenced not only by the level of capital investment but by the manner in which capital is used. Generally, capital is scarce and can be employed in a number of alternative ways. Capital can be wasted by diversion to uneconomic uses but when employed intelligently and efficiently, a lesser amount may achieve a given result.

6.1.9 Report and recommendations

A comprehensive report supported by drawings, etc., should be prepared, containing:

a) The results of the site inspection and evaluation;
b) Ranking of sites in order of merit, supported by reasons for selection; and
c) Recommendations for further action.
d) The site selection phase for a new airport requires an in-depth analysis of alternative sites, looking closely at such factors as physical characteristics of the site, the nature of surrounding development, land cost and availability, ground access, and the adequacy of surrounding airspace. The final choice of one site over others is often quite subjective.

For example, there is probably no objective way to compare the disadvantages of increased noise in some part of the community with the advantages of improved air service for the metropolitan area as a whole. The consultant should not assume that the site selection process described here conclusively results in the selection of the best site. The “right” choice depends on how decision makers weigh various criteria.

6.2 SITE SELECTION SURVEY REPORT

The applicant is required to carry out a site selection survey of the site(s) under consideration. The survey is to ensure that the operation of an aerodrome at the specified location will not endanger the safety of aircraft operations.

Relevant data upon which the survey should be based on reliable wind distribution statistics that extend over as long a period as possible, preferably 5 years or more. The observation should be made at regular intervals of time. Noise contour/exposure map indicating the areas around aerodrome vicinities likely to be exposed to significant or unacceptable levels of noise, based on projected aircraft operations; topographical map and soil investigation report.

The survey should take into consideration the proximity of the aerodrome to other aerodromes and landing sites; any excessive operational restriction requirements; any existing restrictions and controlled airspace; and any existing instrument procedures.

An applicant is advised to employ the services of a consultant with proven track record, experience and expertise in the conduct of site selection studies

The applicant is also required to carry out an Environmental Impact Assessment (EIA) of the site. The primary purpose of the EIA report is to ensure that due cognizance is given to the policies and goals defined in Environment Protection Act and that they are integrated into the proposed aerodrome project. The report should provide fair, full and explicit discussion of significant environmental impact and should inform decision makers and the public of the reasonable alternatives which would avoid or minimise adverse impacts or enhance the quality of the environment.

6.3 AIRPORT MASTER PLAN

To integrate all the facilities, a master plan for the whole airport should be prepared, defining the basic concepts and over-all layout which will best exploit the potential of the site. The master plan should evolve through consideration of all the factors (political, economic, social, and operational) which affect air transport, and which will influence or impinge on the development and use of the airport throughout its working life.

6.4 AIRPORT LAYOUT

The layout of an airport must be suitable for the shape and acreage of available land, but most importantly it must satisfy fully the operational requirements of aircraft for landing and take-off. The airfield, or runway–taxiway system, must contain enough runway(s) to meet air traffic demand and be properly aligned with the optimum flow of aircraft, and the runway(s) must have adequate separation to ensure safe air traffic movements.

Runways must be oriented to take advantage of prevailing winds and should be directed away from fixed air navigation hazards. An airport layout should include suitable parking areas for aircraft and various airport ground service vehicles as well as space for freight processing and baggage handling and storage and for aircraft maintenance and service.
Therefore, airport configuration should facilitate safe and expeditious movements of aircraft and ground service vehicles.

6.5 RUNWAY ORIENTATION AND CROSSWIND COMPONENT

Determination of a runway orientation is a critical task in the planning and design of an aerodrome. The direction of the runway controls the layout of the other airport facilities such as control tower, terminal building, taxiway/apron configurations, hangars etc. It is an important task in the assessment of an airport site.

Because of the obvious advantages of landing and taking off into the wind, runways are oriented in the direction of prevailing winds. Aircraft may not manoeuvre safely on a runway when the wind contains a large component at right angles to the direction of travel. The point at which this component (called the crosswind) becomes excessive will depend upon the size and operating characteristics of the aircraft. In the wind analysis, determining allowable crosswind is critical, and it is the basis of the ICAO Reference Code known as Aerodrome Reference Code (ARC) shown in table 1 below was adopted.

Table 1. Aerodrome reference code

Code element 1	
Code number	Aeroplane reference field length
1	Less than 800 m
2	800 m up to but not including 1 200 m
3	1 200 m up to but not including 1 800 m
4	1 800 m and over
Code element 2	
Code letter	Wingspan
A	Up to but not including 15 m
B	15 m up to but not including 24 m
C	24 m up to but not including 36 m
D	36 m up to but not including 52 m
E	52 m up to but not including 65 m
F	65 m up to but not including 80 m

Runway length, being the most important airside design feature, should logically be linked to other physical characteristics of the airport. Like runway length, the physical dimensions, clearances, and separations are a function of the size and operating characteristics of the critical aircraft.

Large differences in required runway length may be caused by local factors that influence the performance of airplanes. Thus, to provide a meaningful relationship between field length and other physical characteristics of the air side, the actual runway length must be converted to standard sea-level conditions by removing the local effects of elevation, temperature, and gradient. When these local effects are removed, the airplane reference field length remains. ICAO Aerodrome Reference Code takes into account key lateral dimensions of the critical aircraft as well as the runway length requirements of the critical aircraft for sea-level and standard atmospheric conditions.

The allowable crosswind (in kilometers per hour and knots) is based entirely on the Aeroplane Reference Field Length (ARFL), and the maximum permissible crosswind components as;

- 37 km/h (20 kt) in the case of aeroplanes whose reference field length is 1 500 m or over, except that when poor runway braking action owing to an insufficient longitudinal coefficient of friction is experienced with some frequency, a cross-wind component not exceeding 24 km/h (13 kt) shall be assumed;
- 24 km/h (13 kt) in the case of aeroplanes whose reference field length is 1 200 m or up to but not including 1 500 m; and
- 19 km/h (10 kt) in the case of aeroplanes whose reference field length is less than 1 200 m.

As required by Civil Aviation (Aerodromes) Regulations, runway(s) shall be oriented so that the usability factor of the aerodrome is not less than 95% minimum. (The usability factor is the percentage of time during which the use of the runway system is not restricted because of an excessive crosswind component.) Where a single runway or set of parallel runways cannot be oriented to provide a usability factor of at least 95%, one or more crosswind runways may need to be provided.

6.5.1 Weather Data

Weather records can usually be obtained from government weather agency (e.g. Uganda National Meteorological Authority). The wind velocities are generally divided into 22.5 degree increments 16 points of the compass. The weather records contain the percentage of time certain combinations of ceiling and visibility occur e.g. ceiling, 500 to 274 m; visibility, 4.8 to 9.7 km, and the percentage of time winds of specified velocity occur from different directions, e.g. NNE, 4.8 to 8.5 km/h (2.6 to 4.6 kt). The directions are in reference to true north.

Often wind data for an entirely new location have not been recorded. If that is the case, records of nearby measuring stations should be consulted. If the surrounding area is fairly level, the records of these stations should indicate the winds at the site of the proposed airport. If the terrain is hilly, however, the wind pattern is often dictated by the topography, and it is dangerous to utilize the records of stations some distance from the site. In that event, a study of the topography of the region and consultation with long- time residents may prove usefu

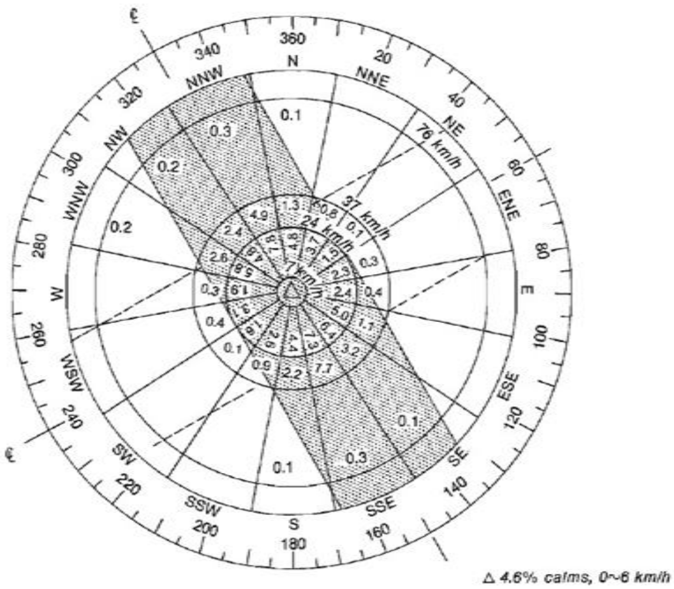

Figure 1: Wind rose chart

6.5.2 Wind Rose Analysis

The orientation of the runway is in part the result of the aircraft performance characteristics. On take-off and landing, aircraft must fly in the direction of the prevailing wind.

The convention for numbering runways is to provide a runway designation number which is the azimuth of the runway in degrees from magnetic north divided by ten. A graphical procedure utilizing the "wind rose" is typically used to determine the "best" runway orientation insofar as prevailing winds are concerned, as depicted in Figure 1. Wind roses are based on true north orientation.

6.6 OPTIMIZING AIRPORT RUNWAY ORIENTATION

Any of the under listed methods can be used to analyse the wind rose that is generated from the available weather data in order to have the best airport runway orientation. However, the applicant's report of the wind rose analysis must show/record the crosswind component of each of the available orientation leading to the choice of the preferred orientation.

6.6.1 Wind Rose Analysis – The Conventional Approach

A conventional approach often used in determining the runway orientation is called the wind rose method. The method uses a wind rose template to arrange velocity, direction, and frequency of wind occurrences within a certain period of time **(normally 5 years or more)**.The directions of the runways can be determined graphically as follows. Example: assume that the wind data for all conditions of visibility are those shown in Table 2. From these data a wind rose can be plotted as shown in Figure 1. The percentage of winds which corresponds to a given direction and velocity range is marked in the proper sector on the wind rose. Optimum runway directions can be determined from the wind rose by the use of a strip of transparent material on which three parallel and equally spaced lines have been plotted. The middle line represents the runway centre line, and the two outside lines are tangent to the selected allowable cross-wind component.

The transparent strip is placed over the wind rose in such a manner that the centre line on the strip passes through the centre of the wind rose. With the centre of the wind rose as a pivot point, the transparent overlay is rotated until the sum of the percentages included between the outside lines is a maximum. When one of the outside lines on the transparent strip divides a segment of wind direction, the fractional part is estimated visually to the nearest 0.1 per cent. This procedure is consistent with the accuracy of the wind data.

The next step is to read the bearing of the runway on the outer scale of the wind rose where the centre line on the transparent strip crosses the direction scale. Because true north is used for published wind data, this bearing usually will be different from that used in numbering runways which are based on the magnetic bearing. In reference to Figure 1, it will be noted that a runway oriented 150 to 330 degrees S30°E true will permit operations 95 per cent of the time with the cross wind components not exceeding 24 km/h or 13 kt.

Thus far the procedure has been illustrated as it applies to wind records with a velocity break at 24 km/h or 13 kt. However, it can also be used to obtain estimates of wind coverage for any other velocity break. The concentric circles on the wind rose are drawn to scale and represent breaks in the wind velocity data. Suppose the break was at 19 km/h instead of 24 km/h 10 kt instead of 13 kt. Then the two parallel lines representing the 24km/h or 13 kt maximum allowable cross-wind component would not be tangent to the 19 km/h or 10 kt circle but would lie outside of it. An estimate must then be made of the fractional percentage segment between the 19 km/h 10 kt circle ahead of the 24km/h 13 kt parallel lines and added to the percentage segment between the 19 km/h 10 kt circle and the 24 km/h 13 kt parallel lines and added to the percentage lying within the 19 km/h 10 kt circle.

6.6.2 Low visibility wind analysis

The next step is to examine wind data during the restricted visibility conditions cited previously and plot a wind rose for this condition. From this analysis it can be ascertained whether the runways are capable of accepting aircraft at least 95 per cent of the time when restricted visibility conditions prevail. The analysis will also yield information on the percentage of the total time each of the conditions prevails. An example of the form on which restricted visibility data are tabulated is shown in Figure 2.

Figure 2 represents observations of winds in one compass direction only, in this instance from the northeast. The total number of observations for all compass directions is 24081, of which 1106 are for winds from the northeast. To complete the analysis, charts of this type would have to be plotted for other compass directions. For the purpose of the example it was assumed that a ceiling of 290 m was equivalent to 300 m. The circled number 7 means that there were seven observations made when the wind was from the northeast with velocities varying from 8 to15 km/h(4 to 8 kt), ceiling between 0 and 30 m, and visibility between 0 and 400 m. The crosshatched area conforms to the ceiling and visibility criteria previously cited.

6.6.3 Wind Rose Analysis – The Airport Design Software

The Federal Aviation Administration (FAA) developed a program as part of the Airport Design Software to help users determine the orientation of runways (FAA 1989).The program provides a spreadsheet template for the calculation of the percentage of wind coverage given inputs of wind data and runway direction specified by the user. The program is useful to automate the optimization process of runway orientation. However it does not consider the "partial coverage" issue and lacks graphical capabilities to allow users to determine the partial coverage and display the suitable alignment.

6.6.4 Wind Rose Analysis – The GIS-Based Wind Rose Method

The best type of wind rose method is the GIS-based wind rose method. The GIS-based wind rose method takes advantages of GIS spatial analysis functions to deal with the partial coverage problem. By formulating the wind rose and runway templates as GIS themes, the new wind rose method avoids intensive geometric computations involved in solving the partial coverage problem

Table 2: Wind Data

Percentage of winds				
Wind direction	**7-24km/h (4-13kt)**	**26-37km/h (14-20kt)**	**39-76km/h (21-41kt)**	**total**
N	4.8	1.3	0.1	6.2
NNE	3.7	0.8	-	4.5
NE	1.5	0.1	-	1.6
ENE	2.3	0.3	-	2.6
E	2.4	0.4	-	2.8
ESE	5.0	1.1	-	6.1
SE	6.0	3.2	0.1	9.7
SSE	7.3	7.7	0.3	15.3
S	4.4	2.2	0.1	6.7
SSW	2.6	0.9	-	3.5
SW	1.6	0.1	-	1.7
WSW	3.1	0.4	-	3.5
W	1.9	0.3	-	2.2
WNW	5.8	2.6	0.2	8.6
NW	4.8	2.4	0.2	7.4
NNW	7.8	4.9	0.3	13.0
Calms – (0 -6Km/hr (0-3Kt))				4.6
Total				100.0

NE wind								Total observations: 24 081	
Ceiling groups in metres	Velocity groups in km	Visibility — metres							
		0~400	400~800	800~1 200	1 200~1 600	1 600~2 400	2 400~4 800	4 800+	Total obs.
300	1~7	4		1	2	4	14	202	227
	8~15	1	5	1	3	6	17	383	416
	16~23	2			1		5	277	285
	24~47							114	114
	48+								
	Total	7	5	2	6	10	36	976	1 042
180 thru 270	1~7		1			1		1	3
	8~15			1	1	1	1	8	12
	16~23				1		3	4	8
	24~47								
	48+								
	Total		1	1	2	2	4	13	23
150	1~7			1				1	2
	8~15						2		2
	16~23								
	24~47								
	48+								
	Total			1			2	1	4
120	1~7			1					1
	8~15				1	1	2		4
	16~23						1		1
	24~47								
	48+								
	Total			1	1	1	3		6
90	1~7	1	1		1	1	1		5
	8~15	1						1	2
	16~23						1	1	2
	24~47								
	48+								
	Total	2	1		1	1	2	2	9
60	1~7					1			1
	8~15	1	1	1			1	1	5
	16~23						1		1
	24~47				1				1
	48+								
	Total	1	1	1	1	1	2	1	8
30	1~7	3							3
	8~15	⑦	1						8
	16~23		3						3
	24~47								
	48+								
	Total	10	4						14
	% by velocity groups		1.6~7 km 10	8~15 km 19	16~23 km 12	24~47 km 5	48 km		

(diagonal hatching, ///) Observations to be considered because of ceiling conditions
(diagonal hatching, \\\) Observations to be considered because of visibility conditions
(cross-hatching) Observations to be considered because of ceiling and visibility conditions

Figure 2: Sample of data for analysing wind coverage in a specific direction during periods of restricted visibility

7.0 DESIGN RUNWAY LENGTH

Selecting a design runway length is one of the most important decisions an airport designer makes. To a large degree, the runway length determines the size and cost of the airport and controls the type of aircraft it will serve. Furthermore, it may limit the payload of the critical aircraft and the range available for its flight.

The runway must be long enough to allow safe landings and take-offs by current equipment and by aircraft expected to use the airport in future operations. Runways must accommodate differences in pilot skill and a variety of aircraft types and operational requirements.

7.1 FACTORS INFLUENCING RUNWAY LENGTH

The following factors most strongly influence required runway length;

a) Performance characteristics of aircraft using the airport
b) Landing and take-off gross weights of the aircraft (MTOW)
c) Elevation of the airport
d) Average maximum air temperature at the airport
e) Runway gradient

Other factors causing variations in required runway length are humidity, winds and the nature and condition of the runway surface.

Note: Aircraft performance curves of individual airplanes have been developed and published by the FAA and by the aircraft manufacturers as a design and planning tool.
These curves, which are based on actual flight test and operational data, make it possible to determine precisely required landing and take-off runway lengths for almost all the civilian aircraft in common use, both large and small.

7.2 RUNWAY LENGTH REQUIRED FOR TAKEOFF

To facilitate the publication of quantitative specifications for the physical characteristics of airports, the operator is required to employ an aerodrome reference code consisting of two elements. As indicated in Table 1, the first element is a number based on the aerodrome reference field length, and the second element is a letter based on the aircraft wingspan and outer main gear wheel span. The code number or letter selected for design purposes is related to the critical airplane characteristics for which the facility is provided. For a given airplane, the reference field length can be determined from the flight manual provided by the manufacturer. It is noted that the airplane reference field length is used only for the selection of a code number. It is not intended to influence the actual runway length provided.

In certain instances, it may be desirable to convert an existing or planned field length to the reference field length. The reference field length is computed by dividing the planned or existing length by the product of three factors representing **local elevation *Fe*, temperature *Ft*, and gradient *Fg* conditions**:

Reference field length $= \dfrac{\text{planned or existing field length}}{Fe \times Ft \times Fg}$

7.3 REQUIRED FIELD LENGTH

There are three basic corrections required to be applied for calculating the lengths of runways for all types of aerodromes. These are elevation, temperature and gradient.

7.3.1 Correction for Elevation

The required field length increases at a rate of 7% per 1000 ft. (300m) elevation above mean sea level. Thus, the elevation factor *Fe* can be computed by the following equation:

$$Fe = 0.07 \times E + 1$$

Where:

E **=** airport elevation (in thousands of feet (m))

7.3.2 Correction for Temperature

The field length that has been corrected for elevation should be further increased at a rate of **1%** for every **1°C** by which the airport reference temperature exceeds the temperature in the standard atmosphere (**15°C at sea level**) for that elevation. The airport reference temperature *T* is defined as the monthly mean of the daily maximum temperatures (24 hrs) for the hottest month of the year. It is recommended that the airport reference temperature be averaged over a period of years. The temperature in the standard atmosphere is 15°C at sea level, and it decreases approximately 1.981 degrees for each 1000ft (300m) increase in elevation. The equation for the temperature correction factor becomes:

$$Ft = 0.01[T\,(°\,C) - (15 - 1.981E)] + 1$$

Note:

Aerodrome reference temperature $= T_1 + \dfrac{T_2 - T_1}{3}$

Where:

T1 = the monthly mean daily temperature for the hottest month of the year.

T2 = the monthly mean of the maximum daily temperature for the same month.

The values of T1 and T2 are determined over a period of years. On any day, it is easy to observe the maximum and minimum temperature, t_2 and t_1, respectively.

Average daily temperature $= \dfrac{t_1 + t_2}{2}$

Maximum daily temperature $= t_2$

For a thirty-day month, therefore, the monthly mean of the average daily temperature, T1 = 1/30 of the thirty values of $\dfrac{t_1 + t_2}{2}$ obtained once every day in the hottest month, all added together.

Similarly, the monthly mean of the maximum daily temperature T2 = 1/30 of the thirty values of t_2 obtained once every day in the hottest month, all added together.

Note: If however, the total corrections for elevation and temperature exceeds 35%, the required corrections should be obtained by means of specific study. The operational characteristics of certain aeroplanes may indicate that these correction constants are not appropriate, and that they need to be modified by results of aeronautical study based upon conditions existing at a particular site and the operating requirement of such aeroplanes.

7.3.3 Correction For Gradient

Where the basic length determined by take-off requirements is 900m and over, it is recommended that the runway length that has been corrected for elevation and temperature be further increased at a rate of 10% for each 1% of effective runway gradient *G*. This recommendation is applicable for take-off conditions when the runway code number is 2, 3, or 4. Thus, for take-off conditions for runway code numbers 2, 3, or 4, the gradient factor is:

$$F_g = (0.10G + 1)$$

8.0 TAXIWAYS

In the interest of safety and good aircraft maneuverability, adequate separations must be provided between runways and taxiways, along with ample clearances to buildings and other obstacles. Tables 3 below summarizes these and other minimum dimensional standards. To use the dimensional standards, first determine the reference field length, the wingspan, and the outer main gear wheel span for the critical aircraft. The standards are keyed to the reference code defined in Table 1 of this Advisory Circular

Table 3– Taxiway minimum separation distances

Distance between taxiway center line and runway center line (meters)												
Code letter	Instrument runway code number				Non-instrument runways code number				Taxiway center line to taxiway center line (meters)	Taxiway, other than aircraft stand taxilane, center line to object (meters)	Aircraft stand taxilane center line to aircraft stand taxilane center line (meters)	Aircraft stand taxilane center line to object
	1	2	3	4	1	2	3	4				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
A	77.5	77.5	-	-	37.5	47.5	-	-	23	15.5	19.5	12
B	82	82	152	-	42	52	87	-	32	20	28.5	16.5
C	88	88	158	158	48	58	93	93	44	26	40.5	22.5
D	-	-	166	166	-	-	101	101	63	37	59.5	33.5
E	-	-	172.5	172.5	-	-	107.5	107.5	76	43.5	72.5	40
F	-	-	180	180	-	-	115	115	91	51	87.5	47.5

9.0 CLEARWAYS AND STOPWAYS

In certain instances, it is possible to substitute clearways and stopways for a portion of the full-depth pavement structure. A clearway is a defined area connected to and extending beyond the end of a runway available for the completion of the take-off operation of turbine-powered airplanes. It increases the allowable airplane operating take-off weight without increasing runway length.

A stopway is an area beyond the runway designated by the airport authority for use in decelerating an aircraft in case of an aborted take-off. It must be at least as wide as the runway and must be capable of supporting an airplane without causing structural damage to it. Because stopways are seldom used, it is often more cost effective to construct a full-strength runway that would be useful in both directions rather than a stopway. The decision to provide a stopway and/or a clearway as an alternative to an increased length of runway will depend on the nature of the area beyond the end of the runway. It also depends on the operating characteristics of airplanes expected to use it.

10.0 RUNWAY STRIP AND RUNWAY END SAFETY AREA CONSIDERATIONS

The runway strip and runway end safety area are designated areas surrounding the runways. These safety areas are to be:

a) Cleared and graded and have no potentially hazardous ruts, humps, depressions, or other surface variations;
b) Drained by grading or storm sewers to prevent water accumulation;
c) Capable, under dry conditions, of supporting, aircraft rescue and firefighting equipment, and the occasional passage of aircraft without causing structural damage to the aircraft, and;
d) Free of objects, except for objects that need to be located in these safety zones because of their function in aiding air navigation.

The dimensions of the runway strip and runway end safety area surrounding the runway are a function of the critical aircraft. Since operations are performed to both runway ends, depending on wind conditions, the safety zones effectively needs to meet the requirements of the Aerodrome Standards Manual beyond both runway ends.

Note: Runway and taxiway safety areas are prepared, graded areas that are suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or deviations from the runway or taxiway. Such areas must be clear of objects except for lights, signs, and other objects whose locations are fixed by function.

11.0 OBJECTS ON THE STRIP OR RUNWAY END SAFETY AREA

Object situated on a runway end safety area which may endanger aeroplanes should be regarded as an obstacle and should be removed. Within the general area of the strip adjacent to the runway, measures should be taken to prevent an aeroplane's wheel, when sinking into the ground, from striking a hard vertical face. Special problems may arise for runway light fittings or other objects mounted in the strip or at the intersection with a taxiway or another runway. In the case of construction, such as runways or taxiways, where the surface must also be flush with the strip surface, a vertical face can be eliminated by chamfering from the top of the construction to not less than 30 cm below the strip surface level. Other objects, the functions of which do not require them to be at surface level, should be buried to a depth of not less than 30 cm.

11.1 SIGHT DISTANCES

The Obstructions in the runway are not likely to be moving. The pilot has, however, to be careful about the possible passing of another aircraft at an intersection with another runway or taxiway. The recommended vertical grades are very gentle. It lays down that for all classes of airport, any two points 3m above the runway must be mutually visible within a distance of half the runway length.

11.2 LONGITUDINAL GRADES AND GRADES CHANGES

Provision of grade along a runway affect the aircraft performance in a number of ways. Frequent grade changes not only restrict the sight distances and increase the runway length needed for landing and take-off, but jeopardize the safety of the aircraft flying at high speeds during the take-off operation. It is for this reason maximum longitudinal gradient along a runway is limited to 1.5% and maximum effective gradient to 1% for permissible grades and grade changes in Civil Aviation (Aerodromes) Regulations.

12.0 VISUAL AIDS AND ELECTRICAL SYSTEMS

Proper design and installation of visual aids (wind direction indicators, markings, lights, markers and signs) are prerequisites for the safety and regularity of civil aviation. Aerodrome developers shall refer to detailed requirements for visual aids contained in Civil Aviation (Aerodromes) Regulations.

13.0 OBSTACLE LIMITATION SURFACES

Airports must be sited in areas where airspace is free from obstruction that could be hazardous to aircraft turning in the vicinity or on take-off or approach paths. It is also necessary to maintain the surrounding airspace free from obstacles, preventing the development and growth of obstructions to airspace that could cause the airport to become unusable.

The regulations on the protection of airspace in the vicinity of airports are laid down by the definition of a set of imaginary or obstacle limitation surfaces, penetration of which represents an obstacle to air navigation. A set of imaginary or obstacle limitation surfaces of international standards is promulgated by the Civil Aviation (Aerodromes) Regulations for consultation to obtain an obstacle free airspace.

14.0 SUBMISSION OF DESIGN DRAWINGS

The concept design drawings of the proposed aerodrome is required to be submitted by the aerodrome developer to Uganda Civil Aviation Authority for appraisal before commencement of any work and should contain and include the following information and format;

14.1 TITLE SHEET

Every sheet should show the following:

- Applicable scale
- Signature and revision blocks completed with signature and date of latest revision
- Existing and/or ultimate airport development elements
- Map legend depicting existing and ultimate elements with different symbology (Note: Not required on project title sheet)
- North Arrow

14.2 PROJECT TITLE SHEET

The project title sheet provides a quick overview of the airport's location, navigational aids, aircraft design type, ALP sheet index, and signatures. Items that must be shown on a title sheet include the following:

- State outline depicting aerodrome boundaries.
- Vicinity map – showing immediate area around the airport
- Location map – showing general area of the location of the airport
- Index to sheets
- Wind rose – all weather and Instrument Flight Rules (IFR) weather wind rose
- Wind coverage data table
- Airport data table
- Approval signature block – should contain revision block and signature blocks for the following:
    - ➢ Client of the Airports
    - ➢ Client's Engineer
    - ➢ Consultant Engineers

14.3 AIRPORT LAYOUT DRAWING

This sheet is a detailed, scaled representation of existing and ultimate airport facilities. It provides pertinent dimensions and clearance information pursuant to applicable standards. This sheet should be scaled to show the entire airport facilities such as:

a) Physical features
    - Runway
    - Taxiway/links

- Runway turn pad (if applicable)
- Apron
- Runway/Taxiway strips
- Runway end safety areas
- Terminal/Technical Building
- Fire Fighting Station
- Power house
- Meteorological Station/ AWOS Sensors' locations
- Control Tower
- Car parking area
- Fuel farm
- Sewage treatment plant
- Aircraft hanger
- Access/emergency roads, access gates and crash gates
- wind direction indicator
- Airfield lighting including approach lights
- ILS Equipment shelter and Antennas Structure locations
- CVOR, DVOR, NDB Equipment shelters and the Antenna structure (for Terminal) locations.
- Surveillance RADAR Equipment shelter and Antenna Structure location.

b) Airport Reference Point (ARP) - latitude and longitude to the nearest second based on WGS-84

c) Elevations - measured to the accuracy of one-half metre above mean sea level including geoidal undulation value

14.4 AIRPORT AIRSPACE DRAWING

The airport airspace drawing sheet(s) (Obstacle Chart Type A and Type B) should include all Obstacle limitation surfaces as contained in the Civil Aviation(Aerodromes) Regulations plus a drawing of the approach surfaces to the full length of the approach surface. The surfaces shown should be for the ultimate runway lengths. The drawing is intended to show the relationship between the imaginary surfaces and the topographical features. Emphasis is on defining significant objects and elevations that are critical to airport operations.

All obstructions, natural and constructed, within any imaginary surface must be shown in a schedule of obstructions with the proposed disposition. The schedule should show a reference number for all obstructions shown on the plan and profile drawings. The disposition of the obstruction must be shown along with the effective date of the disposition.

14.5 INNER PORTION OF THE APPROACH SURFACE DRAWING

This drawing is an easily-readable, scaled detail of the approach surfaces. A separate sheet for the inner portion of the approach surface drawing will be required for each end of each runway.

It should be drawn at a scale to show the approach surface from the ground to at least a height 100 feet (30m) above the elevation of the end of the runway. There should be a plan and profile drawing on each sheet. The approach surface drawing sheets may show other zones, i.e. runway protection zone.

A separate schedule of obstructions should be included on each sheet for each approach surface showing the extent of the penetration and the proposed disposition of the obstruction. Each disposition must have a date associated with it. The schedule of obstructions should give coordinates for each obstruction listed. Obstructions should also be depicted on both the plan and profile drawings.

14.6 LAND USE DRAWING

This sheet provides details for current and future uses of property within and surrounding the airport boundaries. It also serves as a planning tool for communities to ensure that growth in the area around the airport will be compatible in use and not impede future aeronautical expansion. The land use map should show existing, as well as recommended land uses for all properties within the **ultimate** airport boundary, and in the surrounding areas. Property use and zoning should be identified as residential, commercial, industrial, park, etc.

14.7 ZONING MAP (SITE PLAN)

The purpose of this is to identify the extent of the land allocated and approved by the Planning and Development Authority of the State. It may be utilized by the airport operator as well as the local Planning and Development Authority, for use in exhibits for zoning ordinances, planning, and issuing permits for development around existing and proposed airport designs. The map should show all the existing property zoning in the area (agricultural, residential, commercial, etc.), before acquisition and evidence of compensation provided to the UCAA. In addition, all appurtenant topographical data, including waterways, man-made structures, and significant contours, if available, it is recommended that an aerial photo be used as a background for this mapping.

14.8 PROPOSED RUNWAY LONGITUDINAL PROFILE AND CROSS SECTION DRAWINGS

The sheet(s) provide(s) survey details of the proposed runway profile and cross section, this is to be done in three phases; the runway, and along the inner approach of both ends of the runway, this is before and should be repeated after completion of the construction and submitted to Uganda Civil Aviation Authority on each occasion.

UGANDA CIVIL AVIATION AUTHORITY
UGANDA
DIRECTOR
SAFETY, SECURITY AND ECONOMIC REGULATION

Director Safety, Security and Economic Regulation