The Second Meeting of the Asia/Pacific Aerodrome Design and Operations Task Force (AP-ADO/TF/2)

Video Teleconference, 26 to 29 January 2021

Agenda Item 5: AP-ADO/TF Task List

DRAFT REGIONAL GUIDANCE FOR THE DESIGN AND OPERATION OF ALTIPORTS

(Presented by Bhutan, India and Nepal)

SUMMARY

This paper presents the preliminary draft *on Regional Guidance for the Design and Operation of Altiports* prepared by Nepal and collaborated by Bhutan and India.

1. INTRODUCTION

1.1 Task 1/2 of AP-ADO/TF requires that a *Draft Regional Guidance for the Design and Operations of Altiports and Aerodromes in Constrained Environment* ("*Draft Regional Guidance*") be prepared. This paper presents the preliminary draft specifically for altiports.

1.2 In preparing the *Draft Regional Guidance*, the following provisions from the ICAO STOLPORT Manual (Doc 9150) were found relevant (underline added):

> *STOLPORT is defined as "an airport whose physical characteristics, visual and non-visual aids and total infrastructure are created to support safe and effective public air transport in and out of densely populated urban areas as well as to and from rural areas with <u>difficult terrain</u>." (FOREWORD, para 2)*
>
> *The STOLPORT design aeroplane is assumed to be an aeroplane that has a <u>reference field length of 800 m or less</u>. In size, the STOLPORT design aeroplane is assumed to have a <u>wingspan of up to 26 m</u> and a main landing gear measurement of up to 9 m. (para 1.1.3), i.e. <u>up to ARC 1B</u>.*
>
> *Any excessive longitudinal slope on a runway will adversely affect both the landing and take-off roll of an aeroplane. For this reason, wherever possible, the longitudinal slope of a STOLPORT runway should be held to 1.0 per cent or less, <u>not to exceed 2.0 per cent</u>. The longitudinal slope of a runway can be obtained by dividing the difference between the highest elevation and the lowest elevation along the centre line by the runway length. (para 3.2.5.1)*
>
> *In cases where the longitudinal slope of a STOLPORT runway exceeds 2.0 per cent, it may be necessary to advise the operators that operations are restricted to landing uphill and taking off downhill. (para 3.2.5.2)*
>
> *The longitudinal slope of a STOL runway is flatter than even that prescribed for a runway designed for the operation of conventional aircraft and generally has approach/departure areas at both ends of the runway. (FOREWORD, para 4)*

A runway width of 23 m has been considered generally suitable for aeroplanes like the STOLPORT design aeroplane described in Chapter 1, for use in visual meteorological conditions. However, the width of a precision approach runway for such an aeroplane should be not less than 30 m. (para 3.2.4)

Doc 9150 defines an ALTIPORT as "a small airport in a mountainous area with a steep gradient runway, used for landing up the slope and for take-off down the slope, thereby making use of only one approach/departure area." (FOREWORD, para4)

It should, however, be noted that stolport specifications are not applicable to altiports which are constructed in mountainous regions, though some of the STOL aircraft in use today are designed to operate from altiports. (FOREWORD, para4)

2. DISCUSSION

Situations in Nepal, Bhutan and India

2.1 Nepal has a total of 50 airports with one International Airport, four Domestic hub airports, and 44 other domestic airports.

2.2 Among the 44 domestic airports, 35 existing airports are located in the mountainous/hilly terrain, most of which have the steeper longitudinal runway slopes which are referred as altiports in ICAO STOLPORT Manual (Doc 9150). Information of the domestic airports is summarized as follows:

Domestic Airfields of various sizes in different altitudes with different longitudinal slopes

Length (m)	<400	400<800	800<1200	1200<1600	>1600
No. of Airports	2	31	4	6	1

Elevation (meter)	60-305	305-1000	1000-2000	2000-3000	>3000
No. of Airports	9	9	11	12	3

Gradient (%)	0-2%	2-5%	5-10%	>10%
No. of Airports	26	12	5	1

2.3 In addition, there are several domestic airports in Bhutan and India with similar situations. Information of these airports is available as follows:

Some Domestic Airports in Bhutan with higher runway gradient/high altitudes

Airport Name	***Runway dimensions***	***Slope of RWY-SWY***	***Elevation***	***Remarks***
AD 2.1-VQTY-3 Yonphula airport	1 200 X 30 M	RWY 12 slope 2.0% MID RWY slop 1.17% RWY30 slope 2.0%	2 541M AMSL 2 562 M AMSL	One direction of landing and takeoff is permitted. All aircraft shall land from RWY12 and take off from RWY30 due high obstacle toward RWY30.
AD 2.1-VQGP-1	1 500 X 30 M	2.29%	300.944 M AMSL	After departure climb initially 18,000 ft on QNH maintaining visual to terrain/obstacle and

Gelephu Airport			2 66.434 M AMSL	report over designated compulsory reporting points.
AD 2.1-VQBT-3 Bumthang Airport	1200 X 30 M	0.83%	2 580 M AMSL 2 571 M AMSL	

Some Domestic Airports in India with higher runway gradient/high altitudes

Airport Name	***Runway dim***	***Slope of RWY-SWY***	***Elevation***	***Remarks***
AD 2.1-VEBI Barapani Airport	1829X45	-2.3%, -0.4%	2916 FT 2900 FT	INTL - DOM
AD 2.1-VIDN Dehradun Airport	2140X45	+1.03%	1801 FT 1822 FT	INTL - DOM
AD 2.1-VOBM Belgaum Airport	1763X45	-1.2%, +0.18	THR:2478.0FT TDZ:2486.0FT	INTL - DOM

Draft Regional Guidance

2.4 The *Draft Regional Guidance* should make reference to ICAO Annex 14, Volume I and/or ICAO STOLPORT Manual (Doc 9150) in the editorial practices and coverage.

2.5 The table of contents of the *Draft Regional Guidance* is provided in **Appendix 1**. In addition, with reference to *Instruction Technique sur les Aérodromes Civils* (ITAC) by DGAC France, some chapters may be included in the *Draft Regional Guidance*. The chapters are:

a) Determination of Runway Length of Altiports (**Appendix 2**);

b) Sample Runway Profile for Altiports (**Appendix 3**);

c) Obstacles Limitation Surface for Altiports (**Appendix 3**); and

2.6 **Appendix 4** to this WP provides a comparison table on physical characteristics, OLS, visual aids as per Annex 14, Volume I (for ARC 1B), STOLPORT, Altiports (ITAC, DGAC France) and CAAN practices for Altiports, which may be considered while developing a *Draft Regional Guidance*.

2.7 During the preparation of the above materials, the following documents were identified as potential references.

a) ICAO Annex 14 – *Aerodromes*, Volume I – *Aerodrome Design and Operations*;

b) ICAO STOLPORT Manual (Doc 9150);

c) ICAO Aerodrome Design Manual (Doc 9157), Part 1 – *Runways*;

d) FAA AC 150/5325-4B: *Runway Length Requirements for Airport Design*, Chapter 2 *Runway Length for Small Airplanes*;

e) FAA AC 150/5220-22B: *Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns*;

f) CASA CAAP 92A-1(0): *Guidelines on Aerodromes intended for Small Aeroplanes conducting RPT Operations*;

g) ITAC, DGAC France;

h) *Minimum Safety Requirements for Temporary / Unlicensed Aerodromes*, DGCA India; and

i) *Flight Operations Requirements Aeroplane*, Appendix 9: *STOL Field Clearance Requirements*, CAA Nepal

2.8 Meanwhile, efforts will be made to identify additional reference materials.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this Paper;

b) review and refine the table of contents (**Appendix 1**) and individual chapters (**Appendix 2 – 3**); and

c) discuss the way forward for the preparation of the *Draft Regional Guidance* considering materials provided in **Appendix 4**.

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Regional Guidance for the Design and Operations of Altiports and Aerodromes in Constrained Environment

<u>DRAFT</u>

Table of Contents

Determination of the Length of runway of an altiport:

As for aerodromes with normal characteristics *, determination of the length ** of an altiport runway required specialized input from the expert. The simplified method as describe below nonetheless will be good approximation for the determination of the length of an altiport runway for light aircraft.

For longitudinal profile slopes which are adopted on the altiports, the acceleration of an aircraft on take-off in its rolling phase is subjected to additional force due to effect of component of the acceleration due to gravity, g acting along the runway axis in slope of angle α, compared to what it would be on a substantially horizontal runway,.

Therefore, if $\mathbf{a_H}$ denotes the acceleration of the aircraft traveling at speed V on a horizontal runway Fig.13-1-3-A, the acceleration $\mathbf{a_\alpha}$ of the same aircraft traveling at the same speed on a slope of an angle α to the horizontal as shown in the Fig.13-1-3-B has the value:

$\mathbf{a_\alpha} = \mathbf{a_H} + g.\ sin\ \alpha$ **------A**

Fig.13-1-3-A

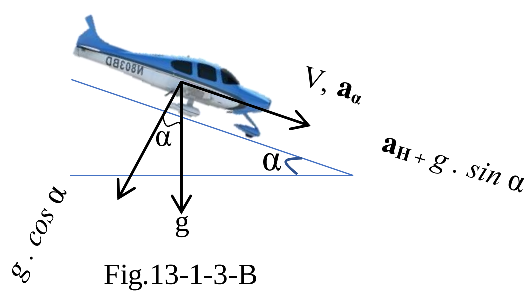


Fig.13-1-3-B

In the case of the deceleration corresponding to an acceleration-stop procedure the force due to gravity would be in opposite direction with respect to deceleration hence the equation-**A** may be rewrite as:

$\mathbf{a_\alpha} = \mathbf{a_H} - g\ .\ sin\ \alpha\ .$ **-------- B**

The assumption is made below that an acceleration $\mathbf{a_H}$ is invariant of the aircraft type which makes this method as the approximation method.

Let us take the scenario with the multiple slopes of the runway, where the aircraft movement uniformly accelerated (respectively decelerated) on each section of runway portion i of constant slope α_i and applying the newton's law of motion elimination of the time variable between expressions the distance traveled on the axis and the speed leads to the relation:

2ad=$v_f^2 - v_i^2$; where,

'a' is an acceleration, 'd' is distance travelled and v_f^2 is the final velocity and v_i^2 is the initial velocity of any object/ aircraft.

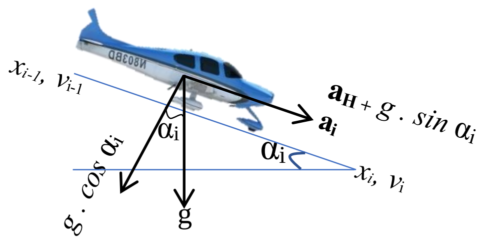


Fig.13-1-3-C

$2\ \mathbf{a}_i\ .\ (x_i - x_{i-1}) = v_i^2 - v_{i-1}^2$ **---------C**

in which:

- ✓ $\mathbf{a}_i = \mathbf{a_H} + g.\ \sin \alpha_i$
- ✓ $(x_i - x_{i-1})$ is the length of the section**,**
- ✓ v_{i-1} is the speed at the origin of said section,
- ✓ v_i is the speed at its end.

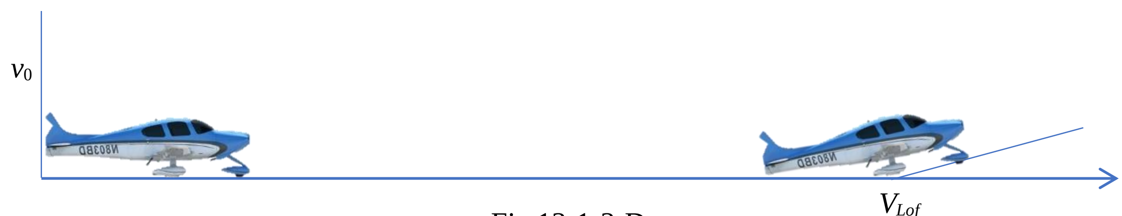


Fig.13-1-3-D

By successively writing this relation for each section of constant slope since the release brake (v_0 = 0) until the speed reaches the flight speed $V_{Lof,}$ we obtain a series of equalities, which, by addition, results in the formula giving the length of runway preceding the point where the reference aircraft leaves the ground after having initiated it's pitch up Fig.13-3-D.

$2\ \Sigma\ \mathbf{a}_i\ .\ (x_i - x_{i-1}) = V_{Lof}^2$**---------D**

Note that by making $\alpha = 0$, in the equation-**D** allows to substitute for the parameter $\mathbf{a}_i$ by value $\mathbf{a}_H$, whose value is not published with respect to the speed V_{Lof} and the distance at the end of at which this speed is reached on a horizontal runway.

For altiports intended to accommodate exclusively only light aircraft, to which the method above is intended, the length to be given to the track is taken equal to the product by 1.25 of the distance thus calculated from the equation-**D**.

Although current regulations do not require deceleration-stop (take-off interruption) for light aircraft, however the possibility of a take-off interruption can also be taken into account for determine the length of the runway track of the altiport.

Slope of the section of the runway of an altiport:

In longitudinal profile, for the section with strong slope, the maximum value of 20% for the average slope and that of 25% at any point. On this same section ****, the maximum change value of longitudinal slope will be taken equal to 8%, the distance between two successive changes of slope must not be less than that given by the formula already explained by figure 3-15 *****.

$D \geq 45\text{m}$

$(\,|\,y - x\,| + |\,y - z\,|\,)\,.\,R$

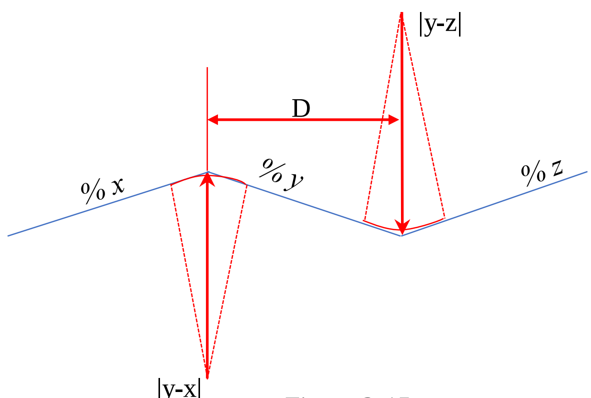


Figure 3-15

** cf. chapter 3 - § A-2*

*** Given the steep slopes, it is specified that the length, referred to here, is that measured in the field.*

**** cf. chapter 3 - § A-2-1 - figure 3-4*

***** This constraint does not naturally apply to the junction between the steep section of the track and the upper part of it.*

****** cf. chapter 3 - § A-4-2*

Width of the runway of an altiport:

The width of an altiport runway can be fixed by reference to the minimum values previously provided * for aerodromes with normal characteristics according to the reference code of the most restrictive airplane to be served.

To add on, the letter of aircraft code does not seem to have to be characterized differently for an altiport other than an aerodrome with normal characteristics, due to the fact, that the reference distance of the same aircraft does not either not by itself significant for an altiport, hence must not give the correlation that exists between the distance and the speed of the aircraft to reach its rotational speed (VR) hence this doesn't not allow to use of the code digit ** associated with it.

The minimum widths previously provided for aerodromes with normal characteristics will be therefore applicable without correction to altiports. This is how the minimum width of the runway will be 50 m in unpaved configuration. With regard to paved runways, the absolute minimum for their width is therefore 18 m.

The choice of location and orientation to give to a runway at hilly region generally have constrains, hence special attention will be required to account for the crosswinds for determination of the width of the runway apart from the other parameters.

Cross Section of the Runway of an altiport:

In cross section, the slope will not exceed 2%, its longitudinal value for the paved runway as well as unpaved runway to account for water drainage.

Regarding the structure of the runway, all the recommendations, which are mention in the chapter 6 for aerodromes with normal characteristics, are applicable to altiports.

However, special attention must be paid to these, brought to the implementation of the more layers / thickness for fairly steep slope runway of an altiport also the possibilities of rapid erosion due to this slope need to be taken into account whiling finalizing the layer/ thickness of the runway.

* cf. chapter 3 - § A-3-1 for paved runways and A-3-2 for uncoated ones

** Without this situation being able to be established as a rule, it is note that, being short take-off and landing, airplanes used on altiport generally assigned the code number 1.

13-1-4 Characteristics of the Runway strip

As for aerodromes with normal characteristics, the runway strip is an area free of any obstacle containing at least the runway – y including its upper section - and its possible stopway extension in the lower part.

In order to allow the use in the best conditions of the entire length of the runway, it is recommended for both paved and unpaved runway to extend the runway strip beyond the top end of the runway of at least half length of the maximum wingspan of corresponding aircraft to which an altiport is intended to serve.

Track of the Alpe d'Huez altiport

Snowy track of the Courchevel altiport

However, in the case of paved runway, the strip should be extended 30 m beyond the lower end of the runway or its possible stopway extension.

In case, an altiport runway being intended to be operated in visual meteorological condition, the minimum clear width of its strip will be as for aerodromes at normal characteristics and except in special cases of an unpaved runway, taken equal to that of said strip released.#

For paved runway grading of the runway strip should have values those corresponding to aerodromes with normal characteristics * whereas in an unpaved runway the grading part should covers the entire runway strip

However, in both case (paved and unpaved) the slope of the graded parts of the runway strip should preferably be identical to that of the runway.

For the paved runway track, in which snow removal and de-icing be done across the width of the runway then on both sides of the runway a drop of 0.50 m be provided at the edge of the runway followed by a slope of 15% up to the lateral boundary of the runway strip.

For the both paved or unpaved runway – grooming should be done on a minimum width of 30 m plus up to 15% of the lateral boundary of the runway strip.

13-1-5 Upper platform of an altiport

The upper platform of an altiport is made of:

- the upper part of the runway that can be used for landing maneuvers or lift-off,

- a waiting area where aircraft carry out tests of engine (s) at the fixed point, area capable of also serve as a turning pad,

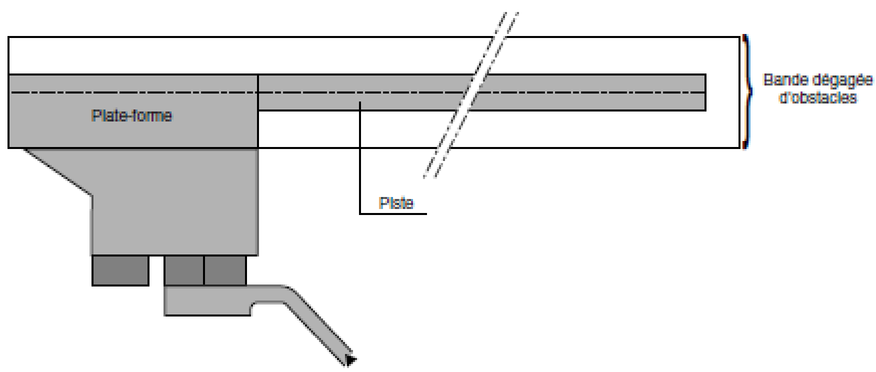
- the parking area.

These components can be sodded or paved.

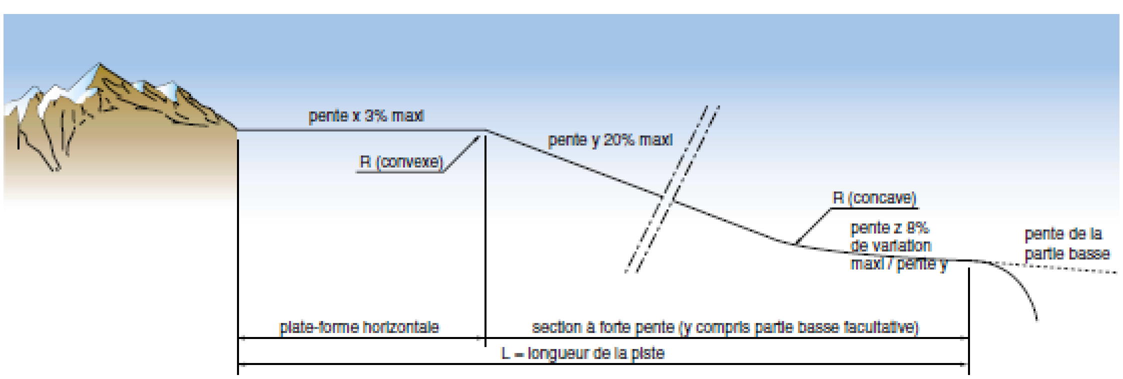
The upper part of the runway can have longitudinal profile up to 3% slope however upper platform part of such runway must not exceed 2% slope in any direction.

Side-by-side parking of planes and helicopters are not advised. If the use of altiports by helicopters are frequent *, it is recommended to reserve a specific parking space for them.

The following figures show the schematic diagram of an altiport having a paved runway (figure 13-1), as well as simplified longitudinal profile of an altiport (figure 13-2).



13-1 - Block diagram of an altiport (case of a paved runway)



13-2 - Longitudinal profile of an altiport runway

13-1-6 Markings and visual aids

General principles of non-illuminated markings applied for aerodromes with normal characteristics * also apply at the altiports.

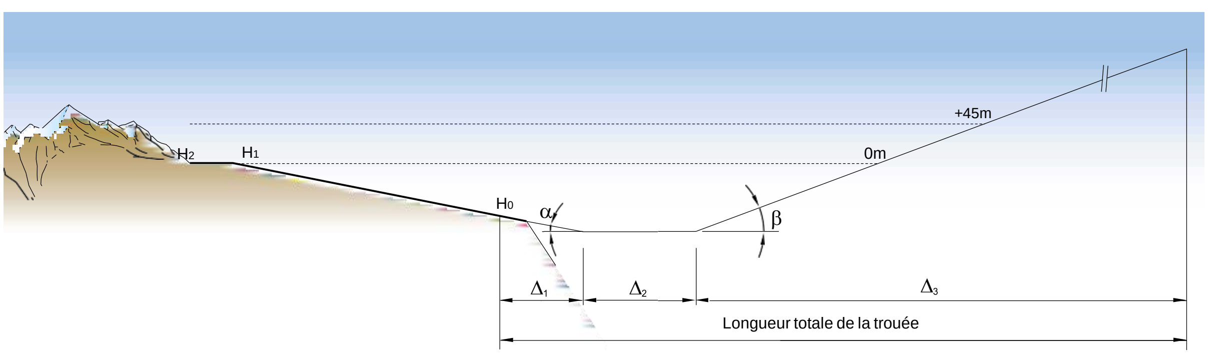
However, for unpaved altiport runways generally it is recommended to have center line (axial) marking at least on the upper section of an altiport runway i.e. at the start of the run before takeoff so as to compensate the possible lack of visibility caused to the pilot by the change of slopes of runway section.

The runway may be equipped with a visual aid indicator such as P.A.P.I. or A.P.A.P.I.

When an altiport will be kept in operation without being cleared of snow, the edges of its runway will be delimited by red flags spaced 25 m apart.

An altiport that may be subject to frequent strong wind, in multiple direction and various intensity, it is necessary to have a wind sock near the waiting area, for planes at take-off, and another at the runway threshold, to landing planes, due to the fact that at these two locations due to strong wind conditions that will be mostly affected.

13-1-7 Clearance surfaces



13-3 – Cross section of the clearance surface

Clearance surfaces, as previously specified for aerodromes with normal characteristics, not applicable at the altiports to which they are not suitable.

The variety of runway configurations ensures clearances that can be provided for an altiport can only be achieved after a review of approach and take-off procedures of airplane.

The description given below of the clearance surfaces that may be associated with a gap unique is therefore only indicative and has no object than to allow dialogue with a service specialized (S.T.B.A. or S.S.B.A.).

The "tailor-made" character of clearance surfaces make no difference here between landing and take-off gaps.

The longitudinal profile of the hole plane axis is generally characterized by:

- a segment Δ1 taking its origin on the center on the small lower side of the strip and slope negative at least as marked as that of the axis of the lower section of the track,

- a horizontal segment Δ2,

- a segment with a positive slope Δ3, the length of which is sufficient for the plane to take off can free himself from nearby obstacles.

The total length of the gap should not be less than 2000 m, the values of Δ1, Δ2 and Δ3 will be determined on a case-by-case basis by the civil aviation in function:

- the reference code corresponding to the aircraft on more restrictive to be accommodated by the altiport,

- site-specific operating constraints studied.

In plan, the gap connects to the perpendicular segment in the axial plane of the track passing through the center of the small lower side of the strip. Equal originally to that of the band, the width of the gap increases linearly until it reaches 1 km, the divergence δ of the downhole straight lines being at least 20% *. Beyond, the width of the plane gap remains constant and equal to 1 km.

The side clearance surfaces are two ruled surfaces, whose generators are contained in a plane perpendicular to the axial plane of the track and of which the directors, who constitute the lower and upper limits of these surfaces, are :

- on the one hand, the line of support defined by the long sides of the band and sides of the trapezoids

hole bottom corresponding to the first two longitudinal profile segments defined above,

- on the other hand, the horizontal lines resulting from upper angles of the strip and forming with the

vertical plane containing the axis of runway one 20% divergence.

The site selected must also allow an aircraft to make, before landing, a passage through reduced vertical height of the installations in order to to ensure, if necessary, that the runway is clear on its upper part.

The conditions of this overflight will also, in each case, the subject of a specific study conclusions with which the contour will be associated a horizontal clearance surface. Placing oneself at a minimum height of 45 m, measured here from its upper platform, this surface will cover an area included in a sector circular, centered on the upper platform, radius equal to 2000 m and sufficient opening *

to allow the U-turn of a type aircraft admitted to the altiport. It is also recommended to provide a gap which protects missed approaches.

When the relief allows this gap to be centered in the extension of the runway (case of pass or dome altiport), it can be constructed as shown in figure 13-5 below.

Its characteristics (lower edge width, slope and divergence) will then be those of the take-off gap of a characteristic runway normal accommodating the same types of planes.

When on the other hand the relief will not allow that the go-around continues in the extension the runway (altiports on the mountainside), the interruption of the approach cannot be carried out than laterally.

Constructed as also shown in the figure 13-5, the clearance surfaces protecting then the intruded approach will be, on the side where this should be done:

- the horizontal half-plane having for dimension that Ho from the lower end of the strip,

- the ruled surface (cylindrical then plane) of which the generator will be contained in a parallel plane

in the axial plane of the runway and whose directing will be successively:

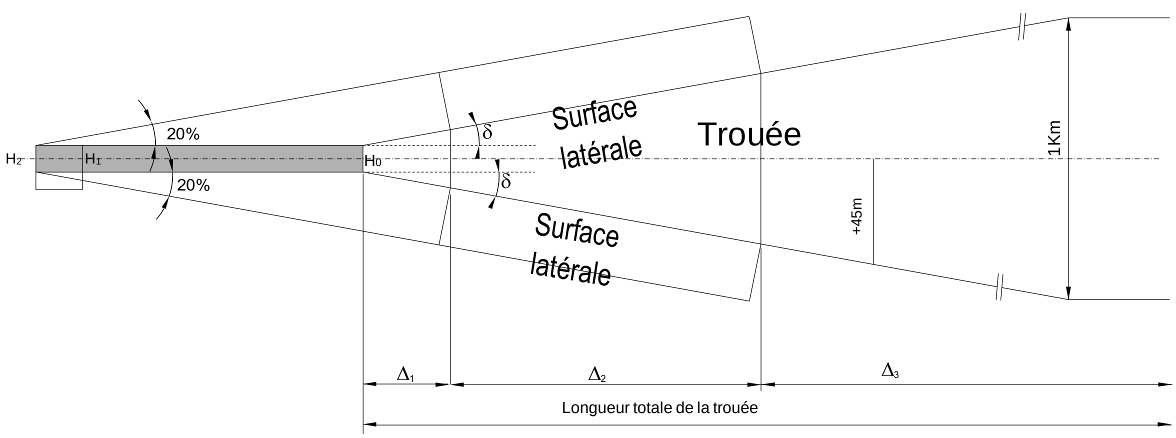
- two horizontal arcs of dimensions Ho and H2 (the latter being that of the small side upper band), each having a radius of at least 600 m, tangent to the plane axial of the track and the opening of which will be equal at the minimum angle of turn (depending on relief) to be performed by the aircraft,

- the horizontal tangents at the end of each of these two arcs.

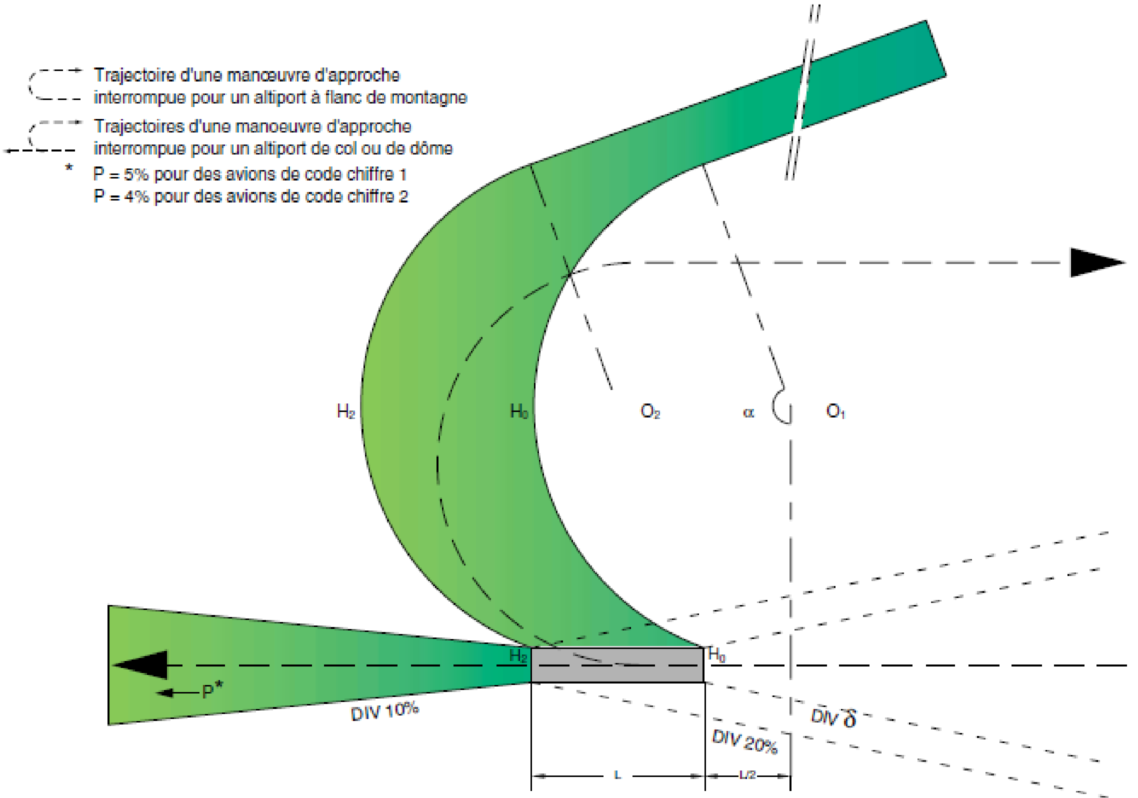
The arc of a circle at the Ho point will be centered beyond the track at a distance from its lower end equal to half the length of its section main steep slope.

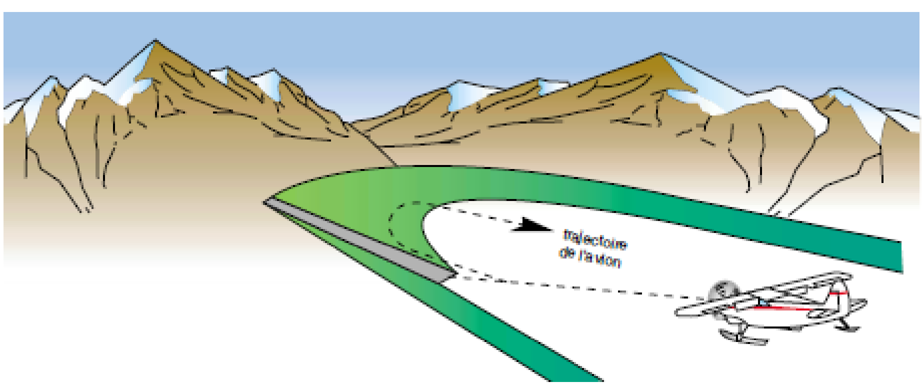
The arc of a circle at dimension H2 will be centered at height from the middle of the track.

As far as possible, this gap lateral rejected landing will complete, as shown in figure 13-5, the gap in the axis of the runway when the latter can be spared.

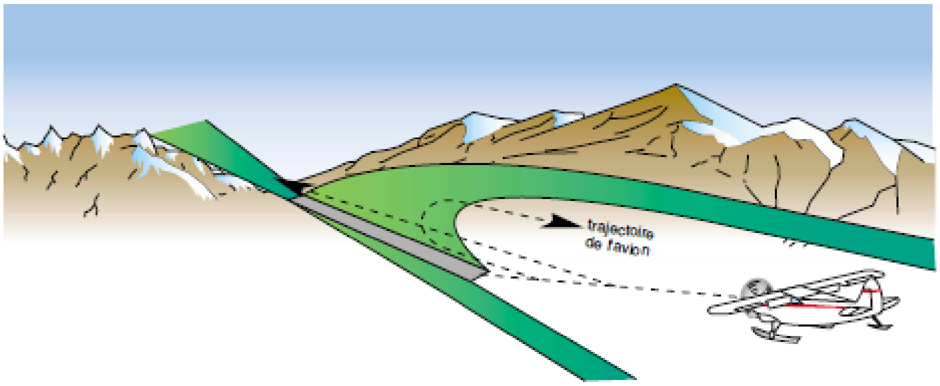


13-4 - Hole and side surfaces





a- Example of an altiport on a mountainside



b- Example of a col or dome altiport

13-5 - Gap and protective surface in the event of a missed approach maneuver

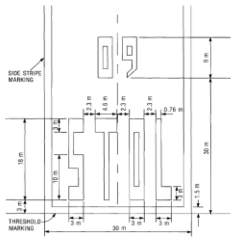
Appendix 4 to WP/13

Sno	Description	STOLport Manual	ICAO Annex 14	French Altiport Manual	Nepalese Context	New Proposed
1	Definition	the altiport is defined as a small airport in a mountainous area with a steep gradient runway, used for landing up the slope and for take-off down the slope, thereby making use of only one approach/departure area.	Definition not given and all STOL aircrafts fall under Category 1	Designed to serve hilly regions, one altiport is at least equipped: - a steeply sloping runway extending, in the upper part, by a gently sloping section, itself associated with a substantially horizontal platform comprising the waiting and parking areas, - a single gap resting itself on the lower end of the strip.	An ALTIPORT may be defined as "a small airport in a mountainous area with a steep gradient runway, used for landing up the slope and for take-off down the slope, thereby making use of only one approach/departure area." STOL FIELDs CLEARANCE REQUIREMENTS, FLIGHT OPERATIONS REQUIREMENTS AEROPLANE Appendix-9	An ALTIPORT may be defined as "a small airport in a mountainous area for STOL Aircraft operations **either** having a steep gradient runway, used for landing up the slope and for take-off down the slope, thereby making use of only one approach/departure area **or** high approach/take-off slope due to presence of natural obstacles often resulting a curved take-off/landing near runway threshold. (To be discussed)
2	No and orientation of runway	95% usability Factor preferable, Should consider traffic on approach, missed approach and departure so that obstructions in these areas or other factors will not unduly restrict operations.	95% usability Factor preferable95% usability Factor preferable Attachment A: Should consider if the airport is to be used in all weather conditions or VMC, and day only or day and night both		access to communities, improve accessibility, Tourism.	
		Should consider if the airport is to be used in all weather conditions or VMC, and day only or day and night both	Climatological Conditions: wind, compliance with OLS, Land use (current and future), noise		runway orientation is dictated by the orientation of ridge and valleys, according to the space available to construct the runway	
		It is likely that the configuration for most stolports would be a single runway usable from either end and an associated taxiway.	Visual and non-visual aids for approach to land		OLS according to Annex 14 cannot be maintained, atleast straight approach and takeoff is preferred No Obstacles in takeoff and landing and for missed approach in at least one direction is necessary whether be it straight or curved.	
3	Runway Length	3.2.2.1 The length of a stolport runway should be based on take-off and landing data obtained from the aeroplane flight manual of the stolport design aeroplane and considered together with the following factors: a) whether the approaches are open or restricted; b) longitudinal slope of the proposed runway; c) elevation of the site; d) temperature and humidity of the site; and e) nature of the runway surface. 3.2.2.2 The length of a runway does not necessarily have to provide for operations by the design aeroplane at its maximum mass. Rather, the aeroplane mass selected should be the mass required to carry out its allocated task and different take-off and landing masses may be determined for each site served by the design aeroplane.	Length of runway is calculated based on Airplane Reference field length after the correction for slope, elevation and temperation	Length of runway is calculated on the basis of additional momentum gained due to acceleration due to gravity	Length of runway for a design critical aircraft is calculated on the basis of it's performance chart on particular elevation, slope and temperature.	
4	Stopways and Clearways	Combination of Runway, stopway and clearway should meet the take-off and landing requirements	The runway, stopway and clearway lengths to be provided are determined by the aeroplane take-off performance, but a check should also be made of the landing distance required by the aeroplanes using the runway to ensure that adequate runway length is provided for landing.		Due to land constraint, we are more focussed on increasing the length of runway.	
5	Runway Width	A runway width of 23 m has been considered generally suitable for aeroplanes like the stolport design aeroplane described in Chapter 1 for use in VMC. However, the width of a precision approach runway for such an aeroplane should be not less than 30 m. ARFL of 800 m or less. Wingspan upto 26 m and Main landing gear measurement of up to 9 m	Runway width of 18 m for OMGWS upto 6 m and 23 m for OMGSW upto 9m < 6m		Stol aircrafts operating in Nepal have OMGWS less than 6 m hence, 20 m paved runway width is constructed	
6	Longitudinal Slope	less than 1% preferred but not exceeding 2%, Furthermore, 3.2.5.2 states, 'In cases where the longitudinal slope of a stolport runway exceeds 2%, it may be necessary to advise the operators that operations are restricted to landing uphill and taking off downhill.', Moreover, 3.2.5.3 states, 'Longitudinal slopes of runways should conform to relevant Annex 14 specifications for runway code number 1'.	Should not exceed 2%	3% maximum in startup platform, 8% maximum in touchdown zone, 20% max in rest area	11% maximum in Lukla airport	Should be as per critical aircraft's performance chart
7	Transverse slope	2% max	2% max		1.5 % to 2%	should be as per frequency of rainfall in particular area but not exceeding 2%.
8	Longitudinal Slope changes	not stated	not to exceed 2%, smooth transition by a curvature of 0.4% per 30 m. Distance between the slope changes is the sum of the absolute numerical values of the corresponding slope changes multiplied by 5000 or 45 m whichever is greater.		Longitudinal slope changes along the length of runway is maintained 2% with smooth transition parabolic curve where there is rapid acceleration or deceleration of aircraft. The slope of L-section of runway at the startup of runway in takeoff position is maintained very less to avoid aircraft roll itself.	Longitudinal slope changes along the length of runway is maintained 2% with smooth transition parabolic curve where there is rapid acceleration or deceleration of aircraft.

9	Sight Distance	none	unobstructed Line of sight from any point 2 m above the runway to all other points 2 m above the runway within a distance of at least half the length of the runway. For B and for A the number is 1.5 m	according to topography
10	Strength of runways	Should have sufficient bearing strength capable of supporting continual traffic of the Stolport design aeroplane along the length of the declared take-off run or the declared landing distance, and throughout it's full width.	A runway should be capable of withstanding the traffic of aeroplanes the runway is intended to serve	detail to be presented with IP
11	Surface of runways	The surface of a stolport runway should be constructed without irregularities that would affect aeroplane performance during take-off or landing. Surface unevenness that would cause vibration or other control difficulties of an aeroplane should be avoided.	The surface of a runway shall be constructed without irregularities that would impair the runway surface friction characteristics or otherwise adversely affect the take-off or landing of an aeroplane. A paved runway shall be so constructed or resurfaced as to provide surface friction characteristics at or above the minimum friction level set by the authority	detail to be presented with IP
12	Runway Strip	45 m on either side from the centre of runway for VMC, and 75 m for IMC. 60 m beyond the end of each runway or stopway is recommended.	30 m on either side from the centre of runway for VMC, and 70 m for IMC. 30 m beyond the end of each runway	Very difficult to maintain strip width and length due to topography.
13	Graded Areas	40 m on the either side of the centreline of runway	30 m on either side from the centre of runway for VMC, and 40 m for IMC. And same distance beyond the end of threshold along runway centreline	runway strip available is graded
14	Longitudinal and transverse slope of runway strip	same as annex 14	2% max	2.5 % max
15	Taxiway width	as per annex 14	1.5 m for OMGWS upto 6 m and 15 m when OMGWS >=9m and <6 m	18 m
16	Apron	the distance from the edge of an apron to the edge of a runway strip should be sufficient for an aeroplane parked on the apron not to penetrate the transitional surface.		Not possible
17	Slope	1% maximum	1% maximum	1% maximum
18	OLS	At the very minimum, for day-time operations in visual meteorological conditions, the surfaces requiring protection are the take-off and approach surface and the transitional surface. For use at night and when a circling procedure as part of an instrument approach is established, an inner horizontal surface will require protection as well.	The objectives of the specifications in this chapter are to define the airspace around aerodromes to be maintained free from obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.	Presence of permanent obstacles around the airport.
	length of inner edge	90 m	60 m for VFR and 140 m for IFR	
	Approach/take-off Divergence	15%	10% for VFR and 15% for IFR	
	Approach/take-off Length	6000 m	1600 m for VFR and 2500 m for IFR	
	Approach/take-off Slope	1 in 15 or 6% (designed by design aeroplane performance)	5% for VFR and 3.33% for IFR	
	Transitional Surface	1 in 5 or 20% The slope of transitional surface may be increased to a maximum of 50% (1 in 2) where: a)Obstacles that are deemed critical and that penetrate a 20% slope are suitably marked and lighted; b)Landing and take-off limits are set high enough to ensure that at decision height or at beginning of take-off any object penetratating a 20% slope is clearly visible; c) only precision approaches are permitted in IMC; d) the steeper slope extends only to the governing obstacle with the slope thereafter to the inner horizontal surface being 20%; e) use of the stolport is restricted to VMC when the required visual and non-visual aids are unservicable	20% for VFR and 14.3% for IFR	
	Inner Horizontal surface	Where it is necessary to provide for circling approach procedures an inner horizontal surface should be established. 3000 m radius with 75 m height. 4.4.2.1 The radius or outer limits of an inner horizontal surface should be at least 3 000 m measured from the stolport reference point. The shape of an inner horizontal surface need not necessarily be circular. 4.4.2.2 An inner horizontal surface should be a common plane at a constant height of 75 m above the elevation of the stolport reference point or the elevation of the highest permanent structure within the area of the inner horizontal surface, whichever is higher, but not exceeding 120 m. 4.4.2.3 Where the height of the inner horizontal surface is less than 9 m above the surface of the ground an imaginary surface located at 9 m should be established. 4.4.2.4 Where the height of the inner horizontal surface would exceed 120 m on one side of the runway a	45 m height 2000 m radius for VFR and 3500 m radius for IFR conical surface: 5% for additional 35m for VFR and 5% for additional 60 m for IFR	

semi-circular inner horizontal surface may be possible permitting a circling approach procedure on the other side of the runway. Where this is not possible, circling as part of an approach procedure should not be designed. Thus the need for an inner horizontal surface would be eliminated.

19 Runway Marking:

	Stolport Designation Marking		
		no of stripes is 4 for runway width of 18 m and 6 for runway width of 23 m	
	15 m long 1.8 m wide spaced 1.8 m apart if there is no stolport designation marking		
centreline marking	length of stripe is 15 m with the gap of 15 m and 45 cm wide.	0.3 m width for VFR and 0.45 for IFR length of stripe plus gap shall not be less than 50 m or more than 75 m. The length of each stripe shall be at least equal to the length of the gap or 30 m, whichever is greater.	
runway Side Stripe Marking	A runway side stripe marking is considered essential for the stolport runway. It should consist of a 90 cm wide stripe located at each edge of the runway for it's full length.	5.2.7.1 A runway side stripe marking shall be provided between the thresholds of a paved runway where there is a lack of contrast between the runway edges and the shoulders or the surrounding terrain. 5.2.7.2 A runway side stripe marking shall be provided on a precision approach runway irrespective of the contrast between the runway edges and the shoulders or the surrounding terrain. 5.2.7.5 A runway side stripe shall have an overall width of at least 0.9 m on runways 30 m or more in width and at least 0.45 m on narrower runways.	45 cm wide
Touchdown zone marking	A stolport touchdown zone marking should consist of two white rectangles at least 22.5 m long and 1.8 m wide as shown in Figure 5-4. The marking should be located symmetrically about the centre line of the runway and at a distance from the threshold that coincides with the glidepath origin and visual approach slope indicator location, if provided.	150 m from threshold to the beginning of marking length of stripe: 30 to 45 m width : 4 m lateral spacing: 6 m 1 pair	