UGANDA

Advisory Circular

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AERONAUTICAL DATA QUALITY REQUIREMENTS

1.0 PURPOSE

This Advisory Circular is intended to serve as guidance to aerodrome operators pertaining to aeronautical data requirements in the Civil Aviation (Aerodromes) Regulations. It outlines the requirements relating to data integrity, data accuracy, data resolution and chart resolution, with the objective of ensuring that aeronautical data and information of high quality and integrity are provided throughout the data chain so as to eliminate corruption of data.

2.0 REFERENCES

a) Civil Aviation (Aerodromes) Regulations as amended
b) Civil Aviation (Aeronautical Information Services) Regulations as amended
c) Civil Aviation (Aeronautical Charts) Regulations as amended
d) ICAO Doc. 8126 AIS Manual)
e) ICAO Doc 9674 – WGS 1984 Manual
f) ICAO Doc 9881 - Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information
g) ICAO Doc 10066 PANS-AIM

3.0 INTRODUCTION

3.1 The Civil Aviation (Aerodromes) Regulations requires that the operator of an aerodrome to ensure that aerodrome related aeronautical data is adequate and accurate and that the integrity of the data is maintained and protected throughout the data process from survey or origin up to the next intended user.

3.2 The Management of aeronautical data is critical in facilitating the implementation of area navigation (RNAV), performance-based navigation (PBN), airborne computer-based navigation systems, performance-based communication (PBC), performance based surveillance (PBS), data link systems and satellite voice communications (SATVOICE).

3.3 Corrupt, erroneous, late, or missing aeronautical data and aeronautical information can potentially affect the safety of air navigation. Whilst, the AIS/Cartography Provider are required to ensure that the accuracy, integrity and protection requirements for aeronautical

data reported by the aerodrome operator are met throughout the data transfer process from the survey/origin to the next intended user.

3.4 The AIS/Cartography Provider will implement measures to ensure that required data quality requirements in accordance with the applicable Civil Aviation (AIS) Regulations and Civil Aviation (aeronautical Charts) Regulations are met.

4.0 TYPE AND CLASSIFICATION OF POSITIONAL DATA

4.1 Air navigation points can be divided into two basic groups, as outlined in the table below:

a) area/en-route points; and
b) aerodrome/heliport points.

Air navigation-related coordinates of interest	
Area/en-route coordinates	Aerodrome/heliport coordinates
ATS/RNAV route points	Aerodrome/heliport reference points
Holding points	Runway, FATO thresholds
En-route radio navigation aids	Terminal radio navigation aids
Restricted/prohibited/danger areas	FAF, FAP and other IAP essential points
Obstacles — en route	Runway centre line points
FIR boundaries	Aircraft standpoints
CTA, CTZ	Aerodrome/heliport obstacles

4.2 Besides this basic categorization, air navigation points can be categorized by the type of positional data. Three types of positional data have been defined namely;

a) Surveyed points

A surveyed point is a clearly defined physical point, specified by latitude and longitude that has been determined by a survey. This includes;

i. NAVAIDS/Communication facilities
ii. Aerodrome beacon
iii. Start and end of Declared distances
iv. Aerodrome elevation
v. Aerodrome reference point
vi. Navigation checkpoints,
vii. Obstacles
viii. Runway thresholds
ix. Aircraft parking stands
x. Taxiway holding position
xi. PAPI

b) Calculated points

A calculated point is a point in space that need not be specified explicitly in latitude and longitude, but that has been derived, by mathematical manipulation, from a known surveyed point. A fix, specified by radial/bearing and range from a known surveyed point such as a NAVAID or by the intersection of a number of radial/bearings from a number of NAVAIDs, is an example of a calculated point. En-route way-points, which are computed from the intersection of routes or from cross radial fixes on routes, are also calculated points, albeit they are reported in latitude and longitude.

c) Declared points

A declared point is a point in space, defined by latitude and longitude that is not dependent upon, nor formally related to, any known surveyed point. Flight information region (FIR) boundary points and prohibited, restricted or danger area points that are outside control areas are often declared points.

4.3 Determination and reporting of aeronautical data shall be in accordance with the accuracy and integrity requirements set forth in Appendix 1. Accuracy requirements for aeronautical data are based upon a 95 per cent confidence level

5.0 SOURCES OF RAW AERONAUTICAL DATA

5.1 It is the responsibility of the AISP to ensure the determination of raw aeronautical data required for promulgation by the aeronautical information products. On receipt of the raw data, the AISP must check, record and edit the data so that they can be released to the next intended user in a standard format. Raw aeronautical data containing positional information can originate from a number of different sources.

a) En-route. The surveyed positions of navaids and communication facilities are normally provided by the owner/operator (ATC) of the equipment.

b) SID, STAR, Instrument approach procedures. The calculated positions are normally determined by the air traffic service provider responsible for the procedure, in coordination with the flight Procedure design unit.

c) Aerodrome/heliport. The surveyed positions of thresholds, gates, obstacles and navaids, etc. located at the aerodrome/heliport are normally provided by the owner or operator of the aerodrome/heliport.

d) Airspace divisions and restrictions. The declared positions are normally defined by State civil aviation or military authorities or other government bodies.

6.0 Data Accuracy Requirements

6.1 For aeronautical data to be usable, it must be accurate and, in this context, can be subdivided into two distinct categories:

a) evaluated aeronautical data; and

b) reference aeronautical data.

6.2 Evaluated aeronautical data include such information as positional data, elevation, runway length, declared distances, platform-bearing characteristics and magnetic variation.

6.3 Reference aeronautical data include NAVAID identifiers, NAVAID frequencies, way-point names, rescue and fire-fighting facilities, hours of operation, telephone numbers, etc.

6.4 The accuracy requirement for the reference data is absolute; the information is either correct or incorrect. Conversely, the required degree of accuracy of the evaluated data will vary depending upon the use to which the data are put.

6.5 For measured positional data the accuracy is normally expressed in terms of a distance from a stated position within which there is a defined confidence of the true position falling.

6.6 Accuracy requirements are based upon a 95% confidence level. The underlying statistical distribution for positional data in two dimensions is usually taken to be the circular normal distribution. The probability P of a point actually falling within a circle of radius $c\sigma$ around its reported position, where σ represents the standard univariate deviation and c is a numeric coefficient, is:

$$P = 1 - \exp(-c2/2).$$

6.7 The Circular Error Probable (CEP) is the radius of the circle within which 50% of the measurements lie, that is, 1.1774 σ. The radius within which 95% of the measurements lie is 2.448 δ or 2.079 $\times$ CEP. Table 2-6 relates σ error values, probable errors and probabilities in one, two and three dimensions.

6.8 The RNP types specify the navigation performance accuracy of all the user and navigation system combinations within an airspace. RNP types can be used by airspace planners to determine airspace utilization potential and as input for defining route widths and traffic separation requirements, although RNP by itself is not a sufficient basis for setting a separation standard.

7.0 Data Resolution Requirements.

7.1 Resolution is the number of units or digits to which a measured or calculated value is expressed and used.

7.2 Resolution of positional data is the smallest separation that can be represented by the method employed to make the positional statement. Care must be taken that the resolution does not affect accuracy the resolution is always a rounded value as opposed to a truncated value.

7.3 The order of publication and the charting resolution of aeronautical data must be that specified in Appendix 1.

7.4 Precision is the smallest difference that can be reliably distinguished by a measurement process. In reference to the geodetic surveys, precision is a degree of refinement in performance of an operation or a degree ofp erfection in the instruments and methods used when making measurements.

7.5 The terms “precision” and “resolution” are often interchangeable in general use. Here precision is a measure of the data field capacities that are available within a specific system design. (Example: 54° 33' 15" is expressed to a resolution of one second.) Any process that manipulates data subsequent to the original measurement or definition cannot increase the precision to which the data were originally measured or defined, regardless of the resolution available within the system itself.

8.0 Data Integrity Requirements

8.1 The data integrity is the degree of assurance that an aeronautical data and its value has not been lost or altered since the origination or authorized amendment.

8.2 The integrity of the data can be regarded as the degree of assurance that any data item retrieved from a storage system has not been corrupted or altered in any way since the original data entry or its latest authorized amendment.

8.3 This integrity must be maintained throughout the data process from survey to data application. In respect to AIS, integrity must be maintained to the next intended user.

8.4 Integrity is expressed in terms of the probability that a data item, retrieved from a storage system with no evidence of corruption, does not hold the same value as intended. Loss of integrity does not necessarily mean loss of accuracy. However, it does mean that it is no longer possible to prove that the data are accurate without a further verification of the data from the point at which integrity can be confirmed.

8.5 The integrity requirements for data are not absolute. The risk associated with a point being in error is dependent upon how that data point is being used. Thus, the integrity of a point at threshold used for landing needs a higher integrity than one used for en-route guidance. It is important to note that a lower accuracy does not necessarily imply a lower integrity requirement.

8.6 Requirement for aeronautical data integrity

8.6.1 A data item’s use forms the basis for determining its integrity requirement. Aeronautical data integrity requirements must therefore be based upon the potential risk resulting from the corruption of data and upon the particular use of the data item. Consequently, the following classification of data integrity must apply.

a) Critical data. There is a high probability when using corrupted critical data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe.

b) Essential data. There is a low probability when using corrupted essential data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe.

c) Routine data. There is a very low probability when using corrupted routine data that the continued safe flight and landing of an aircraft would be severely at risk with the potential for catastrophe.

8.6.2 To each of these types of data, an integrity level requirement has been assigned as follows.

a) Critical data: This level is given to the runway threshold data which define the landing point. The level of integrity has been derived from the integrity requirement for autoland and is defined to ensure that the overall process, of which aeronautical data are only a part, has the required integrity.

b) Essential data: This level is assigned to points which, while an error can in itself result in an aircraft being outside of the envelope required, excursion does not necessarily result in a catastrophe. Examples include en-route navigation aids and obstacles. The reason why obstacle data can be held with a relatively lower level of integrity is that, while the data need to be accurate at the time the procedures are designed, any subsequent corruption should have no impact on the safety of the aircraft on the condition that it conforms to the procedure requirements.

c) Routine data: This level is assigned to data for which errors do not affect the navigation performance. These include FIR boundary points.

8.6.3 The AIS/CART Provider should ensure that integrity of aeronautical data is maintained throughout the data process from survey/origin to the next intended user. Based on the applicable integrity classification, the validation and verification procedures shall:

a) for critical data: ensure corruption does not occur at any stage of the entire process and include additional integrity assurance procedures to fully mitigate the effects of faults identified by thorough analysis of the overall system architecture as potential data integrity risks.
b) for essential data: ensure corruption does not occur at any stage of the entire process and may include additional processes as needed to address potential risks in the overall system architecture to further assure data integrity at this level; and
c) for routine data: avoid corruption throughout the processing of the data;

9.0 DATA PROCESS

9.1 The Generic Data Process

a) The generic data process is designed to describe, at a high-level, those processes which have been found to exist within many States and may not necessarily be the only applicable process. However, once fully understood, it provides a reasonable approximation to process flow. Figure 3 below illustrates the generic high level data process.

b) A high level generic process for all Aeronautical Information/data involves the following:

i. Data/information is provided by defined/approved/certified, ISO9001: 2000 (series as appropriate) and TC211 (the International Standard Organisation Group specializing in the standardization of digital geographic information) entities;
ii. Data/information is held in electronic or other available media, preferably through use of standard worksheets which are used throughout the process;
iii. In order to ensure that data/information being transferred electronically is received at the next activity without having suffered any change, be it accidental or malicious, it is necessary that a Cyclic Redundancy Check (CRC) value be calculated and used;
iv. Data/information being transferred electronically is encrypted to provide further protection to its integrity;
v. Data/information is checked/verified by the Responsible Organisation (Aerodrome Authority, ANSP, CAA etc) if provided by a subcontractor (e.g. surveyor);
vi. Data/information is transferred to AIS;
vii. AIS verifies completeness and integrity of data;
viii. AIS processes the data to publication in the Integrated aeronautical information package.

9.2 Data Origination

Data Origination addresses the functions performed by Requesting Authorities, Originating Authorities, Surveyors and any other third party organizations supplying aeronautical data to such authorities. Those functions are:

a) Surveyed Data:

i. Geodetic datum specification and use;
ii. Establishment of Aerodrome survey control networks;
iii. Recommended procedures for achieving minimum data requirements;
iv. Documentation of survey control stations;
v. Production of survey reports;
vi. Ongoing maintenance of data;
vii. Data management and quality assurance;
viii. Document configuration management.

b) Calculated and Derived Data (Originating Authority activities):

i. Geodetic datum specification and use;
ii. Airspace design;
iii. Instrument flight procedure design;
iv. Audit;

v. Data management and quality assurance;
vi. Document configuration management.

9.3 Data Publication

Data publication addresses the functions undertaken by AIS authorities receiving surveyed, calculated and derived data from their receipt to publication. These apply to both electronic and paper publication. Data publication includes:

a) Document management:
   - Quality assurance;
   - Data management;
   - Document processing requirements;
   - Document modification;
   - Document configuration management.

b) Document publication tool;

c) Guidance for specific publication types.

Director Safety, Security and Economic Regulation

APPENDIX 1- DATA QUALITY REQUIREMENTS

TABLE S1-1 Aerodrome/Heliport Data

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
Aerodrome/ Heliport	Field Elevation	Elevation	Elevation	The vertical distance above Mean Sea Level (MSL) of the highest point of the landing area.	0.5 m	essential	surveyed	1m or 1 ft	1 m or 1 ft
		Geoid undulation	Height	Geoid undulation at the aerodrome/ heliport elevation position, where appropriate	0.5 m	essential	surveyed	1 m or 1 ft	1 m or 1 ft
	Reference temperature		Value	The monthly mean of the daily maximum temperatures for the hottest month of the year at an aerodrome. This temperature should be averaged over a period of years.					
	Mean low temperature		Value	The mean lowest	5 degrees				

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				temperature of the coldest month of the year, for the last five years of data at the aerodrome elevation.					
	Magnetic Variation	Angle	Angle	The magnetic variation angle value	1 degree	essential	surveyed	1 degree	1 degree
	Reference point	Position	Point	Geographical location of aerodrome reference point.	30 m	routine	surveyed/ calculated	1 sec	1 sec
Runway	Nominal length		Distance	The declared longitudinal extent of the runway for operational (performance) calculations.	1 m	critical	surveyed	1 m or 1 ft	1 m
	Nominal width		Distance	The declared transversal extent of the runway for operational (performance) calculations.	1 m	essential	surveyed	1 m or 1 ft	1 m
		Position	Point	The geographical	1 m	critical	surveyed		

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				location of runway centre line at each end of the runway, at the stopway and at the origin of each take-off flight path area, and at each significant change in slope of runway and stopway					
		Elevation	Elevation	The elevation of the corresponding centre line point. Any significant high and low intermediate points along the runway shall be measured to the accuracy of one-half metre or foot.	0.25 m	critical	surveyed		
		Geoid undulation	Height	The geoid undulation at the					

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				corresponding center line point					
	Runway exit line	Exit guidance line	Line	The geographical location of the runway exit line	0.5 m	essential	surveyed	1/100 sec	1 sec
	Shoulder	Width	Distance	The width of the runway shoulder	1m	essential	surveyed	1 m or 1 ft	
Runway Direction	True bearing		Bearing	The true bearing of the runway.	1/100 deg	Routine	surveyed	1/100 degree	1 degree
	Threshold	Position	Point	Geographical location for runway threshold	1 m	critical	surveyed	1/100 sec	1 sec
		Elevation	Elevation of the runway threshold	Threshold elevation for runways with non-precision approaches	0.5 m	essential	surveyed	1 m or 1 ft	1 m or 1 ft
		Elevation	Elevation of the runway threshold	Threshold elevation for runways with precision approaches	0.25 m	critical	surveyed	0.1 m or 0.1 ft	0.5 m or 1 ft
		Geoid undulation	Height	WGS-84 geoid undulation at runway threshold, non-precision approaches	0.5 m	essential	surveyed	1 m or 1 ft	1 m or 1 ft

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
		Geoid undulation	Height	WGS-84 geoid undulation at runway threshold, precision approaches	0.25 m	critical	surveyed	0.1 m or 0.1 ft	0.5 m or 1 ft
		Displacement	Distance	Distance of displaced threshold	1 m	routine	surveyed	1m or 1ft	
	Runway End	Position	Point	Location of the runway end in the direction of departure	1 m	critical	surveyed	1/100 sec	1 sec
		Elevation	Elevation	Elevation of the runway end and any significant high and low intermediate points along the runway for non-precision approaches	0.5 m or 1 ft				
		Elevation	Elevation	Elevation of the runway end and the highest elevation of the touchdown zone for precision approach runways	0.25 m or 1 ft				

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
	Touch Down Zone	Elevation	Elevation	Highest elevation of the touchdown zone of a precision approach runway	0.25 m or 1 ft				
	Stop way	Length	Distance	The longitudinal extent of stopway, if any	1 m	critical	surveyed	1 m or 1 ft	1 m
		Width	Distance	Width of the stop way	1 m	critical	surveyed	1 m or 1 ft	1 m
	Clearway	Length	Distance	The longitudinal extent of the clearway	1 m	essential	surveyed	1 m or 1 ft	
		Width	Distance	The transversal extent of the clearway	1 m	essential	surveyed	1 m or 1 ft	
		Ground profile		The vertical profile (or slope) of the clearway					
	Declared Distances	TORA	Distance	Take-off run available - The length of runway declared available and suitable for the ground run of an aeroplane taking off.	1 m	critical	surveyed	1 m or 1 ft	1 m

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
		TODA	Distance	Take-off distance available - The length of the take-off run available plus the length of the clearway, if provided.	1 m	critical	surveyed	1 m or 1 ft	1 m
		ASDA	Distance	Accelerate-stop distance available - The length of the take-off run available plus the length of the stopway, if provided.	1 m	critical	surveyed	1 m or 1 ft	1 m
		LDA	Distance	Landing distance available - The length of runway which is declared available and suitable for the ground run of an aeroplane landing.	1 m	critical	surveyed	1 m or 1 ft	1 m

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
Final Approach and Take off area (FATO)	Threshold	Position	Point	Geographical location of FATO threshold	1m	critical	surveyed	1/100 sec	1 sec
		Elevation	Elevation	FATO threshold, for heliports with or without a PinS approach	0.5m	essential	surveyed	1 m or 1 ft	FATO threshold, for heliports with or without a PinS approach
				FATO threshold, for heliports intended to be operated in accordance with ICAO Annex 14, Appendix 2	0.25m	critical	surveyed	1 m or 1 ft (non-precision) 0.1 m or 0.1 ft (precision)	FATO threshold, for heliports intended to be operated in accordance with ICAO Annex 14, Appendix 2
		Geoid undulation	Height	WGS–84 geoid undulation at FATO threshold, TLOF geometric centre, for	0.5m	essential	surveyed	1 m or 1 ft	WGS–84 geoid undulation at FATO threshold, TLOF geometric

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				heliports with or without a PinS approach					centre, for heliports with or without a PinS approach
				WGS–84 geoid undulation at FATO threshold, TLOF geometric centre, for heliports intended to be operated in accordance with ICAO Annex 14, Appendix 2	0.25m	critical	surveyed	1 m or 1 ft (non-precision) 0.1 m or 0.1 ft (precision)	WGS–84 geoid undulation at FATO threshold, TLOF geometric centre, for heliports intended to be operated in accordance with ICAO Annex 14, Appendix 2
	Departure end of a runway	Position	Point	Geographical location of DER	1m	critical	surveyed	1/100 sec	
		Elevation	Elevation	The elevation of the DER is the higher of the elevations of the beginning and					

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				end of the runway/FATO.					
	Length		Distance	The longitudinal extent of FATO	1m	critical	surveyed	1 m or 1 ft	1 m
	True Bearing		Bearing	The true bearing of FATO	1/100 deg	routine	surveyed	1/100 degree	
	Declared Distances	TODAH	Distance	Take-off distance available - The length of the FATO plus the length of helicopter clearway (if provided)	1m	critical	surveyed	1 m or 1 ft	
		RTODAH	Distance	Rejected Take-off distance available - The length of the FATO declared available and suitable for helicopters operated in performance class 1 to complete a rejected take-off.	1m	critical	surveyed	1 m or 1 ft	
		LDAH	Distance	Landing distance	1m	critical	surveyed	1 m or 1 ft	

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				available - The length of the FATO plus any additional area declared available and suitable for helicopters to complete the landing manoeuvre from a defined height.					
Touchdown and lift-off area	Centre point	Position	Point	Geographical location of TLOF geometric centre	1m	critical	surveyed	1/100 sec	1 sec
		Elevation	Elevation	FATO threshold, for heliports with or without a PinS approach	0.5m	essential	surveyed	1 m or 1 ft	FATO threshold, for heliports with or without a PinS approach
				FATO threshold, for heliports intended to be operated in	0.25m	critical	surveyed	1 m or 1 ft (non-precision) 0.1 m or	FATO threshold, for heliports intended to

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				accordance with ICAO Annex 14, Appendix 2				0.1 ft (precision)	be operated in accordance with ICAO Annex 14, Appendix 2
		Geoid undulation	Height	WGS–84 geoid undulation at FATO threshold, TLOF geometric centre, for heliports with or without a PinS approach	0.5m	essential	surveyed	1 m or 1 ft	WGS–84 geoid undulation at FATO threshold, TLOF geometric centre, for heliports with or without a PinS approach
				WGS–84 geoid undulation at FATO threshold, TLOF geometric centre, for heliports intended to be operated in accordance with	0.25m	critical	surveyed	1 m or 1 ft (non-precision) 0.1 m or 0.1 ft (precision)	WGS–84 geoid undulation at FATO threshold, TLOF geometric centre, for heliports intended to be operated in

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				ICAO Annex 14, Appendix 2					accordance with ICAO Annex 14, Appendix 2
	Length		Distance	The longitudinal extent of TLOF	1m	critical	surveyed	1 m or 1 ft	1 m
	Width		Distance	The transversal extent of TLOF	1m	critical	surveyed	1 m or 1 ft	1 m
	Bearing strength		Value	The bearing strength of TLOF				1 tone	
Apron	Geometry		Polygon	Geographical location of the apron element	1m	routine	surveyed	1/10 sec	1 sec
Taxiway	Width		Distance	The transversal extent of the taxiway.	1m	essential	surveyed	1 m or 1 ft	
	Centre line points	Position	Point	Geographical coordinates of taxiway center line points	0.5m	essential	surveyed	1/100 sec	1/100 sec
		Elevation	Elevation	Elevation of taxiway center line points	1m	essential	surveyed		
	Shoulder	Width	Distance	The width of the taxiway shoulder	1m	essential	surveyed	1 m or 1 ft	
	Guidance Lines	Geometry	Line	Geographical location of guidance lines	0.5 m	essential	surveyed	1/100 sec	1/100 sec

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
	Intermediate holding position marking line		Line	Intermediate holding position marking line	0.5 m	essential	surveyed	1/100 sec	1 sec
	Runway holding position	Geometry	Line	Geographical location of runway holding position	0.5m	essential	surveyed	1/100 sec	1 sec
Helicopter ground taxiway	Center line points		Point	Geographical location of helicopter ground center line taxiway points	0.5m	essential	surveyed/ calculated		
	Elevation		Elevation	Elevation of helicopter ground taxiway	1m	essential	surveyed		
	Width		Distance	The transversal extent of the helicopter ground taxiway	1m	essential	surveyed		
	Surface type		Text	The surface type of the helicopter ground taxiway					
	Intersection marking line		Line	Helicopter ground taxiway intersection marking line	0.5 m	essential	surveyed	1/100 sec	1 sec

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
Helicopter air taxiway	Center line points		Point	Geographical location of helicopter air taxiway center line points	0.5m	essential	surveyed/ calculated		
	Elevation		Elevation	Elevation of helicopter air taxiway	1m	essential	surveyed		
	Width		Distance	The transversal extent of the helicopter air taxiway	1m	essential	surveyed		
Helicopter air transit route	Width		Distance	The transversal extent of the helicopter air transit route	1m	essential	Surveyed		
INS Checkpoint	Position		Point	Geographical location of the INS check point, where available	0.5m	routine	surveyed	1/100 sec	1/100 sec
Aircraft Stand	Aircraft stand points	Position	Point	Geographical location of aircraft stand point	0.5m	routine	surveyed	1/100 sec	1/100 sec
	Stand guidance line	Geometry	Line	Geographical location of stand guidance line	0.5m	essential	surveyed	1/100 sec	

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
		Elevation	Elevation	Parking guidance line points elevation	1m	essential	surveyed		
Helicopter stand	Position		Point	Geographical location of helicopter stand point/ INS checkpoints	0.5m	essential	surveyed	1/100 sec	
De-Icing Area	Geometry		Polygon	Geographical location of de-icing area	1m	routine	surveyed	1/10 sec	1 sec

TABLE S1-5 Radio navigation aids/systems data

Subject	Property	Sub property	Type	Description	Note	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
Radio navigation aid	Name		Text	The textual name assigned to the navaid						
	Purpose		Code list	Indication whether navigation aid serves en-route (E), aerodrome (A) or dual (AE) purposes.						
	Magnetic Variation	Angle	Angle	The magnetic variation at the	ILS Localizer	1 degree	essential	surveyed	1 degree	

Subject	Property	Sub property	Type	Description	Note	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				radio navigation aid						
					NDB	1 degree	routine	surveyed	1 degree	
		Date	Date	The date on which the magnetic variation had the corresponding value.						
	Position		Point	Geographical location of the radio navigation aid	Aerodrome Navaid	3 m	essential	surveyed	1/10 sec	as plotted
					GBAS Ref Point	1 m				
					Enroute	100 m	essential	surveyed	1 sec	
	Elevation		Elevation	The elevation of the transmitting antenna of DME The elevation of GBAS reference point	DME	30m (100ft)	essential	surveyed	30 m (100 ft)	30 m (100 ft)
					DME/P	3 m	essential	surveyed	3 m (10 ft)	
					GBAS Ref Point	0.25 m	essential		1 m or 1 ft	
	Ellipsoidal height		Height	The ellipsoid height of the	GBAS					

Subject	Property	Sub property	Type	Description	Note	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				GBAS reference point,						
	Localizer alignment	Bearing	Bearing	The localizer course	ILS Localizer	1/100 deg	essential	surveyed	1/100 degree (if true)	1 degree
		Type	Text	Type of localizer alligment, true or magnetic	ILS Localizer					
	Zero azimuth alignment		Bearing	MLS zero azimuth alignment	MLS	1/100 deg	essential	surveyed	1/100 degree (if true)	1 degree
	Angle		Angle	The angle of the glide path of an ILS or the normal glide path angle for the MLS installation	ILS GP /MLS					
	RDH		Value	The value of the ILS Reference Datum Height (ILS RDH).	ILS GP	0.5m	critical	calculated	0.1m or 0.1ft	0.5m or 1ft
	Localizer antenna rwy end distance		Distance	ILS localizer runway/FATO end distance	ILS Localizer	3 m	routine	calculated	1 m or 1 ft	as plotted
	ILS glideslope antenna		Distance	ILS glideslope antenna - threshold	ILS GP	3 m	routine	calculated	1 m or 1 ft	as plotted

Subject	Property	Sub property	Type	Description	Note	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
	TRSH distance			distance along centerline						
	ILS marker TRSH distance		Distance	ILS marker - threshold distance	ILS	3 m	essentail	calculated	1 m or 1 ft	2/10 km (1/10 NM)
	ILS DME antenna TRSH distance		Distance	ILS DME antenna - threshold distance along centerline	ILS	3 m	essential	calculated	1 m or 1 ft	as plotted
	MLS azimuth antenna rwy end distance		Distance	MLS azimuth antenna - runway/FATO end distance	MLS	3 m	routine	calculated	1 m or 1 ft	as plotted
	MLS DME antenna TRHS distance		Distance	MLS DME/P antenna - threshold distance along centre line	MLS	3 m	essential	calculated	1 m or 1 ft	as plotted
	Signal polarization		Code list	GBAS signal polarization (GBAS/H or GBAS/E)	GBAS					
	DOC		Text	Designated operational coverage (DOC or stadard service volume						

Subject	Property	Sub property	Type	Description	Note	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
				SSV) as range or service volume radius from the navaid / GBAS reference point, height and sectors if required						
Aeronautical ground lights	Intensity		Value	Intensity of the light of the beacon					1000 candela	
Special navigation system	Position		Point	Geographical location of the special navigation system		100m	essential	surveyed / calculated		

Table S1-6 Obstacle Data

Subject	Property	Sub property	Type	Description	Accuracy	Integrity	Origin Type	Pub. Resolution.	Chart Resolution.
Obstacle	Obstacle identifier		Text	Unique identifier of obstacle					
	Operator / Owner		Text	Name and Contact information of obstacle operator or owner					
	Geometry type		Code list	An indication whether the obstacle is a point, line or polygon.					

	Horizontal position		Point Line Polygon	Obstacles in Area 1	50 m	routine	surveyed	1 sec	as plotted
				Obstacles in Area 2 (including 2a, 2b, 2c, 2d, take-off flight path area and obstacle limitation surfaces)	5 m	essential	surveyed	1/10 sec	1/10 sec
				Obstacles in Area 3	0.5 m	essential	surveyed	1/10 sec	1/10 sec
				Obstacles in Area 4	2.5 m	essential	surveyed		
	Horizontal extent		Distance	Hoizontal extent of the obstacle					
	Elevation		Elevation	Obstacles in Area 1	30 m	routine	surveyed	1 m or 1 ft	3 m (10 ft)
	Height		Height	Obstacles in Area 2 (including 2a, 2b, 2c, 2d, take-off flight path area and obstacle limitation surfaces)	3 m	essential	surveyed	1 m or 1 ft	1 m or 1 ft
				Obstacles in Area 3	0.5 m	essential	surveyed	0.1 m or 0.1 ft 0.01 m	1m or 1 ft
				Obstacles in Area 4	1 m	essential	surveyed	0.1 m	

Table S2-7. Terrain Data Numerical Requirements

	Area 1	**Area 2**	**Area 3**	**Area 4**
Post spacing	3 arc seconds (approx. 90 m)	1 arc second (approx. 30 m)	0.6 arc seconds (approx. 20 m)	0.3 arc seconds (approx. 9 m)
Vertical accuracy	30 m	3 m	0.5 m	1 m
Vertical resolution	1 m	0.1 m	0.01 m	0.1 m
Horizontal accuracy	50 m	5 m	0.5 m	2.5 m
Confidence level	90%	90%	90%	90%
Integrity classification	**routine**	**essential**	**essential**	**essential**
Maintenance period	as required	as required	as required	as required

Table S2-8 Data Types

Type (1)	Description (2)	Data elements (3)
Point	A pair of coordinates (latitude and longitude) referenced to the mathematical reference ellipsoid which define the position of the point on the surface of the Earth.	Latitude
		Longitude
		Horizontal reference system
		Units of measurement
		Horizontal accuracy achieved
Line	Sequence of Points defining a linear object	Sequence of Points
Polygon	Sequence of Points forming the boundary of the polygon. The first and last Point are identical.	Closed sequence of Points
Height	The vertical distance of a level, point or an object considered as a point, measured from a specific datum.	Numerical value
		Vertical reference system
		Units of measurement
		Vertical accuracy achieved
Altitude	The vertical distance of a level, a point or an object considered as a point, measured from mean sea level.	Numerical value
		Vertical reference system
		Units of measurement
		Vertical accuracy achieved
Elevation	The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.	Numerical value
		Vertical reference system
		Units of measurement
		Vertical accuracy

Type (1)	Description (2)	Data elements (3)
Distance	A linear value	Numerical value
		Units of measurement
		Accuracy achieved
Angle / Bearing	An angular value	Numerical value
		Units of measurement
		Accuracy achieved
Value	Any measured, declared or derived value not listed above.	Numerical Value
		Units of Measurement
		Accuracy achieved
Date	A calendar date referencing a particular day or month	Text
Schedule	A repetitive time period, composed of one or more intervals or special dates (e.g. holidays) occurring cyclically	Text
Code list	A set of predefined Text strings or values	Text
Text	Free text	String of characters without constraints