Title: Guidance Material on Electronic Terrain and Obstacle Data (eTOD)

1 INTRODUCTION

Knowledge of terrain and obstacles is a requirement to ensure safety when evaluating structures to be built or altered in a State's airspace. Increased economic development and prosperity often include infrastructure (buildings, towers etc.) which may encroach upon airspace.

Due to the implications for air traffic and safety operations, it is essential that the impact of these obstacles is continuously assessed, reviewed, and updated. (Annex 15, Amendment 33, Chapter 10, ICAO requires States to make terrain and obstacle data available to airspace users in electronic format.)

This guidance material presents the text of Annex 15 relating to eTOD and consolidates the original proposal in State letter SP 2/2.2-09/13, the final review of States comments and reflecting proposed action in AN-WP/8416 and DP No. 2, Appendix B as well as proposed amendments by the ANC ad hoc working group on eTOD.

Amendment 33 to Annex 15 (adopted in 2004) introduced requirements for States to provide eTOD data over four areas. These requirements became applicable in 2008 as far as the "entire territory of a State" and "Category II and III operations area" are concerned (i.e. Area 1 and Area 4, respectively) and would become applicable in 2010 as far as the "terminal control area" and "aerodrome/heliport area" are concerned (i.e. Area 2 and Area 3, respectively). In reply to State letter AN 2/2.1-09/13 and the associated questionnaire States have indicated that the requirements related especially to Area 2 will be difficult and costly to implement and were not considered justified. This would have led to widespread non-compliance. This issue has been addressed through a revision of associated provisions which are expected to substantially reduce implementation difficulties and costs.

2 REFERENCES

- ICAO Annex 15 – Aeronautical Information Services
- ICAO Annex 4 – Aeronautical Charts
- ICAO Doc 9674 – World Geodetic System – 1984 Manual
- ICAO Doc 9881 – Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information
- Eurocae ED-99A – User Requirements for Aerodrome Mapping Information
- **Aerodrome** - A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

- **Heliport** - An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters

3 DETAIL

ELECTRONIC TERRAIN AND OBSTACLE DATA

Note - Electronic terrain and obstacle data is intended to be used in the following air navigation applications

- ground proximity warning system with forward looking terrain avoidance function and minimum safe altitude warning (MSAW) system;
- determination of contingency procedures for use in the event of an emergency during a missed approach or take-off;
- aircraft operating limitations analysis;
- instrument procedure design (including circling procedure);
- determination of en-route “drift-down” procedure and en-route emergency landing location;
- advanced surface movement guidance and control system (A-SMGCS); and
- Aeronautical chart production and on-board databases.

The data may also be used in other applications such as flight simulator and synthetic vision systems, and may assist in the height restriction or removal of obstacles that pose a hazard to aviation.

Coverage areas and data numerical specifications

Sets of electronic terrain and obstacle data shall be provided in coverage areas specified as:

Area 1: the entire territory of a State;

Area 2: within the vicinity of an aerodrome, sub-divided as follows;

Area 2a: a rectangular area around a runway that comprises the runway strip plus any clearway that exists.

Area 2b: from the ends of Area 2a in the direction of departure, with a length of 10 km and a splay of 15% to each side;

Area 2c: extending outside Area 2a and Area 2b at a distance of not more than 10 km to the boundary of Area 2a; and

Area 2d: outside the Areas 2a, 2b and 2c up to a distance of 45 km from the aerodrome reference point, or an existing TMA boundary, whichever is nearest;

Area 3: the area bordering an aerodrome movement area that extends horizontally from the edge of a runway to 90 m from the runway centre line and 50 m from the edge of all other parts of the aerodrome movement area.

Area 4: The area extending 900 m prior to the runway threshold and 60 m each side of the extended runway centre line in the direction of the approach on a precision approach runway, Category II or III.

Recommendation - Where the terrain at a distance greater than 900 m (3 000 ft) from the runway threshold is mountainous or otherwise significant, the length of Area 4 should be extended to a distance not exceeding 2 000 m (6 500 ft) from the runway threshold.

Note - See Appendix 8 for graphical illustrations of the coverage areas.

Electronic terrain data shall be provided for Area 1. The obstacle data to be provided for Area 1 shall be those that penetrate the relevant obstacle data collection surface specified in Appendix 8.

From 15 November 2012, at aerodromes regularly used by international civil aviation, electronic terrain and obstacle data shall be provided for all obstacles within Area 2 that are assessed as being a potential hazard to air navigation.

From 15 November 2012, at aerodromes regularly used by international civil aviation electronic terrain and obstacle data shall be provided for:

Area 2a; for those obstacles that penetrate the relevant obstacle data collection surface specified in Appendix 8;

penetrations of the take-off flight path area obstacle identification surfaces; and

Penetrations of the aerodrome obstacle limitation surfaces.

Note - Take-off flight path area obstacle identification surfaces are specified in Annex 4, 3.8.2.1. Aerodrome obstacle limitation surfaces are specified in Annex 14, Volume 1, Chapter 4.

Recommendation - At aerodromes regularly used by international civil aviation, electronic terrain and obstacle data should be provided for Areas 2b, 2c and 2d for obstacles and terrain that penetrate the relevant obstacle data collection surface specified in Appendix 8 and where there is an operational need.

Recommendation - At aerodromes regularly used by international civil aviation, electronic terrain and obstacle data should be provided for Area 3 for terrain and obstacles that penetrate the relevant obstacle data collection surface specified in Appendix 8.

At aerodromes regularly used by international civil aviation, electronic terrain and obstacle data shall be provided for Area 4 for terrain and obstacles that penetrate the relevant obstacle data collection surface specified in Appendix 8, for all runways where precision approach Category II or III operations have been established and where detailed terrain information is required by operators to enable them to assess, the effect of terrain on decision height determination by use of radio altimeters.

Note - Area 4 terrain data and Area 2 obstacle data are normally sufficient to support the production of the Precision Approach Terrain Chart — ICAO. When more detailed obstacle data is required for Area 4, this may be provided in accordance with the Area 4 obstacle data requirements specified in Appendix 8, Table A8-2. Guidance on appropriate obstacles for this chart is given in the Aeronautical Chart Manual (Doc 8697).

Recommendation - Where additional electronic obstacle or terrain data is collected to meet other aeronautical requirements, the obstacle and terrain datasets should be expanded to include these additional data.

Recommendation - Arrangements should be made for the coordination of providing Area 2 electronic terrain and obstacle data for adjacent aerodromes where their respective coverage Areas overlap to assure that the data for the same obstacle or terrain is correct.

Recommendation - At those aerodromes located near territorial boundaries, arrangements should be made among States concerned to share Area 2 electronic terrain and obstacle data.

Terrain data set — content and structure

A terrain data set shall contain digital sets of data representing terrain surface in the form of continuous elevation values at all intersections (points) of a defined grid, referenced to common datum. A terrain grid shall be angular or linear and shall be of regular or irregular shape.

Note - In regions of higher latitudes, latitude grid spacing may be adjusted to maintain a constant linear density of measurement points.

Sets of electronic terrain data shall include spatial (position and elevation), thematic and temporal aspects for the surface of the Earth containing naturally occurring features such as mountains, hills, ridges, valleys, bodies of water, permanent ice and snow, and excluding obstacles. In practical terms, depending on the acquisition method used, this shall represent the continuous surface that exists at the bare Earth, the top of the canopy or something in-between, also known as “first reflective surface”.

In terrain data sets, only one feature type, i.e. terrain, shall be provided. Feature attributes describing terrain shall be those listed in Table A8-3. The terrain feature attributes listed in Table A8-3 represent the minimum set of terrain attributes, and those annotated as mandatory shall be recorded in the terrain data set.

Electronic terrain data for each area shall conform to the applicable numerical requirements in Appendix 8

Obstacle data set — content and structure

Obstacle data shall comprise the digital representation of the vertical and horizontal extent of the obstacle. Obstacles shall not be included in terrain data sets. Obstacle data elements are features that shall be represented in the data sets by points, lines or polygons.

In an obstacle data set, all defined obstacle feature types shall be provided and each of them shall be described according to the list of mandatory attributes provided in Table A8-4 of Appendix 8.

Note - By definition, obstacles can be fixed (permanent or temporary) or mobile. Specific attributes associated with mobile (feature operations) and temporary types of obstacles are annotated in Appendix 8, Table A8-4, as optional attributes. If these types of obstacles are to be provided in the data set, appropriate attributes describing such obstacles are also required.

Electronic obstacle data for each area shall conform to the applicable numerical requirements in Appendix 8.

Terrain and obstacle data product specifications

To allow and support the interchange and use of sets of electronic terrain and obstacle data among different data providers and data users, the ISO 19100 series of standards for geographic information shall be used as a general data modelling framework.

A comprehensive statement of available electronic terrain and obstacle data sets shall be provided in the form of terrain data product specifications as well as obstacle data product specifications on which basis air navigation users will be able to evaluate the products and determine whether they fulfil the requirements for their intended use (application).

Note - ISO Standard 19131 specifies the requirements and outline of data product specifications for geographic information.

Each terrain data product specification shall include an overview, a specification scope, data product identification, data content and structure, reference system, data quality, data capture, data maintenance, data portrayal, data product delivery, additional information, and metadata.

The overview of terrain data product specification or obstacle data product specification shall provide an informal description of the product and shall contain general information about the data product. Specification of terrain data may not be homogenous across the whole data product but may vary for different parts of the data sets. For each such subset of data, a specification scope shall be identified. Identification information concerning both terrain and obstacle data products shall include the title of the product; a brief narrative summary of the content, purpose, and spatial resolution if appropriate (a general statement about the density of spatial data); the geographic area covered by the data product; and supplemental information.

Content information of feature-based terrain data sets or of feature-based obstacle data sets shall each be described in terms of an application schema and a feature catalogue. Application schema shall provide a formal description of the data structure and content of data sets while the feature catalogue shall provide the semantics of all feature types together with their attributes and attribute value domains, association types between feature types and feature operations, inheritance relations and constraints. Coverage is considered a subtype of a feature and can be derived from a collection of features that have common attributes. Both terrain and obstacle data product specifications shall identify clearly the coverage and/or imagery they include and shall provide a narrative description of each of them.

Note 1 - ISO Standard 19109 contains rules for application schema while ISO Standard 19110 describes feature cataloguing methodology for geographic information.

Note 2 - ISO Standard 19123 contains schema for coverage geometry and functions.

Both terrain data product specifications and obstacle data product specifications shall include information that identifies the reference system used in the data product. This shall include the spatial reference system and temporal reference system. Additionally, both data product specifications shall identify the data quality requirements for each data product. This shall include a statement on acceptable conformance quality levels and corresponding data quality measures. This statement shall cover all the data quality elements and data quality sub-elements, even if only to state that a specific data quality element or sub-element is not applicable.

Note - ISO Standard 19113 contains quality principles for geographic information while ISO Standard 19114 covers quality evaluation procedures.

Terrain data product specifications shall include a data capture statement which shall be a general description of the sources and of processes applied for the capture of terrain data. The principles and criteria applied in the maintenance of terrain data sets and obstacle data sets shall also be provided with the data specifications, including the frequency with which data products are updated. Of particular importance shall be the maintenance information of obstacle data sets and an indication of the principles, methods and criteria applied for obstacle data maintenance.

Terrain data product specifications shall contain information on how data held with data sets is presented, i.e. as a graphic output, as a plot or as an image. The product specifications for both terrain and obstacles shall also contain data product delivery information which shall include delivery formats and delivery medium information.

Note - ISO Standard 19117 contains a definition of the schema describing the portrayal of geographic information including the methodology for describing symbols and mapping of the schema to an application schema.

The core terrain and obstacle metadata elements shall be included in the data product specifications. Any additional metadata items required to be supplied shall be stated in each product specification together with the format and encoding of the metadata.

Note - ISO Standard 19115 specifies requirements for geographic information metadata.

The obstacle data product specification, supported by geographical coordinates for each aerodrome included within the dataset, shall describe the following areas:

- Areas 2a, 2b, 2c, 2d;
- the take-off flight path area; and
- The obstacle limitation surfaces

Appendix 1 CONTENTS OF AERONAUTICAL INFORMATION PUBLICATION (AIP)

AD 2.10 - Aerodrome obstacles

Detailed description of obstacles, including:

- obstacles in Area 2:
  - obstacle identification or designation;
  - type of obstacle;
  - obstacle position, represented by geographical coordinates in degrees, minutes, seconds and tenths of seconds;
  - obstacle elevation and height to the nearest metre or foot;
  - obstacle marking, and type and colour of obstacle lighting (if any);
  - if appropriate, an indication that the list of obstacles is available in electronic form, and a reference to GEN 3.1.6; and
  - NIL indication, if appropriate.

Note 1.— Chapter 10, 10.1.1, provides a description of Area 2 while Appendix 8, Figure A8-2, contains graphical illustrations of obstacle data collection surfaces and criteria used to identify obstacles in Area 2.

Note 2.— Specifications governing the determination and reporting (accuracy of field work and data integrity) of positions (latitude and longitude) and elevations for obstacles in Area 2 are given in Annex 11, Appendix 5, Tables 1 and 2, and in Annex 14, Volume I, Appendix 5, Tables A5-1 and A5-2, respectively.

- Where an Area 2 data set for the aerodrome is not available, as a minimum, include the obstacles that exist at the aerodrome, penetrate the obstacle limitation surfaces, the take-off flight path area obstacle identification surface, or are otherwise assessed as being a hazard to air navigation, with a clear statement that the full Area 2 obstacle data set is not provided.
- indication that information on obstacles in Area 3 is not provided, or if provided:
  - obstacle identification or designation;
  - type of obstacle;
  - obstacle position, represented by geographical coordinates in degrees, minutes, seconds and tenths of seconds;
  - obstacle elevation and height to the nearest metre or foot;
  - obstacle marking, and type and colour of obstacle lighting (if any);

- if appropriate, an indication that the list of obstacles is available in electronic form, and a reference to GEN 3.1.6; and
- NIL indication, if appropriate.

Note 1.— Chapter 10, 10.1.1, provides a description of Area 3 while Appendix 8, Figure A8-3, contains graphical illustrations of obstacle data collection surfaces and criteria used to identify obstacles in Area 3.

Note 2.— Specifications governing the determination and reporting (accuracy of field work and data integrity) of positions (latitude and longitude) and elevations for obstacles in Area 3 are given in Annex 14, Volume I, Appendix 5, Tables A5-1 and A5- 2, respectively.

AD 3.10 Heliport obstacles

Detailed description of obstacles, including:

- obstacles in Area 2:
  - obstacle identification or designation;
  - type obstacle position,
  - represented by geographical coordinates in degrees, minutes, seconds and tenths of seconds;
  - obstacle elevation and height to the nearest metre or foot;
  - obstacle marking, and type and colour of obstacle lighting (if any);
  - if appropriate, an indication that the list of obstacles is available in electronic form, and a reference to GEN 3.1.6; and
  - NIL indication, if appropriate of obstacle;

Note 1 - Chapter 10, 10.1.1, provides a description of Area 2 while Appendix 8, Figure A8-2, contains graphical illustrations of obstacle data collection surfaces and criteria used to identify obstacles in Area 2.

Note 2 - Specifications governing the determination and reporting (accuracy of field work and data integrity) of positions (latitude and longitude) and elevations for obstacles in Area 2 are given in Annex 11, Appendix 5, Tables 1 and 2, and in Annex 14, Volume II, Appendix 1, Tables 1 and 2, respectively.

- Where an Area 2 data set for the heliport is not available, as a minimum, include the obstacles that exist at the heliport, within the approach and takeoff areas, penetrate the obstacle limitation surfaces, or are otherwise assessed as being a hazard to air

navigation, with a clear statement that the full Area 2 obstacle data set is not provided; and

- Indication that information on obstacles in Area 3 is not provided, or if provided:
  - obstacle identification or designation;
  - type of obstacle;
  - obstacle position, represented by geographical coordinates in degrees, minutes, seconds and tenths of seconds;
  - obstacle elevation and height to the nearest metre or foot;
  - obstacle marking, and type and colour of obstacle lighting (if any);
  - if appropriate, an indication that the list of obstacles is available in electronic form, and a reference to GEN 3.1.6; and
  - NIL indication, if appropriate.

Note 1 - Chapter 10, 10.1.1, provides a description of Area 3 while Appendix 8, Figure A8-3, contains graphical illustrations of obstacle data collection surfaces and criteria used to identify obstacles in Area 3.

Note 2 - Specifications governing the determination and reporting (accuracy of field work and data integrity) of positions (latitude and longitude) and elevations for obstacles in Area 3 are given in Annex 14, Volume II, Appendix 1, Tables 1 and 2, respectively.

Appendix 8 TERRAIN AND OBSTACLE DATA REQUIREMENTS

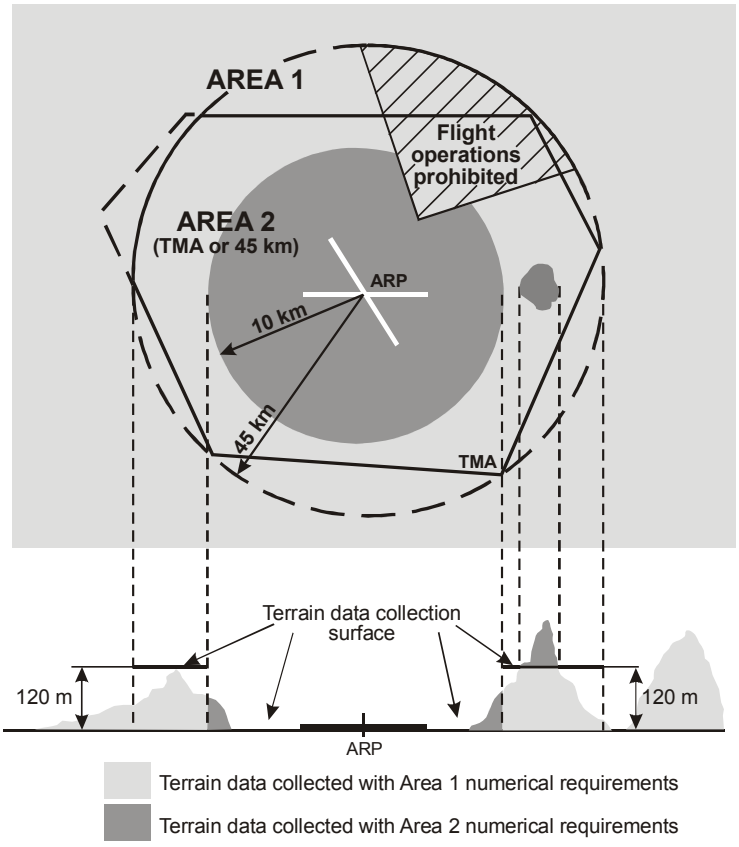


Figure A8-1. Terrain data collection surfaces — Area 1 and Area 2

Within the area covered by a 10-km radius from the ARP, terrain data shall be collected and recorded in accordance with the Area 2 numerical requirements.

In the area between 10 km and the TMA boundary or 45-km radius (whichever is smaller), data on terrain that penetrates the horizontal plane 120 m above the lowest runway elevation shall be collected and recorded in accordance with the Area 2 numerical requirements.

In the area between 10 km and the TMA boundary or 45-km radius (whichever is smaller), data on terrain that does not penetrate the horizontal plane 120 m above the lowest runway elevation shall be collected and recorded in accordance with the Area 1 numerical requirements.

In those portions of Area 2 where flight operations are prohibited due to very high terrain or other local restrictions and/or regulations, terrain data shall only be collected and recorded in accordance with the Area 1 numerical requirements.

Note - Terrain data numerical requirements for Areas 1 and 2 are specified in Table A81

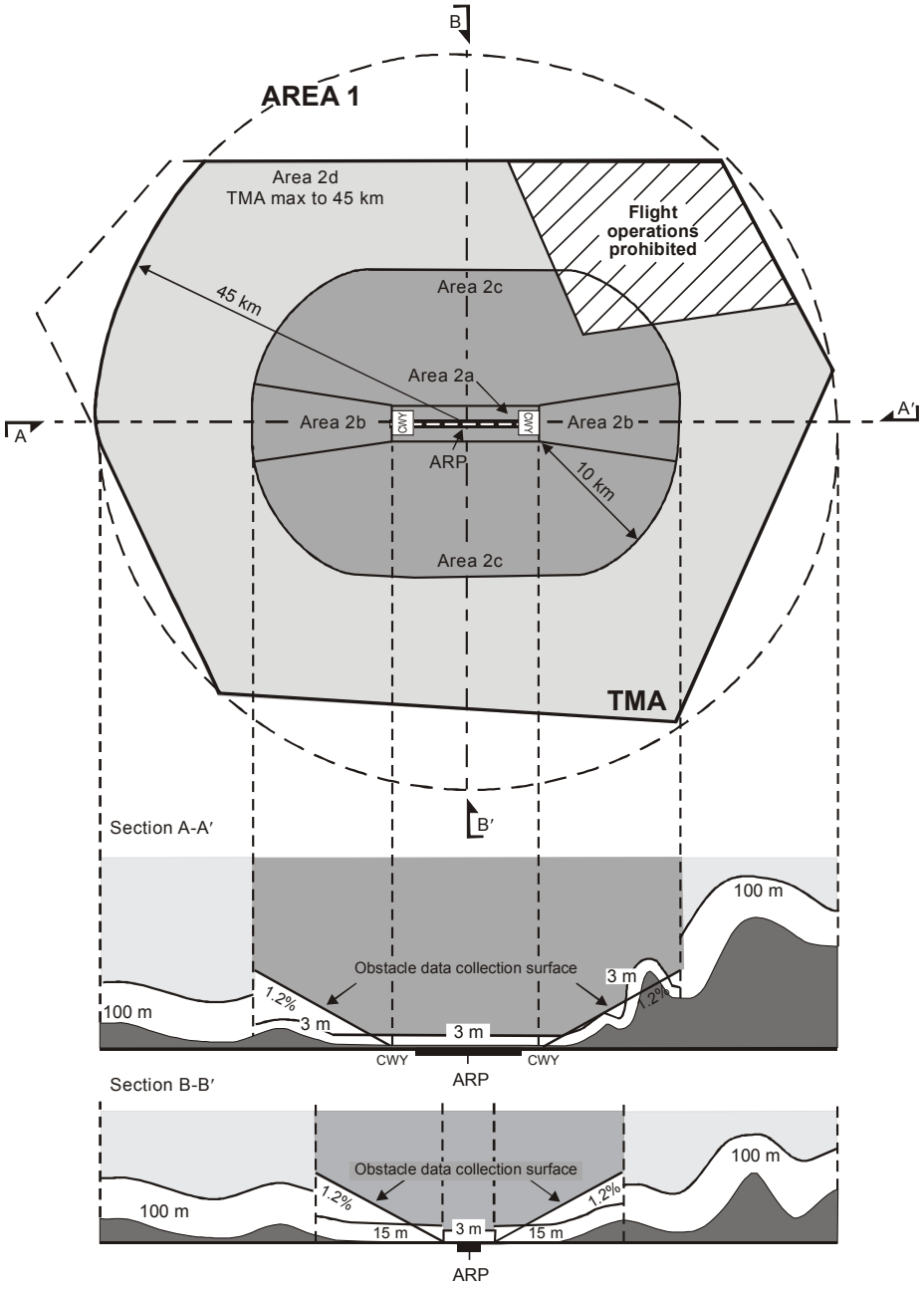


Figure A8-2. Obstacle data collection surfaces — Area 1 and Area 2

Obstacle data shall be collected and recorded in accordance with the Area 2 numerical requirements specified in Table A8-2

Area 2a: a rectangular area around a runway that includes the runway strip plus any clearway that exists. The Area 2a obstacle collection surface shall have an elevation of the nearest runway elevation measured along the runway centre line, and for those portions related to a clearway, if one exists, at the elevation of the nearest runway end;

Area 2b: extending from the ends of Area 2a in the direction of departure, with a length of 10 km and a splay of 15% to each side. The Area 2b collection surface has a 1.2% slope extending from the ends of Area 2a at the elevation of the runway end in the direction of departure, with a length of 10 km and a splay of 15% to each side;

Area 2c: extending outside Area 2a and Area 2b at a distance of not more than 10 km from the boundary of Area 2a. The Area 2c collection surface has a 1.2% slope extending outside Area 2a and Area 2b at a distance of not more than 10 km from the boundary of Area 2a. The initial elevation of Area 2c shall match the elevation of the point of Area 2a at which it commences; and

Area 2d: outside the Areas 2a, 2b and 2c up to a distance of 45 km from the aerodrome reference point, or an existing TMA boundary, whichever is nearest. The Area 2d obstacle collection surface has a height of 100 m above ground.

In those portions of Area 2 where flight operations are prohibited due to very high terrain or other local restrictions and/or regulations, obstacle data shall be collected and recorded in accordance with the Area 1 requirements.

Data on every obstacle within Area 1 whose height above the ground is 100 m or higher shall be collected and recorded in the database in accordance with the Area 1 numerical requirements specified in Table A8-2.

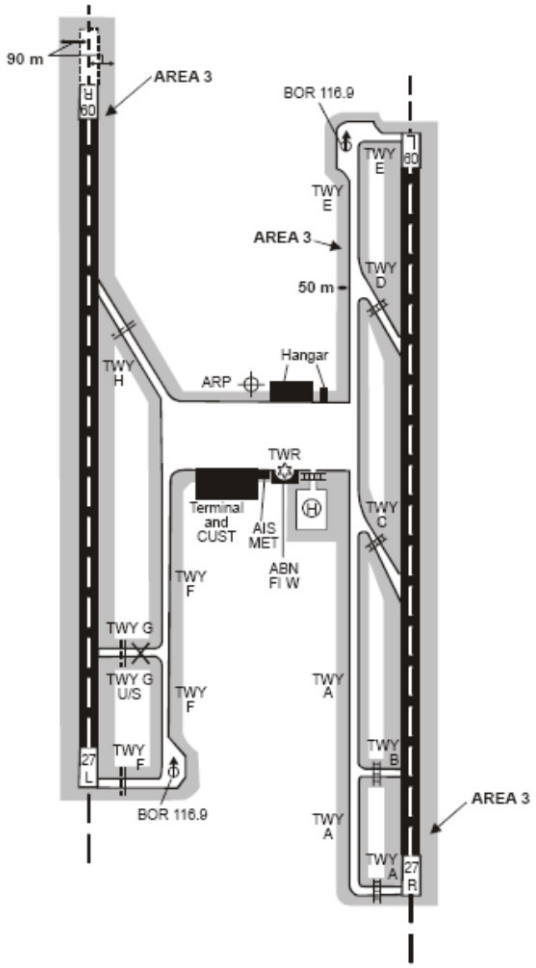
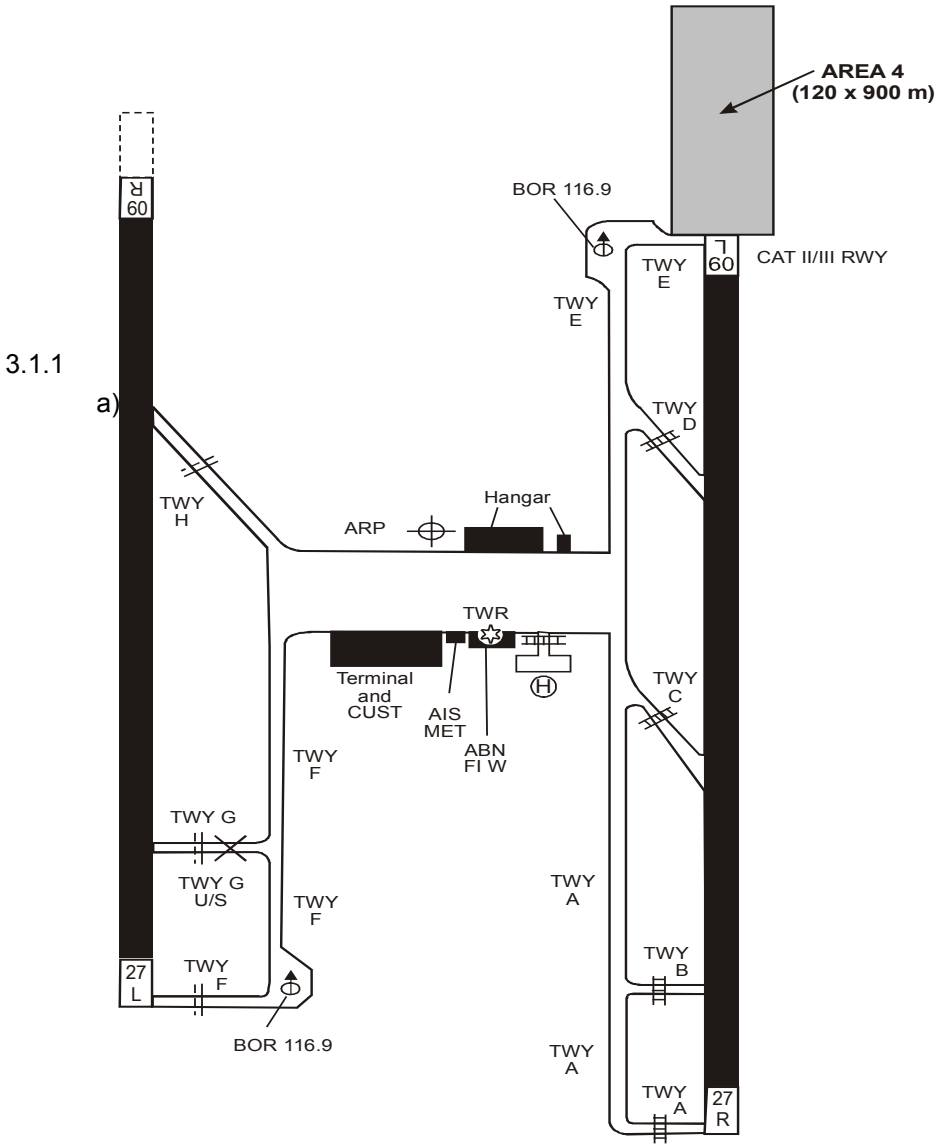


Figure A8-3. Terrain and obstacle data collection surface — Area 3

The data collection surface for terrain and obstacles extends a half-metre (0.5 m) above the horizontal plane passing through the nearest point on the aerodrome/heliport movement area.

Terrain and obstacle data in Area 3 shall be collected and recorded in accordance with numerical requirements specified in Table A8-1 and Table A8-2, respectively



3.1.1

a)

Figure A8-4. Terrain and obstacle data collection surface — Area 4

Terrain data shall be collected and recorded in Area 4 in accordance with the numerical requirements specified in Table A81.

Note 1 - The horizontal extent of Area 2 covers Area 4. More detailed obstacle data may be collected in Area 4 in accordance with Area 4 numerical requirements for obstacle data specified in Table A8-2. (See 10.1.8.)

Note 2 - Area 4 may be extended in accordance with 10.1.2.

Table A8-1. 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 ~~(1σ)~~	90%	90%	90%	90%
Data classification Integrity level	routine 1×10^{-3}	essential 1×10^{-5}	essential 1×10^{-5}	essential 1×10^{-5}
Maintenance period	as required	as required	as required	as required

Table A8-2. Obstacle data numerical requirements

	Area 1	Area 2	Area 3	Area 4
Vertical accuracy	30 m	3 m	0.5 m	1 m
Vertical resolution	1 m	0.1 m	0.01m	0.1 m
Horizontal accuracy	50 m	5 m	0.5 m	2.5 m
Confidence level ~~(1σ)~~	90%	90%	90%	90%
Data classification Integrity level	routine 1×10^{-3}	essential 1×10^{-5}	essential 1×10^{-5}	Essential 1×10^{-5}
Maintenance period	as required	as required	as required	as required

Table A8-3. Terrain attributes

Terrain attribute	Mandatory/Optional
Area of coverage	Mandatory
Data originator identifier	Mandatory
Acquisition method	Mandatory
Post spacing	Mandatory
Horizontal reference system	Mandatory
Horizontal resolution	Mandatory
Horizontal accuracy	Mandatory
Horizontal confidence level	Mandatory
Horizontal position	Mandatory
Elevation	Mandatory
Elevation reference	Mandatory
Vertical reference system	Mandatory
Vertical resolution	Mandatory
Vertical accuracy	Mandatory
Vertical confidence level	Mandatory
Surface type	Optional
Recorded surface	Mandatory
Penetration level	Optional
Known variations	Optional
Integrity	Mandatory
Date and time stamp	Mandatory
Unit of measurement used	Mandatory

Table A8-4. Obstacle attributes

Obstacle attribute	Mandatory/Optional
Area of coverage	Mandatory
Data originator identifier	Mandatory
Obstacle identifier	Mandatory
Horizontal accuracy	Mandatory
Horizontal confidence level	Mandatory
Horizontal position	Mandatory
Horizontal resolution	Mandatory
Horizontal extent	Mandatory
Horizontal reference system	Mandatory
Elevation/Height	Mandatory/Optional
Vertical accuracy	Mandatory
Vertical confidence level	Mandatory
Elevation reference	Mandatory
Vertical resolution	Mandatory
Vertical reference system	Mandatory
Obstacle type	Mandatory
Geometry type	Mandatory
Integrity	Mandatory
Date and time stamp	Mandatory
Unit of measurement used	Mandatory
Operations	Optional
Effectivity	Optional
Lighting	Mandatory
Marking	Mandatory