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Agenda Item 8: Other business

THE NEED FOR eTOD INFORMATION FROM AN INDUSTRY PERSPECTIVE

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SUMMARY

Amendment 33 to ICAO Annex 15 introduced requirements for States to ensure that electronic sets of Terrain and Obstacle data (eTOD) are made available. The purpose of eTOD provisions is justified as supporting data for various air navigation applications which can bring significant safety benefits for the international civil aviation. This information paper summarizes the ICAO requirements, source data collection platforms and repositories, along with the cockpit-based, ground-based and aerodrome mapping applications using sets of eTOD collected/recorded in accordance with all four coverage areas and it continues with description and benefits of specific navigation applications based on eTOD Area 1 & 4. Finally, the paper presents Jeppesen's role as data integrator: on one side, its evolving eTOD-based applications fully support the end state of the ICAO Global ATM concept and, on the other side, recognizing the challenge for States of eTOD implementation, the set-up of eTOD Area 1 and 2 programs for States CAA.

1 ELECTRONIC TERRAIN AND OBSTACLE DATA

1.1 Background

1.1.1 Amendment 33 to ICAO Annex 15 introduced requirements for States to ensure that electronic sets of Terrain and Obstacle data (eTOD) are made available. The data shall be made accessible for four distinct coverage areas, ranging from the entire territory of the State (Area 1) through to the precision approach areas at an aerodrome (Area 4) with each area having differing data collection requirements. The new provisions in Annex 15 on the subject of electronic terrain and obstacle data are based on work done by ICAO with RTCA SC-193 and EUROCAE WG-44 industry groups as well as on comments received from States during the amendment process. It was acknowledged by ICAO, however, that the introduction of SARPS thru amendment 33 related to the provision of terrain and obstacle data was a challenge and, consequently, a new amendment 36 to ICAO Annex 15 was formally issued on the 1st April 2010 and was effective from 12th July 2010, becoming applicable on 18th November 2010. This Amendment offers significant cost savings over the original requirements introduced by Amendment 33.

1.1.2 The new provisions deal with the electronic terrain and obstacle data function, coverage, obstacle numerical requirements, content and structure of terrain and obstacle databases (defined as two separate databases), data product specifications for terrain and obstacle data and their availability. To be noted that the new ICAO SARPS in Chapter 10 "Electronic Terrain and Obstacle Data" to Annex 15 as published with amendment 36 have brought important changes regarding collection surfaces, new/updated data attributes as well as the implementation date for Area 2 implementation by member States. It is not within the scope of this Information Paper to extensively describe new definition of coverage area 1, 2, 3 and 4. However, we would like highlighting the major changes occurred with Area 2. The standard establishes four basic areas for which terrain and obstacle data is required i.e. Area 2a, 2b, 2c and 2d which precise collection surfaces are to be found as textual and graphical description in Appendix 8 to Annex 15. The provision of a full Area 2 data set for all aerodromes are considered to be costly and, as a result, unlikely to be justifiable in many cases. Whilst the original intent of ICAO had been the provision of Area 2 data for all IFR aerodromes published in the State AIP, feed-back received from States indicated that this was not considered feasible or necessary. Consequently, the standard for the provision of full Area 2 had been revised with Amendment 36, such that the provision of data Area 2a, 2b, 2c and 2d is now a Recommended Practice only. Further, this Recommended Practice relates only to aerodromes "*regularly used by international civil aviation*". Finally, the standard requires that a limited set of eTOD data set i.e. sub-area 2a is made available from the specified date of 12th November 2015.

1.2 Definition of coverage area 1, 2, 3 and 4

1.2.1 In order to satisfy the ICAO requirements for eTOD the source data used to generate the terrain and obstacles needs to exceed the minimum requirements for the following four coverage areas as defined in ICAO Annex 15 Chapter 10 Appendix 8. This also includes the need to meet the attribution and metadata requirements that will describe the features and data contained within the terrain and obstacle database. Below is a high-level overview of the requirements for each Area.

1.3 AREA 1

1.3.1 **Terrain:**

- Coverage: Entire territory of the State (excluding the geographical footprint of Area 3 & 4 and some portions of Area 2).
- Accuracy Requirements: The horizontal accuracy is 50m (CE90) and 30m (LE90) for vertical with a 90m post spacing and data precision of 1.0m.
- Data Integrity Requirements: Maximum loss of 1 in 1000 (focusing on the integrity and consistency of stored data between two updates of a data record).
- Attribution: There are 25 attributes that are associated with the terrain data, with 3 of the attributes being optional.

1.3.2 **Obstacles:**

- Coverage: Entire territory of the State (excluding the geographical footprint of Area 3 & 4 and some portions of Area 2).
- Minimum Collection Requirements: all obstacles having minimum height of 100m AGL.
- Accuracy Requirements: The horizontal accuracy is 50m (CE90) and 30m (LE90) vertical, with a data precision of 1.0m.
- Data Integrity Requirements: Maximum loss of 1 in 1000 (focusing on the integrity and consistency of stored data between two updates of a data record).
- Attribution: There are 21 attributes that are associated with the obstacle data, with 3 of the attributes being optional.

1.4 AREA 2

1.4.1 **Terrain:**

- Coverage: Terminal Control Area (10km buffer from ARP extending to the TMA boundary or 45km radius whichever is smaller, terrain penetrating the horizontal plane of 120m above lowest THR elevation).
- Accuracy Requirements: the horizontal accuracy is 5m (CE90) and 3m (LE90) for vertical with a 30m post spacing and a data precision of 0.1m.
- Data Integrity Requirements: Maximum loss of 1 in 100,000 (focusing on the integrity and consistency of stored data between two updates of a data record).
- Attribution: There are 25 attributes that are associated with the terrain data, with 3 of the attributes being optional.

1.4.2 **Obstacles:**

- Coverage: Terminal Control Area (conical surface extending 10km from the end of the runway and buffering Area 2a following the elevation of the runway profile extending to the TMA boundary or 45km radius whichever is smaller).
- Minimum Collection Requirements: Obstacles are collected based they penetrate or relative distance to the Area 2 Aerodrome surface.
- Accuracy Requirements: the horizontal accuracy is 5m (CE90) and 3m (LE90) for vertical with a 30m post spacing and a data precision of 0.1m.
- Data Integrity Requirements: Maximum loss of 1 in 100,000 (focusing on the integrity and consistency of stored data between two updates of a data record).
- Attribution: There are 21 attributes that are associated with the obstacle data, with 3 of the attributes being optional.

1.5 AREA 3

1.5.1 **Terrain:**

- Coverage: Runway/heliport area (Area adjacent to the movement area and extending from the edges of the runways up to 90m from runway centreline and for the rest of the movement area 50m from its edges).
- Accuracy Requirements: the horizontal accuracy is 0.5m (CE90) and 0.5m (LE90) for vertical with a 20m post spacing and a data precision of 0.01m.
- Data Integrity Requirements: Maximum loss of 1 in 100,000 (focusing on the integrity and consistency of stored data between two updates of a data record).
- Attribution: There are 25 attributes that are associated with the terrain data, with 3 of the attributes being optional.

1.5.2 **Obstacles:**

- Coverage: Runway/heliport area (Area adjacent to the movement area and extending from the edges of the runways up to 90m from runway centreline and for the rest of the movement area 50m from its edges.).
- Minimum Collection Requirements: Collect all obstacles that are greater than 3m.
- Accuracy Requirements: the horizontal accuracy is 0.5m (CE90) and 0.5m (LE90) for vertical with a data precision of 0.01m.
- Data Integrity Requirements: Maximum loss of 1 in 100,000 (focusing on the integrity and consistency of stored data between two updates of a data record).
- Attribution: There are 21 attributes that are associated with the obstacle data, with 3 of the attributes being optional.

1.6 AREA 4

1.6.1 **Terrain:**

- Coverage: CAT II/III operations area (Rectangular area of 60m each side of the extended runway centreline with the length of 900m extending from the runway threshold.)
- Accuracy Requirements: the horizontal accuracy is 1.0m (CE90) and 2.5m (LE90) for vertical with a 9m post spacing and data precision of 0.1m.
- Data Integrity Requirements: Maximum loss of 1 in 100,000 (focusing on the integrity and consistency of stored data between two updates of a data record)
- Attribution: There are 25 attributes that are associated with the terrain data, with 3 of the attributes being optional.

1.6.2 **Obstacles:**
Not required.

2 TERRAIN AND OBSTACLE DATA COLLECTION METHODS

There are many important factors that need to be taken into consideration during the source data acquisition planning phase. Since the ICAO Area 1, 2, 3 & 4 terrain and obstacle specifications state the accuracies and resolution required to satisfy the minimum requirement, there are source data platforms that are recommended for each specified area. These platforms include satellite-based, aerial-based and ground-based systems, along with the availability of ancillary sources, such as States AIP and the internet. Before the source data is acquired an organization needs to take into account the cost-effectiveness, acquisition methods, accuracy requirements, data integrity and data availability of the source data. One important factor that needs to be understood is that source data collection methods that are incorporated for Area 3 & 4, could technically be used for Area 1 or 2, but are usually cost prohibitive. Below is a breakdown of the primary data platforms or repositories that enable collection of the essential eTOD data, which then allow the ICAO requirements to be met.

2.1 Satellite-based

2.1.1 Imagery: there are multiple commercial satellite vendors available today that have the capability to capture imagery in locations throughout the world using a multitude of satellite image sensor platforms. This imagery can be collected in the form of monoscopic (2-D) or stereoscopic (3-D) and either as color or black and white. Stereo imagery could be used as a primary source for terrain generation as well as obstacle collection. The standard satellite image product usually is delivered with 0.5m pixel resolution, 5m horizontal accuracy and a 3m vertical accuracy. Most sensors today are exceeding these values, which are providing customers with a higher quality product.

eTOD Application: The primary use for stereo imagery would be to generate terrain and obstacle data for Area 2. Mono Imagery could be used to generate obstacle data for Area 1 & 2 using 2-D measuring techniques.

2.1.2 Radar: there are a limited number of commercial satellite vendors that provide access to RADAR sensors. Radar sensors are primarily responsible for generating the world wide terrain datasets, such as Shuttle Radar Terrain Mission (SRTM) and Digital Terrain Elevation Data (DTED), which we use today. Most of these dataset are used in the form of Digital Elevation Models (DEM). Two sub products that are produced from DEM’s include Digital Terrain Models (DTM) and Digital Surface

Models (DSM). These datasets, when using at least a 5m posting, can achieve vertical accuracies of +/- 0.5m to +/- 3.0 m. It is important to understand that the accuracy the requirements or requests, greater the cost. (Remote Sensing for GIS Mangers, 214).

eTOD Application: The primary use for these datasets is the generation of terrain data for Area 1. A Radar satellite could produce terrain data with Area 2 accuracy requirements, but at an increase in cost.

2.2 Aerial-based

2.2.1 Imagery: there are multiple commercial vendors available today that have the capability to capture imagery in locations throughout the world using an aircraft platform. This imagery could be in the form of monoscopic or stereoscopic and either in color or black and white. Based on the aircraft's flying height and available ground control, the imagery's resolution and accuracy could vary, but would exceed the Area 3 & 4 requirements.

eTOD Application: Stereo aerial imagery is primarily used for Area 3 & 4 terrain and obstacle collection. Mono imagery, limited to 2-D collection methods, has applications in Area 2, 3 & 4 obstacle collection, with additional data processing.

2.2.2 LiDAR: LiDAR, which stands for Light Detection and Ranging, uses active remote sensing technology that measures the distance to, or other properties around, targets by illuminating the target with laser light and analyzing the backscatter. This data is used for generating highly accurate terrain data and allows you to collect obstacle features based on the resolution of the data collected. Accuracy of this data when flown from an aerial platform can exceed horizontal accuracies of 30cm and vertical accuracies of 20cm, which would exceed Area 3 & 4 requirements. (Remote Sensing for GIS Managers, 231).

eTOD Application: LiDAR data can be used for both obstacle and terrain generation for Area 3 & 4 if collected at an optimal resolution.

2.3 Ground-based

2.3.1 Ground Survey: includes all data that is collected using survey grade data collection instruments and the less accurate GPS systems. It also includes any technical process for height collection such as laser range finders or manual measurement devices.

eTOD Application: This data could be used as control data for runway extents and for the more rigorous Area 3 & 4. This control data could also be used for image control data applied to Area 2.

2.3.2 Field Data: includes any data, physical, cultural, etc. collected on-site or researched that provides additional characteristics for eTOD attribution or assists in the data collection process.

eTOD Application: this data collection method is primarily used in the analysis of Area 1 through 4.

2.4 Ancillary

2.4.1 State sources: includes Aeronautical Information Publications (AIP), archived data and cultural information used to extract terrain or obstacle data.

eTOD Application: the primary use for state sources in the past has been for Area 1 terrain and obstacle data. If the data has proven accuracy attributed then it could be applied to Area 2, 3 or 4 once verified.

2.4.2 Internet sources: includes any internet based system that provides reliable data and information relating to terrain or obstacle data.

eTOD Application: the primary use for internet sources would be to access archived terrain data (SRTM or DTED). There potential opportunities to access obstacle data, but they would need to be verified before use.

3 TERRAIN AND OBSTACLE DATA APPLICATIONS

3.1 Background

3.1.1 There is an emerging need for the development of digital aviation databases which are required to support the implementation of communications, navigation and surveillance/air traffic management (CNS/ATM) systems. During the past several years, there has been an increasing awareness within the aviation community that digital, computer-based avionics can be used to provide flight crew with additional information to support better, more balanced decisions. Situational awareness is the term that best describes the ability of pilots to know what is going on in relationship to their aircraft and the external environment. The underlying philosophy is to make additional but relevant information available to pilots in order to assist them in their decision-making process. At the heart of a cockpit-centred situational awareness architecture is an advanced data management computer system. Beside the functions provided by existing avionics systems to fly the aircraft and to select optimized flight tracks as prescribed by procedure designers, the advanced CNS on-board system can support thru digital aviation databases a variety of new cockpit-based operational applications. The “core” aviation databases include navigation, terrain, obstacles, aerodrome maps, airspace, and noise abatement procedures. Additional supportive aviation databases may also need to be developed and standardized in the future.

3.2 Navigation applications using terrain & obstacle data

Significant safety benefits for international civil aviation will be provided by in-flight and ground based applications that rely on quality electronic terrain and obstacle data. Terrain and obstacle databases can sustain two-dimensional (2-D), three-dimensional (3-D) and four-dimensional (4-D) predictive Controlled Flight into Terrain (CFIT) prevention systems as well as Approach and Landing Accident Reduction (ALAR) systems. Sets of electronic terrain and obstacle data used in combination with relevant aeronautical data shall support the following air navigation applications:

3.2.1 Cockpit-based applications

- Ground Proximity Warning System (GPWS) with forward looking terrain avoidance function;
- En-route “drift-down” procedures;
- En-route emergency landing location selection and,
- Synthetic vision.

3.2.2 Ground-based or ground-used applications

- Minimum Safe Altitude Warning (MSAW) system;
- Instrument procedure design (including curved i.e. RF leg based approach procedures);
- Contingency procedure analysis (one-engine inoperative departure climb profile, etc);
- Flight simulator and, Aeronautical chart production.

3.2.3 Aerodrome mapping data applilcations

3.2.3.1 Based on the availability of a standardized aerodrome mapping data set, a wide variety of applications can be envisioned. Note that several of the applications listed below can be used by multiple user classes e.g. pilots, Air Traffic Controllers, airline, Cargo, Business/General aviation, vehicle operators, etc:

- Map display information;
- Taxi guidance display information;
- Surveillance and conflict/runway incursion detection/alerting;
- Route/Hold-short portrayal and deviation detection/alerting;
- Advanced Surface Movement Guidance and Control System (A-SMGCS);
- Portrayal of D-ATIS information;
- D-NOTAMs with aeronautical data overlays.

4 FUNCTIONS OF eTOD AREA 1 AND 4

From the diversity of cockpit and ground-based set of applications where terrain and obstacle data play a significant role and which are listed in paragraph 2 above, this information paper will now continue to emphasize the respective functions supported by eTOD datasets collected and recorded in databases in accordance with coverage Area 1 and 4. According to ICAO Annex 15, paragraph 10.6 '*Availability*', member States looking for compliance with Chapter 10, Annex 15 requirements shall ensure that terrain Area 4 and terrain & obstacle Area 1 data are made available already as of 20 November 2008.

4.1 eTOD Area 1 applications

4.1.1 Terrain Awareness and Warning System (TAWS)

4.1.1.1 Ground Proximity Warning System (GPWS) technology with forward-looking capabilities provides flight crew with information of impending dangerous terrain and obstacles. This will result in earlier alerts and more time to take appropriate corrective action. New multifunction displays are merging terrain and obstacle databases, aircraft GNSS and Flight Management System sensor data. Many qualified terrain warning systems use digitized terrain data intended for advisory use only since these data sets are not certified for navigation use as they lack stringent quality requirements (integrity). Consequently, there is a significant safety benefit made possible by developing a comprehensive terrain and obstacle database.

4.1.2 Minimum Safe Altitude Warning MSAW) System

4.1.2.1 MSAW systems use ground-based radar to monitor the flight paths of aircraft equipped with encoding transponders to ensure adequate terrain and obstacle separation. The alerting function is accomplished by comparing the flight paths with a three-dimensional grid map stored in the ground-based radar system. If a potentially unsafe condition is detected, the controller will alert the pilot by radio. This operational application is a flight critical safety application as air traffic relies on this data to provide flight crews with guidance pertaining to safe terrain and obstacle avoidance. Consequently, comprehensive terrain and obstacles data sets of higher accuracy in the aerodrome vicinity may provide increased protection against approach and landing accidents and CFIT.

4.1.3 En-route “Drift-Down” procedures

4.1.3.1 As aviation moves forward to use Area Navigation (RNAV), with point-to-point direct routings predicated on navigation systems, more aircraft will likely fly off-airways. Many of these routes will overfly mountainous terrain (for example, over the Alps), or areas such as the Greenland Ice Cap. Occasional re-routings take commercial aircraft on routes where a one-engine inoperative “drift-down” may require the aircraft to descend over mountainous terrain. In some situations, the one-engine inoperative cruise flight may be performance limited such that the aircraft is unable to sustain flight above Minimum Obstacle Clearance Altitude (MOCA). Consequently, without any outside help, pilots need to quickly and accurately calculate their best “escape” route to avoid high terrain and/or to maintain the necessary terrain and obstacle clearance. Therefore, this operational application has both a safety as well as an operational component.

Note: Although the requirements related to these procedures are provided in ICAO Annex 6 ‘*Operations of Aircraft’* - Part I, there is no association with the name “drift-down” as indicated in the Annex 15, Chapter 10, paragraph 10.1.

4.1.4 En-route emergency landing location selection

4.1.4.1 During an in-flight emergency, especially in general aviation operations, selection of an acceptable emergency landing site can often mean the difference between an aircraft sustaining only minor or no damage, versus suffering catastrophic damage. The risks are great when an aircraft must land immediately for any reason when flying at night or over unfamiliar territory. Under such circumstances, a high resolution, digital image, containing vegetation and cultural features, overlaid onto a terrain and obstacle database could assist pilots in identifying the safest location for a forced, emergency landing.

4.1.5 Aeronautical chart production

4.1.5.1 For pilots, a graphical portrayal of all aeronautical, cultural and topographic information generally specified for all type of charts by Annex 4 ‘*Aeronautical Charts*’, is essential to safe and efficient navigation. Currently, this graphical portrayal is mostly provided to flight crews by way of paper charts. Alternatively, chart images can be portrayed on electronic displays of a flight deck. Electronic chart displays or electronic data-driven charts distributed via digital media or world-wide web connectivity respectively are the most appropriate solutions to enable flight crews to execute, in a convenient and timely manner, route planning, route monitoring and navigation. Consequently, the usage of terrain and obstacle dataset satisfying Area 1 numerical requirements for generating the topographic layer (including possible contour generation capability) will significantly enhance the chart display for following ICAO Annex 4 type of charts: En-route Chart, Area Chart, Aeronautical Chart 1: 500000, Aeronautical Navigation Chart – Small Scale, Plotting Chart and Radar Minimum Altitude Chart.

4.2 eTOD Area 4 applications

4.2.1 The Annex 15 definition for Area 4 terrain intents to support the high demanding operational requirements (flare profile, rate of descent, etc) for CAT II/III approaches in terms of characteristics of the pre-threshold terrain areas. The Precision Approach Terrain Chart (PATC) is the current graphical depiction mean by which State authorities provide to operators information necessary to perform height determination during precision approaches. The area covered by PATC matches exactly eTOD Area 4, however Annex 4 requires that within PATC area all elevations (terrain and objects) that differ with more than 3m (10ft) from the runway centreline profile shall be indicated.

Note: Although Annex 14 'Aerodrome Design and Operations' - Vol. I recommends establishment of a Radio Altimeter Operating area located in the pre-threshold area of a precision approach runway in order to accommodate aeroplanes making auto-coupled approaches and automatic landings, the length of the area i.e. at least 300m is not matching Area 4 longitudinal profile of 900m.

5 JEPPESEN PERSPECTIVE TOWARDS ICAO eTOD BENEFITS

5.1 JEPPESEN as eTOD user

5.1.1 For several years, Jeppesen has been doing considerable research and development work on collection, management, systems interfaces and display of terrain and obstacle information. Starting with the basic terrain data provided by the Shuttle Radar Topography Mission (SRTM), Jeppesen has been significantly augmented the quality of the SRTM datasets by applying sound methods, intelligent mathematical algorithms as well as other datasets with very high accuracy. The final result was the generation of a worldwide terrain envelopes databases with designated confidence levels of 10^{-3} (routine), 10^{-5} (essential) and 10^{-8} (critical) – called TerrainScape Level 1, 2 and 3 respectively.

5.1.2 Furthermore, Jeppesen efforts have been focused on creation of a single-source geo-spatial data repository of terrain, terrain high-points and man-made obstacles in order to ensure that all chart images (En-route High and/or Low, Terminal and VFR/GPS 1:500000 charts) utilize a single common terrain source of the highest quality with known quality characteristics. In parallel, we are concentrating our development efforts on the data that air-framers and aircraft operators require to support new on-board systems designed to enhance situational awareness in the air and on the airport surfaces e.g. data-driven electronic charts, Airport Mapping (AMDB), Electronic Flight Bag (EFB), Airspace and Procedure Design, Opsdata analysis, TAWS/MSAW & Flight Simulation (Terrain + Navdata ARINC 424), Synthetic Vision System (SVS) displays, etc. Practically, our evolving navigation applications where eTOD information is an important product component will continue to fully support the end state of the ICAO Global ATM concept.

5.2 JEPPESEN Area 1 Terrain and Obstacle Data Program

5.2.1 Jeppesen recognizes that the terrain and obstacle requirements of ICAO Annex 15, Chapter 10 challenge many Civil Aviation Authorities (CAA) and Air Navigation Service Providers (ANSP) around the world. Also, Jeppesen understands that certain States may not have processes established to deliver eTOD information to other users or may wish to outsource this responsibility. Therefore, we have established processes, in cooperation with States that contract with Jeppesen, to maintain a State's Area 1 terrain and/or obstacle database and deliver it as required. It should be noted that our Terrain and Obstacle Area 1 data model has resolved the issues in relation to cross-border harmonisation as we have consistently applied same DO-200A/ED-76A quality-driven processes. Finally, it can be mentioned that Jeppesen eTOD service for CAAs and ANSPs offers the possibility for States to notify compliance with Chapter 10 in its AIP (see also reference in GEN 1.7 'Differences from ICAO SARPS').

5.3 JEPPESEN Area 2 Terrain and Obstacle Data Program

5.3.1 The Jeppesen Area 2 electronic Terrain and Obstacle Database (eTOD) is comprised of man-made and certain natural obstacles considered as relevant to aviation procedure design and related products. The Jeppesen eTOD product contains complete terrain models and project-based obstacle datasets that cover only the specified ICAO Area 2 regions (10 km buffer from the runway extents) for each airport. The TMA or 45 km buffer from the ARP, based on the customers' project requirements, will be offered, but adds a significant cost to the project and is considered in most cases cost prohibitive. The Jeppesen Area 2 Terrain and Obstacle program is delivered to the customer following the most stringent guidelines set forth by ICAO and RTCA for aeronautical terrain and obstacle data generation. Below are some of the key product features:

- Jeppesen eTOD exceeds the DO-276B/ ED-98A integrity requirement. Essential integrity is achieved by developing data generation processes in compliance with the DO-200A/ED-76 [1]. One of the key steps for achieving this accuracy is validation at different levels of data generation. The data in Jeppesen eTOD Database is provided as compliant to DO-200A 9 [C.2.3 & B.1.3]. This assurance level applies to DO-200A only and does not imply adherence to any other aviation standards.

- Jeppesen generates terrain data for each airport and the final terrain database will exhibit horizontal accuracies exceeding +/- 5m (CE90) and vertical accuracies greater than +/- 3m (LE90) and will encompass the Area 2 polygon specific to each airport.

- Jeppesen also generates obstacle data with a horizontal accuracy exceeding +/- 5m (CE90) and vertical accuracy exceeding +/- 3m (LE90). The data will encompass the Area 2 polygon specific to each airport.

- Jeppesen's terrain data will contain the 25 attributes and the obstacle data will contain 21 attributes to comply with the ICAO Annex 15.

- Jeppesen supplies terrain and obstacle data under a data license agreement. Under the terms of this agreement, Jeppesen provides a database file of terrain and obstacle data for select airports within Area 2 regions as defined by DO-276B/ ICAO chapter 15, appendix 8. This data is provided per customer format as specified in a Data Quality Requirement (DQR) document. Customer DQR's are mutually agreed to and documented by agreement letters between Jeppesen and the OEM customer prior to data delivery. The DQR is then further confirmed during delivery through the use of metadata attached to the provided database. The supplied metadata will comply with DO-276B for imagery, obstacles and terrain datasets.

Bibliography

Aronoff, Stan, Remote Sensing for GIS Managers, Redlands, California, ESRI Press, 2005

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