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CAR/SAM Regional Planning and Implementation Group (GREPECAS)
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(AGA/AOP/SG/7)
Buenos Aires, Argentina, 9 to 13 November 2009

Agenda Item 5 **Review of other technical matters**
5.2 e-TOD Aerodrome mapping

ELECTRONIC TERRAIN, OBSTACLE AND AERODROME MAPPING INFORMATION

(Presented by the Secretariat)

SUMMARY

The following working paper refers to the geographical coordinates of obstacles that shall be measured and reported to the aeronautical information services (AIP), as required by Annex 14 and the implementation of Annex 15 provision 10.6.1.2 concerning the availability, as of 18 November 2010, of obstacle data according to Area 2 and Area 3 specifications that should be facilitated by appropriate advanced planning for the collection and processing of such data.
It also describes the benefits associated with the implementation of aerodrome mapping information based on E-TOD.

References:

- Annex 4 — *Aeronautical Charts*
- Annex 6 — *Operation of Aircraft,* Part I — *International Commercial Air Transport — Aeroplanes*
- Annex 11 — *Air Traffic Services*
- Annex 14 — *Aerodromes,* Volume I — *Aerodrome Design and Operations,* Volume II —*Heliports*
- Annex 15 — *Aeronautical Information Services*
- Doc. 8168 — *Procedures for Air Navigation Services — Operations* (PANS-OPS)
- Doc. 8126 — *Aeronautical Information Services Manual*
- Doc. 8697 — *Aeronautical Chart Manual*
- Doc. 9674 — *World Geodetic System — 1984 (WGS-84) Manual*
- Doc. 9881, Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information.

Strategic Objectives	*This working paper is related to Strategic Objective D.*

1. Introduction

1.1 It is recognized that at large aerodromes, many activities are performed by number of participants such as pilots, airline operations personnel, general aviation operations personnel, air traffic controllers, apron controllers, surface vehicle operators, construction/maintenance crews, emergency/security personnel, etc. All the participants involved, must cooperate closely, to ensure safe and efficient flight operations at the aerodrome and for this purpose they must be knowledgeable of the aerodrome layout.

1.2 The reporting geographical coordinates of obstacles are in the form of aeronautical data quality requirements prescribed for specific aerodrome design characteristics and their presentation in State Aeronautical Information Publication (AIP) in the textual or graphical form.

1.3 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. The increasing worldwide equipage of aircraft and air traffic control units with systems that make use of electronic terrain data requires standardization in the provision of supporting data. Furthermore, as terrain information is increasingly finding its primary usage in the cockpit, many other personnel involved with operations will also benefit from the use of quality terrain and obstacle data.

1.4 The new provisions in Annex 15 deal with the electronic terrain and obstacle data function, coverage, terrain and obstacle numerical requirements, content and structure of terrain and obstacle databases, data product specifications for terrain and obstacle data and their availability. In addition, applications for which quality terrain and obstacle data, used in conjunction with aeronautical data, are required have also been identified.

2. Electronic terrain and obstacle data

2.1 To satisfy identified user requirements for electronic terrain and obstacle data, while taking into account cost-effectiveness, acquisition methods and data availability, the data are to be provided according to four basic coverage areas:

- Area 1: entire territory of a State;
- Area 2: terminal control area;
- Area 3: aerodrome/heliport area; and
- Area 4: Category II or III operations area.

2.2 Area 1 has coverage over the whole territory of a State, including aerodromes/heliports. Area 2 covers the established terminal control areas, not exceeding a 45 km radius from the aerodrome reference point (ARP), to coincide with the existing specification for the provision of topographical information on the Aerodrome Obstacle Chart — ICAO Type C (Annex 4, paragraph 5.3.1 c) refers)). Area 3 covers the area which is within the specified distances from the edges of a defined aerodrome or heliport surface movement area while Area 4 is restricted for use only for those runways where precision approach Category II or III operations have been established.

2.3 ***Terrain Database — Content and Structure.*** A terrain database 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. 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”

2.4 ***Obstacle Database — Content and Structure.*** One obstacle database shall contain a digital set of obstacle data and shall include those features having vertical significance in relation to adjacent and surrounding features that are considered hazardous to air navigation. Obstacle data shall comprise the digital representation of the vertical and horizontal extent of man-made objects. Obstacles shall not be included in terrain databases. Obstacle data elements are features that shall be represented in the database by points, lines or polygons.

2.5 ***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.

2.6 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. 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.

2.7 Availability. States shall ensure that as of 18 November 2010, electronic terrain and obstacle data are made available in accordance with Area 2 and Area 3 specifications.

3. Aerodrome mapping information

3.1 Document 9881 – *Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information*, provides a complete guidance for the aerodrome surface mapping information required for aeronautical users and particularly for on-board aircraft use. The guidance included provides minimum requirements and reference material for the content, origination, publication, maintenance and enhancements of aerodrome mapping information. It also provides a comprehensive statements regarding available aerodrome mapping information data sets in the form of the data product specification. This specification is intended for use by air navigation users when evaluating the products and determining if they satisfy requirements for use in a particular application.

3.2 Terminal Area Terrain Data. Consideration of terrain on and around the aerodrome is essential to terminal area airspace operations such as approach, departure, and contingency procedure planning. Hazards related to terminal area terrain awareness and avoidance have been cited as a major contributing factor in controlled flight into terrain (CFIT) accidents. Terrain is also important to surface navigation. It defines the surface topography of the ground in and around the surface movement areas. Since terrain data shares a physical boundary with many surface geometric objects on the aerodrome (runways, taxiways, buildings, etc.), it is important that the terrain data be correlated with these other data types.

3.3 ***Aerodrome Facility Management-Operational Concept.*** There are six primary categories of activities that come within the scope of aerodrome facility management:

- Planning
- Aerodrome design
- Facility design
- Construction
- Environmental
- Administration

3.4 Each of these activities can benefit from the availability of aerodrome mapping information. To ensure consistency across the applications, a GIS layered database structure with attribute data can be utilized. Every aerodrome implementation will be unique. It is anticipated that the primary repository for this database will be some form of an aerodrome operational control centre. Secondary repositories, with full functionality, may be located at maintenance control centres, aerodrome engineering centres, and aerodrome movement area control centres.

3.5 The benefits for aerodrome facility management are categorized as:

- Reduced staff time for analysis
- Quick response to questions
- Ability to address complex issues
- Ability to provide better information to the decision makers
- Reduced cost to develop applications

- Creation of a basic framework to administer geospatial data

3.6 Another benefit of such a database is the capability of data to retain its natural spatial information. For example, data can be visualized as in the real world and thus, can create a common language for the aerodrome organization to use.

4. Conclusion

4.1 The Meeting is invited to:

a) take note of the information provided in this working paper;

b) review the Appendix to this working paper, containing information on Electronic Terrain, Obstacle and Aerodrome Mapping Information, extracted from Document 9881; and

c) urge States and Territories to measure and report to the AIP the geographical coordinates of obstacles in Areas 2 and 3, as required by Annex 14.

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APPENDIX / APÉNDICE

(Available only in English / Disponible únicamente en inglés)

For all the activities by the different users detailed aerodrome geospatial information is required. This information is commonly made available in aerodrome mapping databases (AMDBs). These databases contain aerodrome information that is organized and arranged for ease of electronic storage and retrieval in systems that support a range of activities on and around the aerodrome.

Document 9881-Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information, provides a complete guidance for the aerodrome surface mapping information required for aeronautical users and particularly for on-board aircraft use. The guidance included provides minimum requirements and reference material for the content, origination, publication, maintenance and enhancements of aerodrome mapping information. It also provides a comprehensive statements regarding available aerodrome mapping information data sets in the form of the data product specification. This specification is intended for use by air navigation users when evaluating the products and determining if they satisfy requirements for use in a particular application.

- The information contained in this document has been compiled for the purpose of stating aerodrome surface mapping information requirements for aeronautical uses, particularly on-board aircraft. The requirements are not all-inclusive, but represent those of more immediate concern. As future applications are developed, more stringent numerical requirements may be needed. Airworthiness authorities, civil aviation authorities, and the aviation industry urge the aerodrome mapping data originators and integrators to use this information when providing those data to system designers and users.

- Based on the availability of standardized aerodrome mapping databases (AMDBs), a wide variety of applications can be envisioned. It is important to note that multiple user classes can benefit from using these databases, for example: pilots, controllers, aerodrome managers, and aerodrome emergency/security personnel.

- Applications of AMDBs

    - Chart information
    - Surveillance and runway incursion detection and alerting
    - Route and hold-short display and deviation detection and alerting
    - Display of digital ATIS information
    - Aerodrome surface guidance and navigation
    - Runway operations
    - Aerodrome and airline resource management
    - Training (flight simulation)
    - Aerodrome facility and asset management
    - Emergency and security service management
    - Notice To Airmen (NOTAM) and aeronautical data overlays
    - Synthetic vision

The figure depicts the data integration processes that contribute to the development of an AMDB. Initially, data originators may collect aerodrome mapping data using various technologies (e.g. aerial photography, satellite imagery, or topographical surveys). The originators may collect data to support non-aeronautical applications; however, any data to be used to support aeronautical applications must meet the requirements defined herein (illustrated as Requirements A, in Figure 4-1).

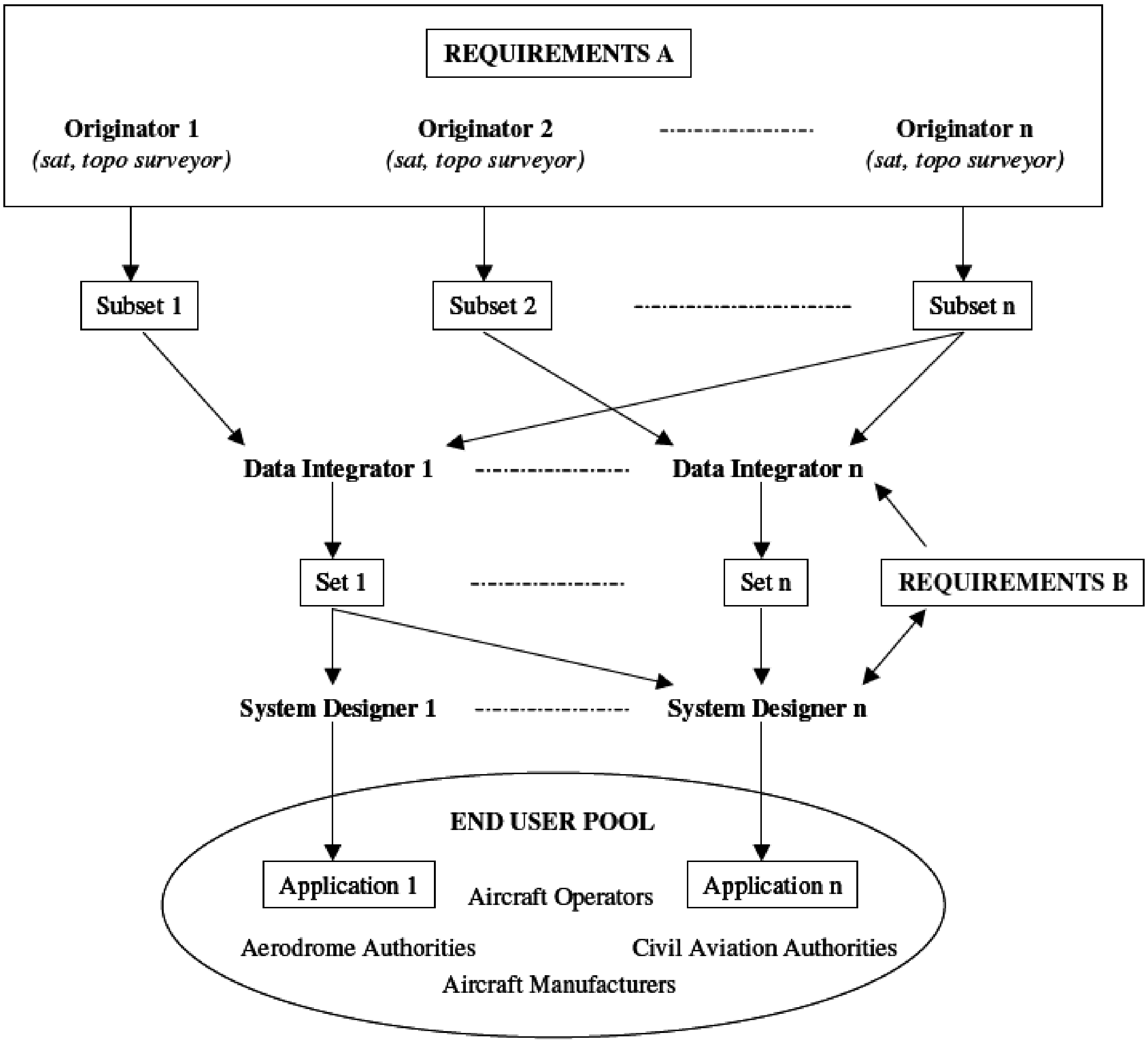


Figure 4-1. Data integration processes

When using data provided from multiple data originators, data integrator(s) may be responsible for merging all appropriate data sets for two purposes:

- ❖ the correlation of multiple data sets representing the same aerodrome area to ensure full aerodrome coverage and to ensure the required accuracy and integrity
- ❖ the concatenation of the many aerodromes into a consistent, globally-referenced database that may also include other data types such as terrain, obstacles, and/or air navigation data

Aerodrome Mapping Information

Most of the existing standards and guidance materials are primarily applicable to air navigation data and were not written with aerodrome surface applications in mind. Issues specific to AMDBs include:

- Data may be derived from aerial survey and/or engineering drawings that are not traditional sources of aeronautical information
- Suppliers of aerodrome mapping data may not be familiar with typical civil aeronautical requirements, standards, and methods
- There are many different formats available for aerodrome mapping data (vector, raster, digital elevation models, etc.)

The starting point for aerodrome information is the data published by States in their Aeronautical Information Publication (AIP) in accordance with Annex 15. However, much of the specific detail required to support the kinds of applications envisaged in Appendix A is not reported on, as it is not necessary for traditional aviation operations. Therefore, other sources of information for the aerodrome may be necessary for these applications.

The majority of existing AMDBs have been captured and maintained using Geographic Information Systems (GIS). GIS technology has evolved from the Computer-Aided Design (CAD) industry, combining the detailed information available in engineering drawings with a geographic reference system. A GIS is a computer program that combines geographically referenced digital data with spatial and attribute analysis tools. The strength of a GIS lies in the methods it provides to represent and analyze geographic information. A GIS can include many different types of data including: control networks, vector data, raster grid data, triangulated irregular networks (TINs), 3-D surface representations, remotely sensed data, and other digital source data such as geo-referenced drawings or Airport Layout Plans (ALPs)

Aerodrome Mapping Data Considerations

Different datums and sufficient conversion algorithms do not exist. Air navigation considerations and the state of the art regarding the use of the Global Navigation Satellite System (GNSS) for instantaneous positioning and navigation require that the reference frame for AMDBs be based on the theoretical surface and universally-positioned ellipsoid defined as WGS-84 (see Section _4.2). WGS-84 is the adopted aviation standard for horizontal reference system while Mean Sea Level (MSL) is the adopted vertical reference system. MSL elevations can be derived using an appropriate geoid model. The Earth Gravitational Model (EGM-96) is the adopted global gravity model.

- From an interoperability standpoint, having the data available using a common datum is essential.
- Problems may be encountered when dealing with sources that have an unknown datum.
- Further, on-board sensors and avionics instruments may provide dynamic inputs to aerodrome mapping databases. These are other sources of information that may need to be converted within the system. It is expected that these datums will be known and the appropriate conversion can be applied.
- In cases where an AMDB already exists and is based on a different reference system, the data must be transformed to a WGS-84 reference. This transformation may induce errors. Therefore, care must be taken to ensure that the conversion process does not impact the integrity of the data and prevent its use in the application for which it was intended.

Characterization of Aerodrome Mapping Data

Unlike terrain databases, which are typically represented as grid points with associated elevation data, aerodrome databases are typically constructed from a photogrammetric image that is converted to vectors and assigned themes and attributes using GIS techniques. This is because many important data elements are features and not just elevations. These features are more easily characterized by points, lines, and polygons. Examples include runway edges, hold points, and stand locations

The use of vector-based data has several advantages:

- ❖ Small data storage requirement
- ❖ Easy use of a relational data base structure
- ❖ Easier for updating purposes
- ❖ No need of feature recognition software
- ❖ Easy attachment of attributes

Consequently, it is recommended that vector-based data (points, lines, and polygons) be used for the characterization of aerodrome features in AMDBs. An alternate approach is to use raster data or imagery. Using this approach, features are portrayed via contiguous pixels of equal or similar density number. This less precise approach may be acceptable for some applications. Aerodrome surface data, unlike terrain data, represents regular geometric objects that can be grouped or classified. Examples of classifications are: runways, taxiways, service roads, localizer antennas, glide slope antennas, buildings, radar sites, radio navigation facility sites, etc. All of these can be described with their own set of attributes, most of which are related to horizontal positioning, and not elevation.

Obstacle Data for the Aerodrome Surface

Aerodrome obstacles penetrate a defined obstacle identification surface. In determining obstacle data requirements, certain accuracy parameters are applied to construct buffers around obstacles and estimate whether they penetrate the defined surface. Depending on the radius specified, unrealistically large, converging or overlapping buffers may be generated, resulting in high false alarm conditions. Internationally recognized survey standards should be used. Annex 14 defines the requirements for identifying aerodrome obstacle limitation surfaces. Further criteria for evaluating obstacles are contained in the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS). An equivalent approach to those mentioned above has been taken when considering which aerodrome obstacles should be included in AMDBs.

Terminal Area Terrain Data

Consideration of terrain on and around the aerodrome is essential to terminal area airspace operations such as approach, departure, and contingency procedure planning. Hazards related to terminal area terrain awareness and avoidance have been cited as a major contributing factor in controlled flight into terrain (CFIT) accidents. Terrain is also important to surface navigation. It defines the surface topography of the ground in and around the surface movement areas. Since terrain data shares a physical boundary with many surface geometric objects on the aerodrome (runways, taxiways, buildings, etc.), it is important that the terrain data be correlated with these other data types.

General Requirements

The horizontal reference for all position data must be the WGS-84 ellipsoid. All aerodrome mapping data that includes horizontal position information must be described in units of latitude/longitude for the purpose of data interchange. It is expected that for many applications, implementation may include conversion to a local coordinate system (e.g. Cartesian) along with at least one geodetic reference point. Data quality must be preserved when performing coordinate system conversion. For all aerodrome mapping data that requires a vertical component, the vertical reference must be orthometric height (referenced to MSL) for the purpose of data interchange. Orthometric height can be derived using WGS-84 ellipsoidal heights and an appropriate geoid undulation. Geoid undulation must be derived using the Earth Gravitational Model of 1996 (EGM-96) or its later realizations. If EGM-96 is not used, the geoid model used to derive orthometric height must be provided (See Annex 15, Chapter 3). The metric system must be used for all linear measurements (e.g., runway length).

Data Acquisition

Any method is acceptable for capturing aerodrome mapping data subject to the information requirements specified in this document. Examples include: aerial photogrammetry, satellite photogrammetry, field surveying, and digitizing existing charts.
A description of the process used to acquire aerodrome mapping data must be provided. This must be consistent with this document.

Data Merging

In order to maintain quality where multiple data sets are merged to create a complete AMDB, each individual data set must be geo-referenced to the WGS-84 ellipsoid (horizontal) and orthometric height (vertical).

Data Conversion

Data sets may be converted to WGS-84 latitude/longitude (horizontal) and orthometric height (vertical); however, the original data, prior to conversion, must meet the quality standards described in this document.

Vertical Objects

Requirements regarding the collection of vertical objects are given in Annex 15 through terrain/obstacle data collection surfaces.

When surveying vertical objects, the horizontal spatial extent to be surveyed must include the aerodrome surface movement area plus a buffer of 50 meters (Figures 4-3 and 4-4), or the minimum separation distances specified in Doc 9157, whichever is greater.
When surveying vertical objects from a runway, the horizontal spatial extent to be surveyed must cover the area that extends from the edge(s) of the runway(s) to 90m from the runway centerline(s).
All vertical objects and terrain in the horizontal spatial extent region that extend more than 0.5 meters above the horizontal plane passing through the nearest point on the aerodrome surface movement area may be hazardous for surface movement and must, therefore, be surveyed (Figure 4-4).
Control towers must always be captured regardless of the location on the aerodrome.

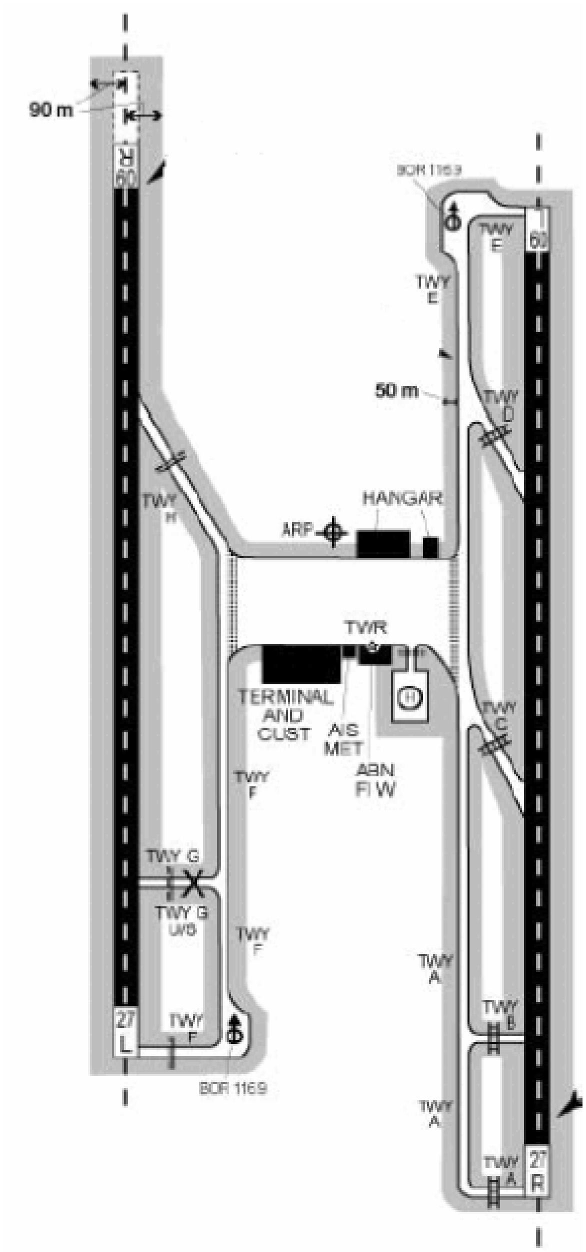


Figure 4-3. Aerodrome Mapping Data Horizontal Extent

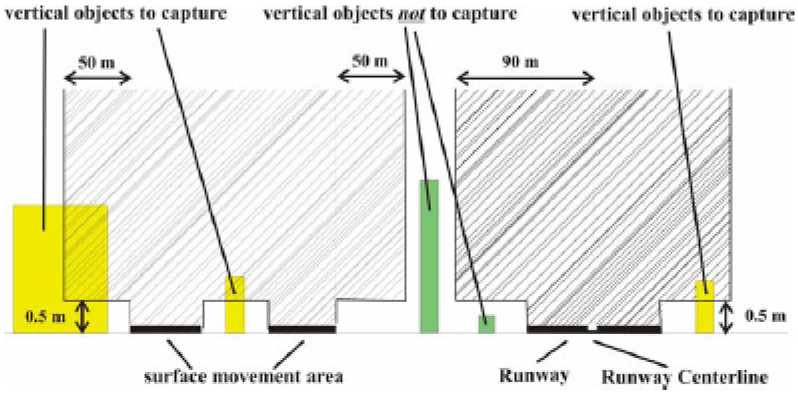


Figure 4-4. Aerodrome Mapping Data Vertical Extent

Data Elements

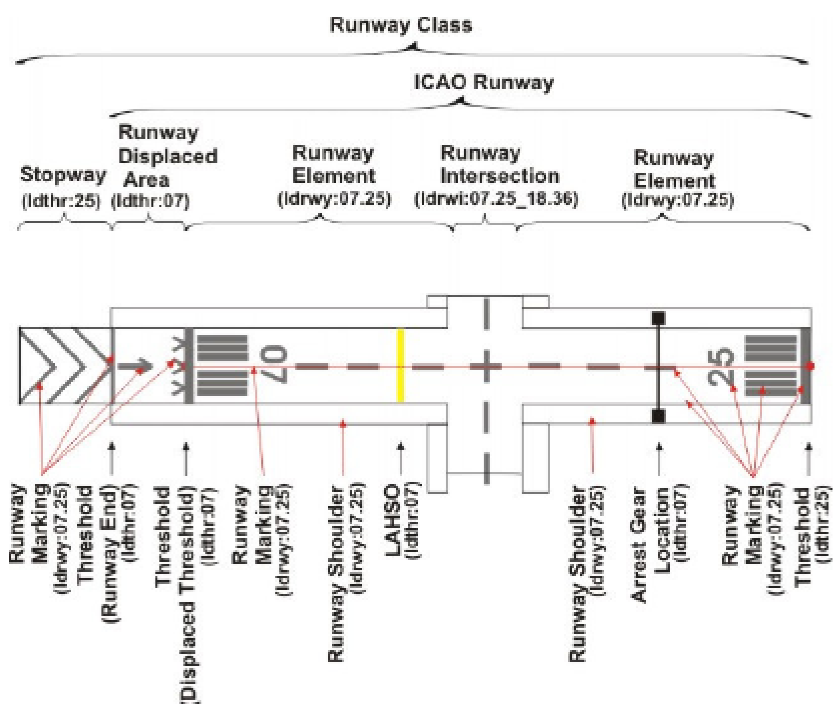
For the purposes of this document, data elements have been listed by class. The seven classes are runways, helipads, taxiways, aprons, vertical structures, construction areas, and quality data. Each class requires that different objects be captured in the AMDB.

Supplemental data classes that have not been specified but may be useful to some applications include, for example, INS/VOR checkpoints, noise abatement zones, special use areas, signage, and aerodrome boundaries.

AMDB features and attributes must be encoded according the rules of the feature catalogue.

Runways

An overview of runway data elements is shown in the following **Figure 4-11. Runway Elements:**



Aprons

The Apron as defined in Annex 14, Volume I, paragraph 1.1 is an aggregate of the features Apron Element, Parking Stand Area, and those Taxiway Elements that are located within the defined Apron Area. See Figure 4-19.

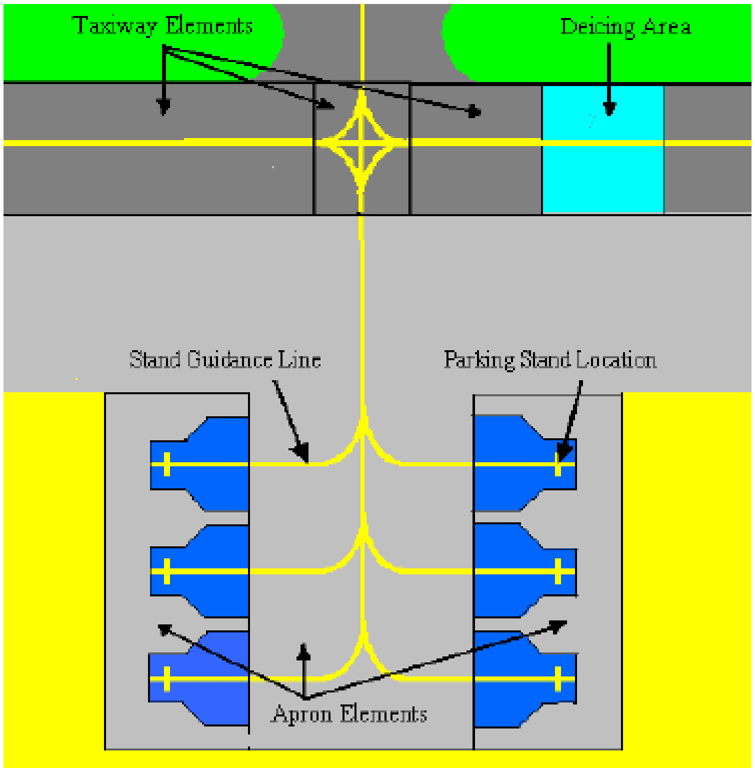


Figure 4-19. Aprons

Navigation Applications that use Aerodrome Mapping Data

Based on the availability of a standardized aerodrome mapping data set, a wide variety of applications can be envisioned. Twelve are described below and are listed and separated by user class. Note that several of the applications can be used by multiple user classes.

- *Pilots*
  - Chart information
  - Surveillance and conflict/runway incursion detection/alerting
  - Route/hold-short portrayal and deviation detection/alerting
  - Portrayal of digital ATIS information
  - Aerodrome surface guidance/navigation
  - Runway operations
  - Notices to Airmen (NOTAMs) and Aeronautical Data Overlays
  - Synthetic vision
- *Air Traffic Controllers*
- *Airline, Cargo, GA, and Business Aviation Operations*

  - o Resource management
  - o Training and High Fidelity Simulation
- *Vehicle Operators*
- *Aerodrome Operations*
  - o Aerodrome facility management
  - o Emergency and security service management
  - o Aerodrome Asset Management

Charting Information
Operational Concept

For pilots, a graphical portrayal of the aerodrome site, including aerodrome movement/non-movement areas, is essential to safe and efficient navigation. Currently, this graphical portrayal is provided to flight crews by way of paper charts. An alternate or supplemental means, of graphically depicting aerodromes is by way of a flight deck electronic display. This would provide a tool for pilots to visualize their physical environment while on the aerodrome surface, or while planning an arrival to a specific aerodrome. This tool could also provide access to aerodrome-specific data that are also included in paper charts such as frequencies, operational constraints, and local procedures. In addition, such a display system could make use of a spatial database that included themes, or layers, that would allow pilots to assimilate specific displayed information types with the out-the-window scenes. These themes can include:

Runways	Taxiways	Aprons
Shoulders	Service Roads	Stands
Hold Lines/Points	Paint Features	Jetways
Pavement Segments	Centerlines	Contour Lines
Hydrography	Building/Structures	Fences
Radar Sites	Elevation Models	Signage
Lighting	SMGCS Plans	Obstacles
Navigation Points	Survey Control Points	Concourses
Highways	Primary Roads	Secondary Roads
Land Use	De-Icing Pads	Land Fills

The above table presents a list of terrestrial physical features that can be surveyed and stored in a database. The database may also support multiple spatial models, or polygonal zones. Polygonal zones are 2-D and/or 3-D shapes used to provide spatial cueing or visualization of data by way of illustration. A list of themes that support various modeling constructs is presented in the following table:

Noise Contours	Incursion Zones	Movement Areas
Airspace Cylinders	Ground Water Models	De-Ice Solvent Plumes
Bird Strike Areas	ILS Hold Segments	Tower Field of View
Emergency Response Time/Distance Zones	Approach/Departure Corridors	Obstacle buffer zones

This application of aerodrome databases does not require any interfaces to real-time data and could operate on a "stand-alone" basis in the flight deck.

Benefits

In addition to the graphical portrayal of the aerodrome layout, spatial and tabular information included in the database could be utilized as a source of Aerodrome/Facility Directory data, NOTAM data, communications frequencies, procedures, and other textual annotation information overlaid on graphics/maps that have customarily been included in the charts/manuals. Information could be made available in electronic format eliminating the need for paper copies of maps and charts in most instances. For pilots, this would reduce cockpit clutter and workload during surface operations and ease flight planning activities. This electronic charting information may also be used by other aerodrome users to support:

- Aerodrome operations and facilities management
- Planning, e.g., environmental, noise, construction, etc.
- Leases, pavement utilization, utilities, snow removal, etc.
- Airline/Cargo/GA resource management
- ATC and apron control, routing, dispatch, and decision support tools
- Efficient routing of aircraft and vehicles; conflict detection and alerting
- Emergency response and security operations

Finally, an electronic data-driven chart, distributed to the pilot/user community on electronic media and/or via network (or the world-wide web) connectivity, can be maintained and disseminated in an efficient and cost-effective manner.

Surveillance and Conflict (Runway Incursion) Detection and Alerting Operational Concept

In today's operations, flight crews maintain traffic awareness on the surface by way of frequent visual scans and, in some cases, radio communications with ATC to obtain traffic advisories. Except for a few rare runway/taxiway geometries (obtuse-angled intersections) and high-workload situations, this method of surveillance is adequate during VMC. However, as weather conditions deteriorate (i.e., IMC), at night, or under high workload conditions, maintaining awareness of traffic on the aerodrome surfaces can become increasingly difficult. In these types of situations, uncertainties can arise that, in the best case, reduce traffic flow rates, and in the worst case, increase the likelihood of a runway incursion and/or surface accident.

Runway incursions and potential surface collisions can be detected and presented in the cockpit using a graphical portrayal of the aerodrome once surveillance data and an aerodrome mapping database are available. Once detected, alerts can be issued to either ATC (via data link) or directly to the flight crew. This detection and alerting can be functionally similar to the approach taken by AMASS and/or TCAS. This runway incursion alerting concept has undergone flight simulation testing at NASA and flight testing at the Dallas-Ft. Worth International Aerodrome

Benefits

For pilots, access to a Cockpit Display of Traffic Information (CDTI) during surface operations at controlled and uncontrolled aerodromes can increase traffic awareness while decreasing the uncertainties associated with available visual cues and radio communications14. This increased awareness can:

- Reduce the likelihood of runway incursions and surface accidents
- Reduce the likelihood of navigation errors on the surface
- Enable tighter separations on the surface and higher taxi speeds
- Enable strategic planning to avoid departure queues
- Enable strategic planning by choosing an optimum runway exit
- Reduce the amount of radio communications required

Airline, cargo, GA, and business aviation operations centers could also benefit from real-time surveillance data depicted on a graphical aerodrome mapping database. This capability would enable operations that are more efficient. For example, apron controllers can make more informed decisions about controlling the movement of aircraft and vehicles in the apron areas to avoid conflicts and to reduce delays. In addition, scheduling and managing service vehicle operations (e.g., fuel, baggage, etc.) can be improved by tracking the location of vehicle and aircraft locations.

Aerodrome Facility Management - Operational Concept

There are six primary categories of activities that come within the scope of aerodrome facility management:

- Planning
- Aerodrome design
- Facility design
- Construction
- Environmental
- Administration

Each of these activities can benefit from the availability of aerodrome mapping information. To ensure consistency across the applications, a GIS layered database structure with attribute data can be utilized. Every aerodrome implementation will be unique. It is anticipated that the primary repository for this database will be some form of an aerodrome operational control center. Secondary repositories, with full functionality, may be located at maintenance control centers, aerodrome engineering centers, and aerodrome movement area control centers.

The current problem at most aerodromes is the establishment of “data islands” within each organization established within one aerodrome. Consequently, the practice has been to develop databases for a specific need. The result has been duplicated databases with inconsistent key fields and an environment where no standards exist. Many aerodrome departments use incompatible vendor-specific formats that lead to inefficiencies and low performance, as well as high costs and low quality. Storing data in a GIS database structure can result in tremendous efficiencies being realized.

Benefits

The benefits for aerodrome facility management are categorized as:

- Reduced staff time for analysis
- Quick response to questions
- Ability to address complex issues
- Ability to provide better information to the decision makers
- Reduced cost to develop applications
- Creation of a basic framework to administer geospatial data

Another benefit of such a database is the capability of data to retain its natural spatial information. For example, data can be visualized as in the real world and thus, can create a common language for the aerodrome organization to use. In addition, spatial queries will serve to broaden the information that is available, and users will want to use the system because it is user-friendly and intuitive. Some of the benefits of standard data are:

- Ease of processing and integrating data into various applications
- Longevity given to the data
- Assistance given in maintaining links to the legacy systems
- Ensured compatibility between systems
- Cooperation facilitated between database application developers
- Opening to additional external sources of data

Runway Operations - Operational Concept

Using a robust position sensor (e.g., augmented GNSS), a display (either auditory or graphical), and an adequate aerodrome database, guidance can be provided in real-time to pilots so that they can effectively manage aircraft speed and location during take-off and during landing roll-out and turn-off from the runway.

During take-off, access to sufficient runway information can allow a guidance profile to be generated based on conditions that may be changing dynamically. This guidance can be provided on either the personal flight display, navigational display, HUD, or any other available display in the flight deck.

Further, important situational information could be provided, such as where on the runway the aircraft is projected to reach specific V speeds and where the flight crew would need to consider a take-off abort. Finally, alerts could be generated to warn the pilot if there is insufficient runway remaining to either perform a take-off abort or to lift-off.

Similarly, during the last stages of landing (e.g., the flare) and during landing roll-out and runway exit, sufficient runway information could enable guidance profiles to be generated to aid the pilot's decision making in these critical stages. This guidance could be tailored to provide several functions:

- Warning if landing fast or long
- Guidance to optimal touchdown point
- Flare guidance
- Optimal guidance to desired exit
- Runway remaining guidance
- Warning of potential overrun
- Deceleration guidance to ensure passenger comfort and reduce brake wear

Finally, in conditions of low visibility or at night, this application could help the pilot ensure that he is maintaining an appropriate track, both laterally and longitudinally, during take-off roll, landing roll-out, and normal taxi. In conditions of good visibility, this is done using visual references such as center lines/lights, runway edge lines/lights, and other relevant runway signs. An aerodrome moving map could be used to prevent runway excursions, whereby the landing gear exits the runway or taxiway, leading to aircraft shutdown, and tow.

Benefits

Potential benefits of this application for take-offs include:

- ❖ Reduced number of take-off aborts
- ❖ Reduced likelihood of take-off accidents
- ❖ Optimized aircraft performance during departure roll
- ❖ Improved fuel efficiency

Potential benefits of this application for approach and landings include:

- ❖ Reduced number of overruns
- ❖ Reduced number of go-arounds
- ❖ Reduced/predictable roll-out times in any visibility or weather condition
- ❖ Reduced brake wear
- ❖ Optimized aircraft performance
- ❖ Fewer runway excursions

— END/FIN —