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TERRAIN AND OBSTACLE DATA (TOD)



**Interregional EUR/MID Workshop on Aeronautical
Information Datasets (Cairo, Egypt, 21-22 May 2023)**



Outline

- BACKGROUND AND HISTORY
- ICAO TERRAIN AND OBSTACLES DATA REQUIREMENTS
- TOD COVERAGE AREAS
- TOD NUMERICAL REQUIREMENTS
- TOD APPLICATIONS
- DIGITAL DATA SETS CONSIDERATIONS
- TOD IMPLEMENTATION PLAN
- DEVELOPMENT OF NATIONAL TOD POLICY





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BACKGROUND AND HISTORY

2004: Amendment 33
Requirements for eTOD

2010: Amendment 36
Major revisions Area 2

2013: Amendment 37
Small updates

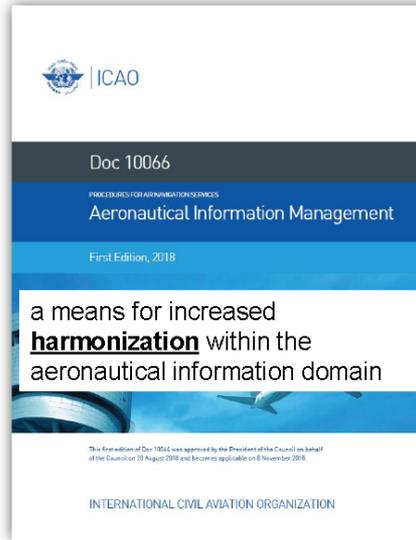
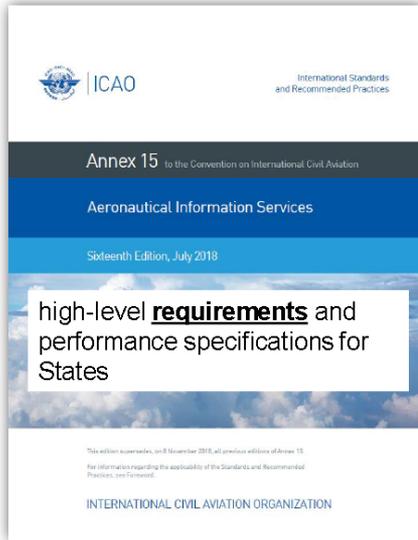
2018: Amendment 40,
PANS-AIM and Data
Catalogue



ICAO Terrain and Obstacles Data requirements



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- Annex 15 - Chapter 5. aeronautical information products and services
 - 5.3 Digital data sets
- PANS-AIM, Appendix 8 TOD requirements
- Doc 8126, AIS Manual 7th Edition
- Doc 9881 –Guidelines for Electronic Terrain, Obstacle and Aerodrome Mapping Information – **requires updates since Amdt 33**
- Annex 14 - 2.5 Aerodrome dimensions and related information - OLS
- Annex 4 - AOC



ICAO Terrain and Obstacles Data requirements



PART I - Regulatory Framework for Aeronautical Information Services

PART II - Processing Aeronautical Data

PART III - Aeronautical Information in a Standardized Presentation and Related Services

PART IV - Digital Aeronautical Information Products and Related Services



PART IV: DIGITAL AERONAUTICAL INFORMATION PRODUCTS AND RELATED SERVICES (being drafted)

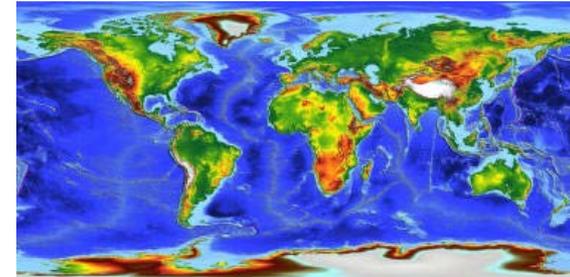
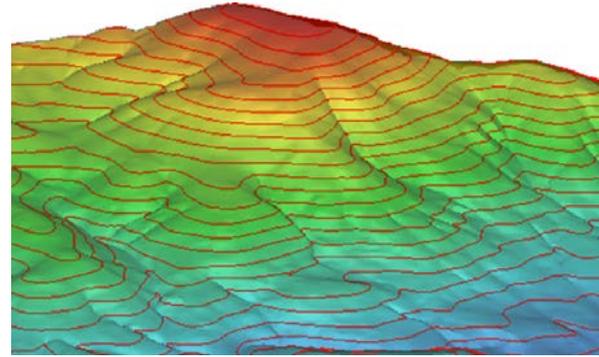
- Provides guidance specific for the provision of digital data sets that are part of the AIS Products.
- Explains the type of digital data sets that are available as part of the aeronautical information products, their purpose and benefits
- Digital aeronautical information services
- *Coding specifications for digital AIS Data Sets*
- Distribution services



TERRAIN DATASETS

ICAO PANS-AIM states that sets of electronic terrain data shall include

- Positional information
- Thematic aspects of the terrain
- Temporal aspects



Obstacles always have to be filtered out from a DTM



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OBSTACLE DATASETS

PANS-AIM states that Obstacle shall be represented in the data sets by :

- Point
- Line
- Polygon



TERRAIN AND OBSTACLE DATA: ANNEX 15 COVERAGE AREAS

With the introduction of TOD in Amendment 33 to ICAO Annex 15, ICAO has defined four coverage areas where different numerical requirements apply for terrain and obstacle Data.

- Area 1 The entire territory of a State
- Area 2 The vicinity of an aerodrome
- Area 3 An area bordering the movement area on an aerodrome
- Area 4 The radio altimeter area operating in front of a precision approach runway, Category II or III.

With Amendment 36 to ICAO Annex 15, Area 2 was broken down into four sub-areas. The areas are defined in ICAO Annex 15 and ICAO PANS-AIM.



TERRAIN AND OBSTACLE DATA: AREA 1

Area 1: The entire territory of a State (2008)

Terrain dataset for whole State

- Mostly available from civ/mil national geodetic agencies
- No format defined by ICAO
- User preferred format:
 - GeoTIFF or shape
 - + metadata





TERRAIN AND OBSTACLE DATA: AREA 1

Area 1: The entire territory of a State (2008)

- Obstacle dataset for >100m above ground
- Obstacle collection policy should exist for AIP ENR 5.4 'Air Navigation Obstacles'
- Dataset requires additional attributes (meta data) to ENR 5.4
- Dataset to be provided with caveat if some attributes are missing (annotate the limitation of use of the published information until resurveyed data is available).
- Synergies possible between CIV and MIL



Area 1 : Why coordination with MIL is beneficial

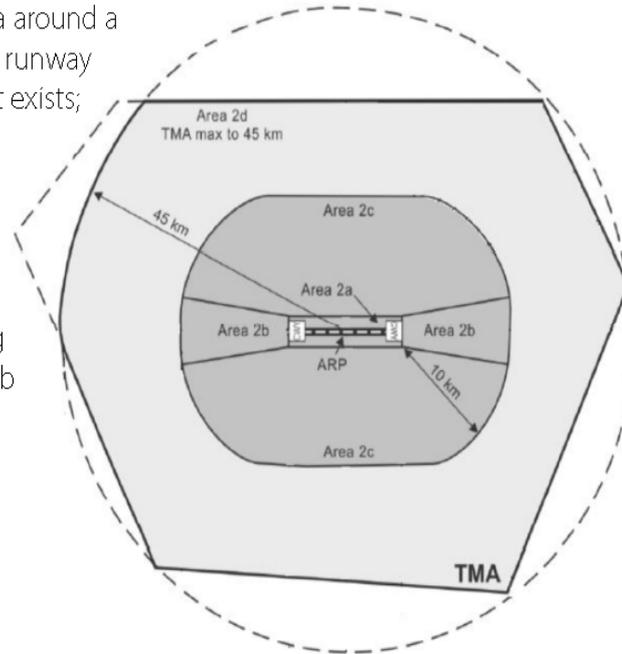
- MIL requirements: all obstacles >60m AGL for whole territory of State
- ICAO requirements: all obstacles >100m AGL for whole territory of State
- Synergies - saving costs for data collection/storage/maintenance/ verification and validation
- Advantages:
 - single entry point for obstacle owners
 - no duplication for submission of same type of information to different authorities
 - notification on any changes (e.g. light out of order) immediately available for both CIV/MIL users
 - Single repository/storage/etc
 - Similar approach adopted in other States



TERRAIN AND OBSTACLE DATA: AREA 2

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

Area 2c: An area extending outside Area 2a and Area 2b at a distance of not more than 10 km from the boundary of Area 2a



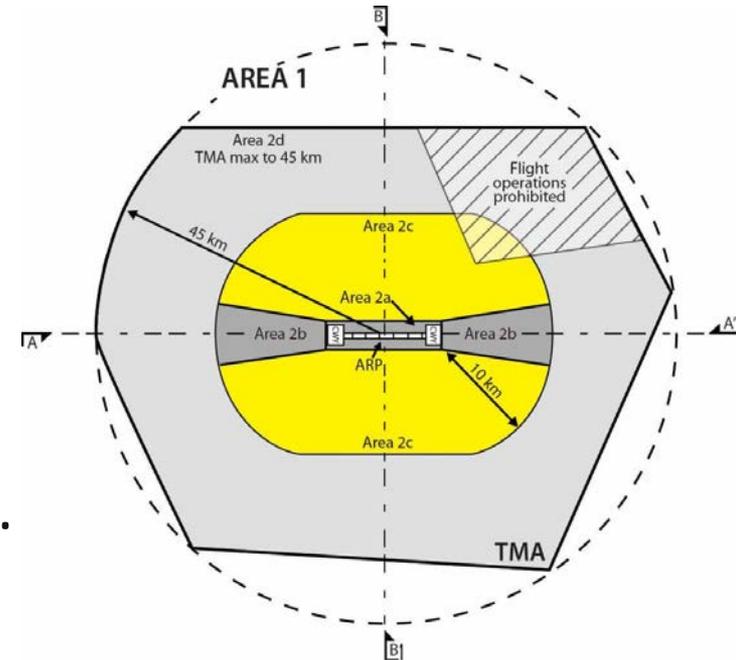
Area 2b: An area extending from the ends of Area 2a in the direction of departure, with a length of 10 km and a splay of 15% to each side

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



TERRAIN AND OBSTACLE DATA: Area 2

- Applicable from 12th November 2015
- Provision of Area 2 split into two parts:
- Standard (shall):
 - Area 2a;
 - Take-off flight path area surface; and
 - Aerodrome obstacle limitation surfaces.
- Recommended Practice (should):
 - Area 2b, 2c and 2d.





TERRAIN AND OBSTACLE DATA: ANNEX 14 OLS

The obstacle limitation surfaces comprising:

- Outer horizontal surface
- Conical surface
- Inner horizontal surface
- Approach surface
- Inner approach surface
- Transitional surface
- Inner transitional surface
- Balked landing surface
- Take-off climb surface





TERRAIN AND OBSTACLE DATA: ANNEX 4 TOFP areas

The take-off flight path area

- it commences at the end of the area declared suitable for take-off (i.e. at the end of the runway or clearway as appropriate)
- its width at the point of origin is 180 m (600 ft) and this width increases at the rate of $0.25D$ to a maximum of 1 800 m (6 000 ft), where D is the distance from the point of origin
- it extends to the point beyond which no obstacles exist or to a distance of 10.0 km (5.4 NM), whichever is the lesser.

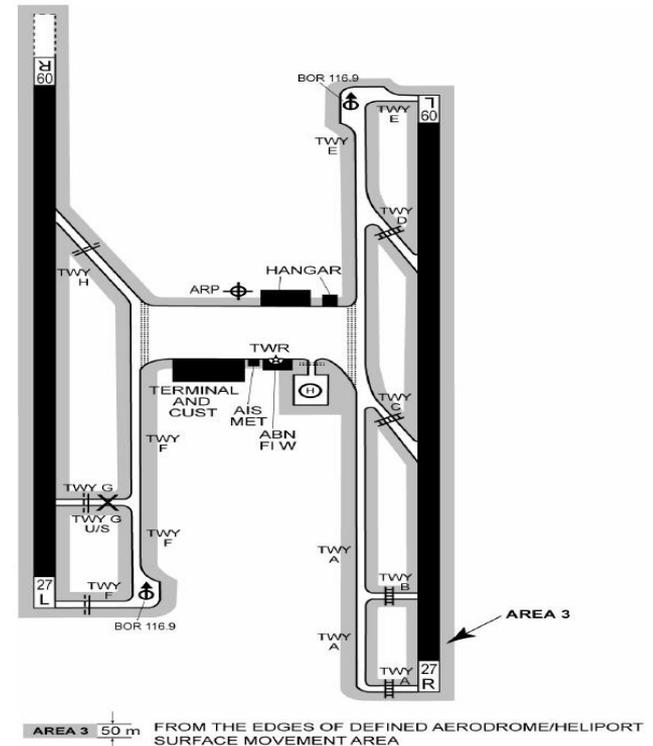




TERRAIN AND OBSTACLE DATA: AREA 3

Area 3 = Aerodrome/Heliport (Recommendation)

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

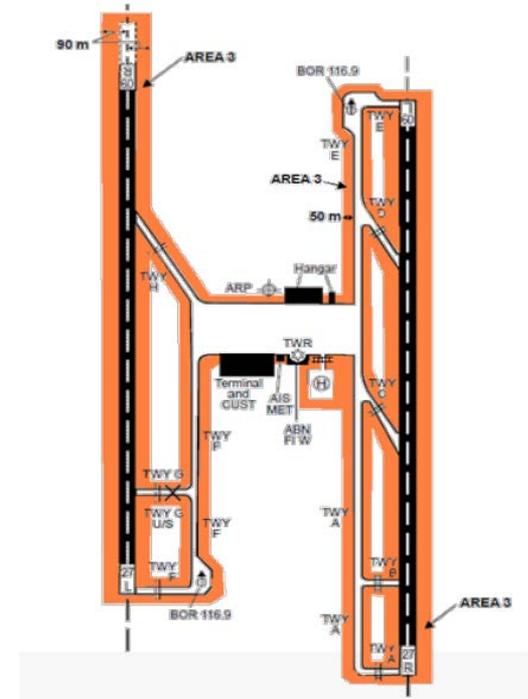




TERRAIN AND OBSTACLE DATA: AREA 3

Area 3 = Aerodrome/Heliport (Recommendation)

- Recommendation in Annex 15
- To be provided only together with the digital aerodrome mapping information (e.g. AMDB) in order to ensure the consistency and quality of all geographical data related to the aerodrome.

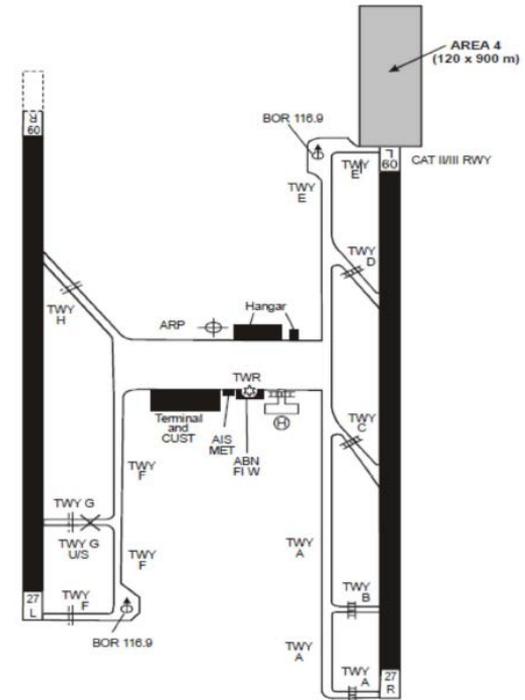




TERRAIN AND OBSTACLE DATA: AREA 4

Area 4 = CATII/III RWY

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





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TERRAIN AND OBSTACLE DATA: AREA 4

- Applicable from Nov 2008
- Digital representation of area covered today by Precision Approach Terrain Chart (PATC)
- Mostly available with AD authorities and used for PATC production
- Used to determine decision height when using Radio Altimeter





TOD NUMERICAL REQUIREMENTS

Table A1-8. Terrain data

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



TOD NUMERICAL REQUIREMENTS

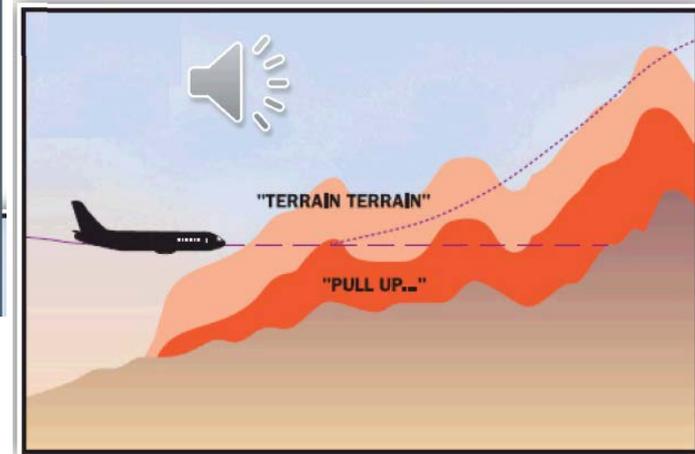
Table A1-6 Obstacle data

Obstacles in Area 1	50 m	routine	surveyed	1 sec	as plotted
Obstacles in Area 2 (including 2a, 2b, 2c, 2d, take-off flight path area and obstacle limitation surfaces)	5 m	essential	surveyed	1/10 sec	1/10 sec
Obstacles in Area 3	0.5 m	essential	surveyed	1/10 sec	1/10 sec
Obstacles in Area 4	2.5 m	essential	surveyed		
Obstacles in Area 1	30 m	routine	surveyed	1 m or 1 ft	3 m (10 ft)
Obstacles in Area 2 (including 2a, 2b, 2c, 2d, take-off flight path area and obstacle limitation surfaces)	3 m	essential	surveyed	1 m or 1 ft	1 m or 1 ft
Obstacles in Area 3	0.5 m	essential	surveyed	0.1 m or 0.1 ft 0.01 m	1m or 1 ft
Obstacles in Area 4	1 m	essential	surveyed	0.1 m	



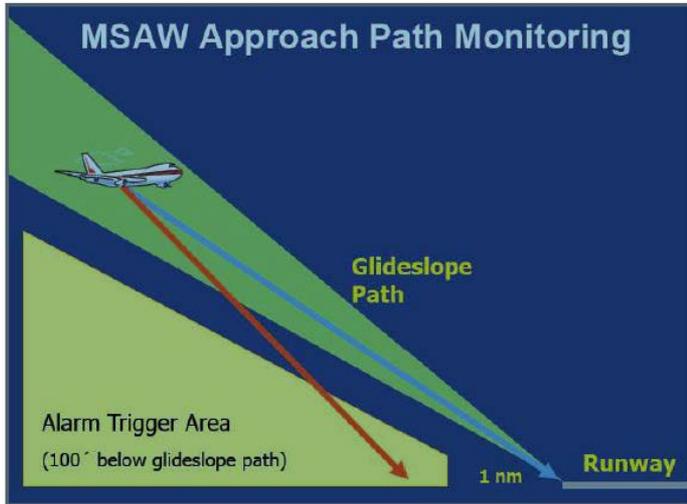
TOD APPLICATIONS: SAFETY NETS

Terrain Awareness and Warning Systems

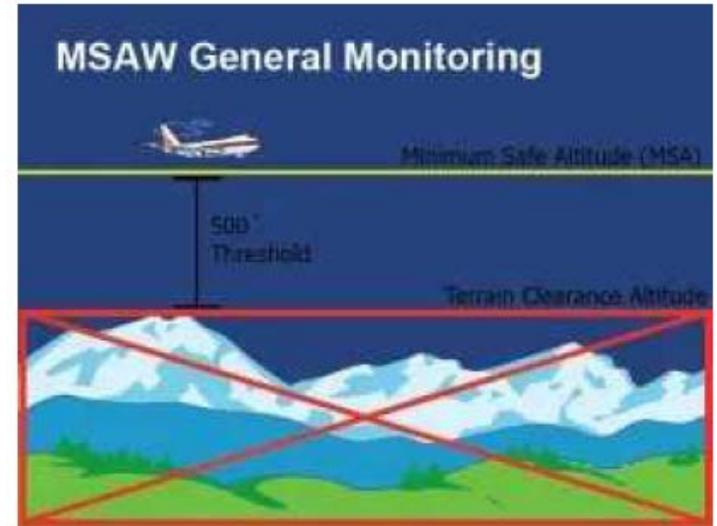




TOD APPLICATIONS: SAFETY NETS



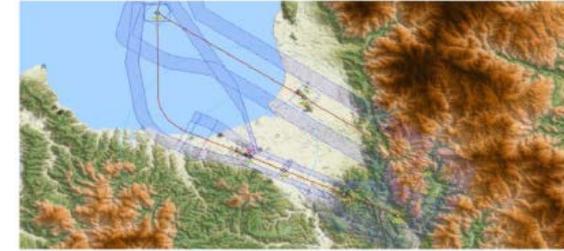
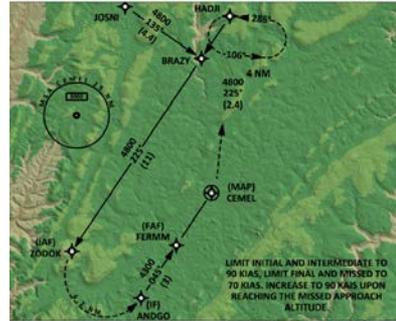
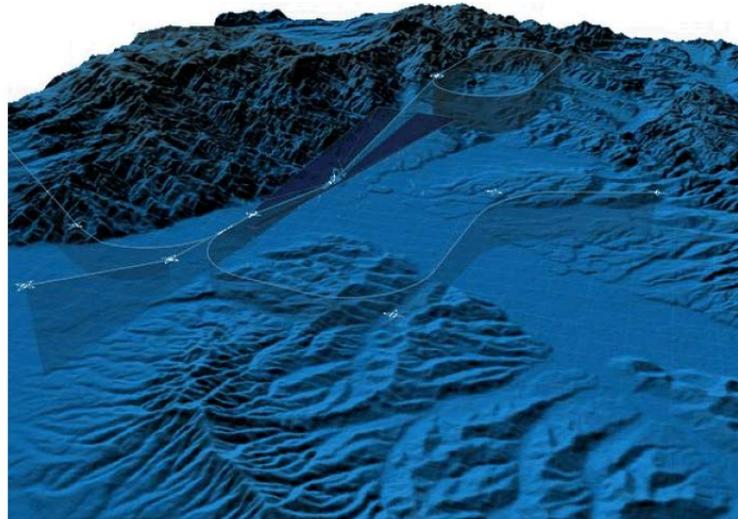
Minimum Safe Altitude
Warning
Approach Path Monitor





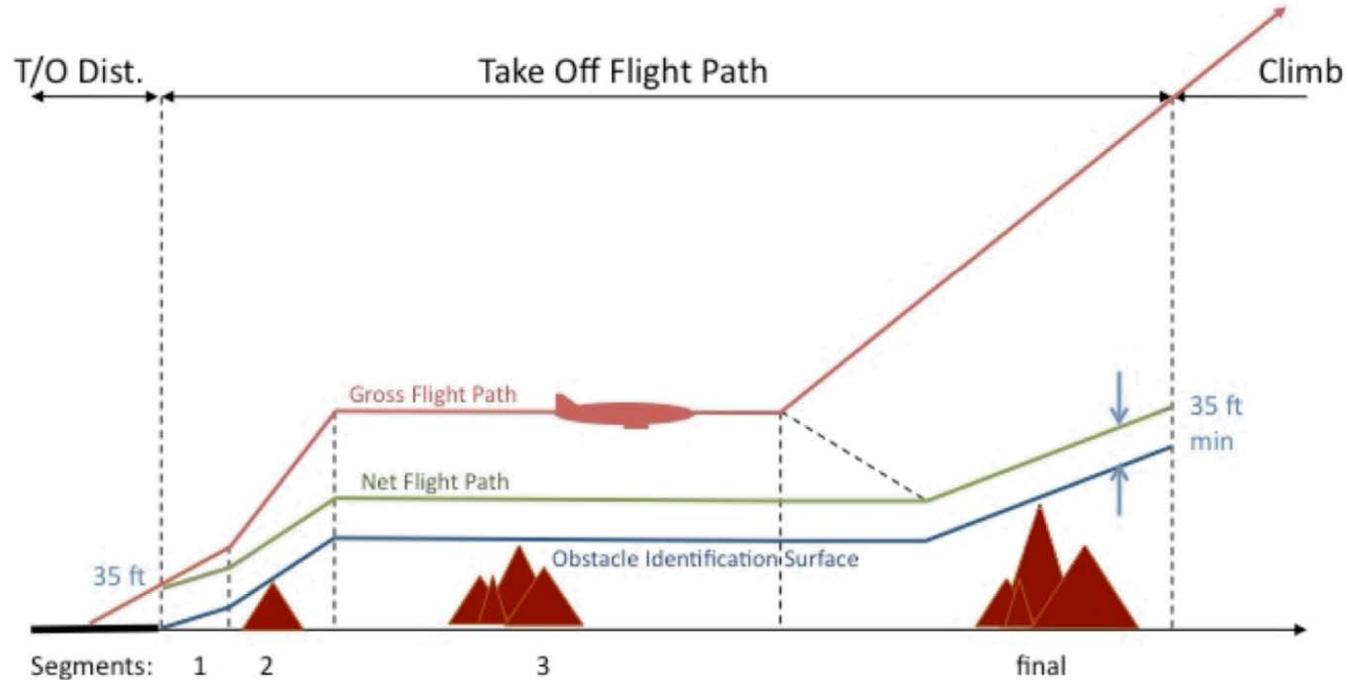
TOD APPLICATIONS: PRODECURE DESIGN

Instrument Flight including Circling Procedures



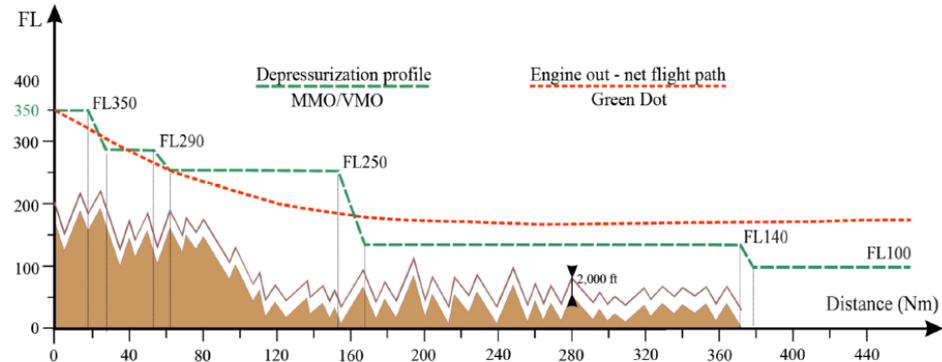
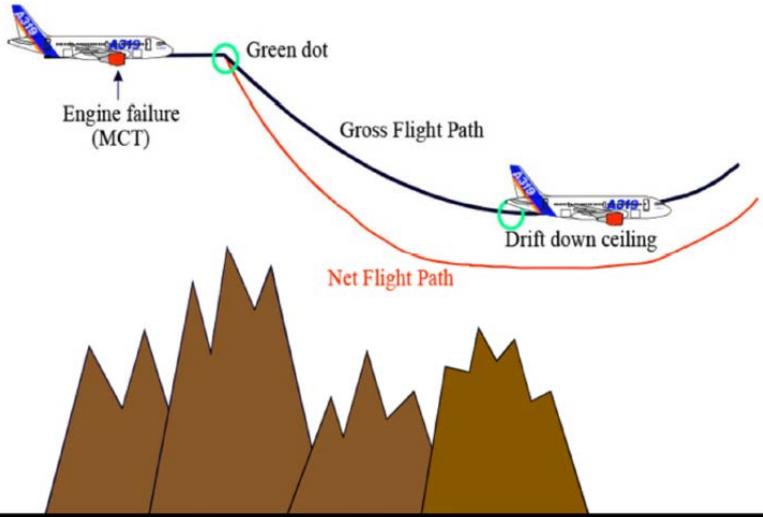


TOD APPLICATIONS: CONTINGENCY PROCEDURES



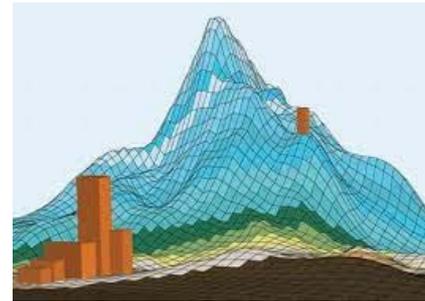
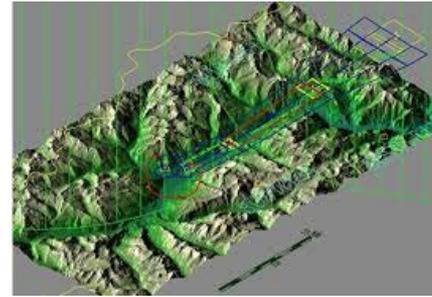
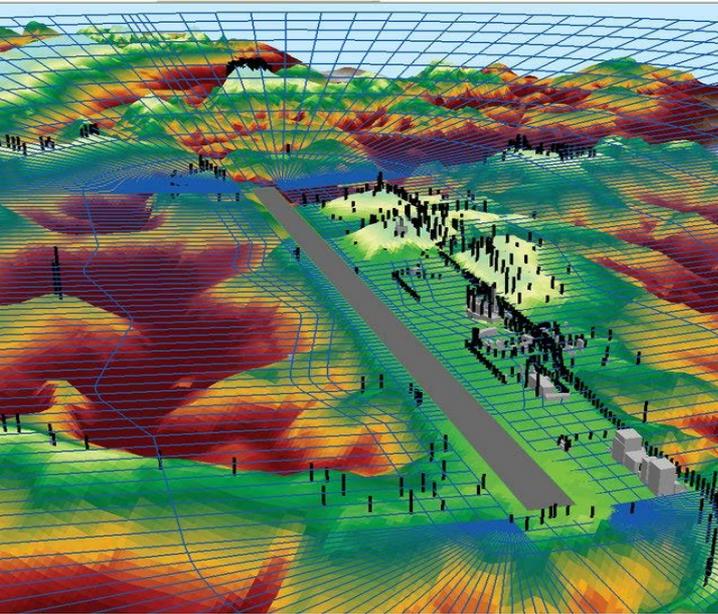


TOD APPLICATIONS: DRIFT DOWN





TOD APPLICATIONS: EMERGENCY EN-ROUTE LANDING





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TOD APPLICATIONS: A-SMGCS





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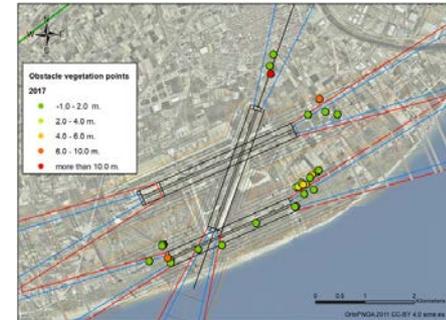
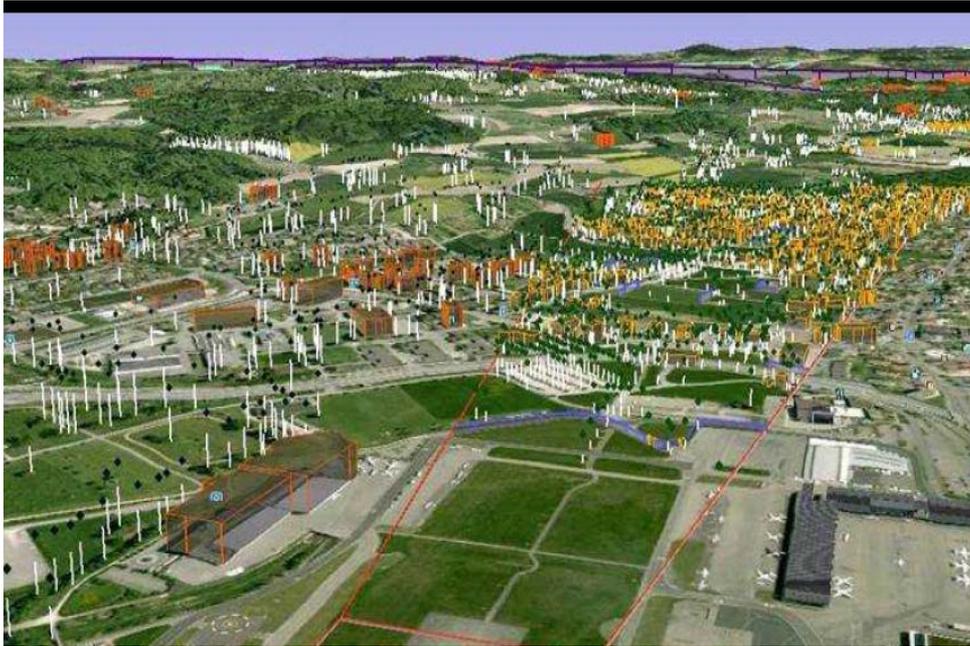


TOD APPLICATIONS: ELECTRONIC FLIGHT BAG





TOD APPLICATIONS: AERODROME/HELIPORT OBSTACLE RESTRICTION/REMOVAL





TOD APPLICATIONS: RADIO ALTIMETER HEIGHT DETERMINATION





TOD APPLICATIONS: SYNTHETIC AND ENHANCED VISION SYSTEMS





TERRAIN AND OBSTACLE DATA: DIGITAL DATA SETS CONSIDERATIONS

- Annex 15 states that “Each data set shall be provided to the next intended user together with at least the minimum set of metadata that ensures traceability.
- Annex 15 stipulates that “A checklist of valid data sets shall be regularly provided.”
- Form of such a checklist has not been provided
- DPS is mandatory
- AIXM 5.1 for obstacle data
- ICAO Annex 15 requires to amend or reissue data sets at “regular intervals as may be necessary to keep them up to date”
- Removal of tables should be evaluated by States availability of TOD sets has to be announced in the AIP GEN 3.1.6.



Metadata



Checklist



Data Product Specification



Aeronautical Information Model



Aeronautical Data Exchange Model



Data Set Updates



Removal of obstacle tables from the AIP



Announcement of the TOD availability in the AIP



TERRAIN AND OBSTACLE DATA: IMPLEMENTATION ACTIONS

Identification of Responsible Body

Identification of Stakeholders

TOD Awareness Day

State Working Group

Focal Points and Functions

State Policy with Regard to TOD

Assessment of Regulation

State Policy on Aerodrome Safeguarding

Obstacle Permission Process

Data Sources and Originators

Data Acquisition

Cross-border Provision of Data

Data Validation and Verification

Data Maintenance

Obstacle Identification

Data Provision

Monitoring/Audit of Implementation

Cost Recovery and Charging



DEVELOPMENT OF NATIONAL TOD POLICY

Why late/no TOD implementation? Main identified issues:

- The root cause of delay with TOD implementation: absence of national regulations defining the roles and responsibilities of all parties
- Other:
 - Additional complexity for TOD: non-ATM data origination
 - Aerodromes eligible for provision of Area 2
 - Cross-border Harmonisation
 - Area 2 in one State is Area 1 for another
 - Cost-allocation



SOLUTION

- Establish National TOD Policy
- Define responsibilities within the State - WHO, WHAT, HOW, by WHOM, who OWNS, who PAYS and LIABILITY
- National TOD Policy: not a regulation, but a course, plan or principle of action adopted and agreed by all affected parties (e.g. REG, ASP, APO & Geodetic agencies)
- !Important!: ASP and APO participate in the definition of the National TOD policy





National TOD Policy template

- Developed to assist the regulators with the outline structure of the National TOD policy
- Based on TOD manual - TOD Implementation Plan Template
- Additions based on implementation experience from the TOD WG formed by Eurocontrol

Appendix A National TOD Policy template

(The contents of the National TOD Policy template are not intended to be considered as an indication of ICAO's view on the matter. It is for the sole use of the member States and is not intended to be used as a basis for any other action.)

(This is a template and should be adapted to the needs of the member State. The use of green text in this document is to indicate the parts that should be adapted to the needs of the member State.)

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A.2.1 Scope definition	5
A.2.2 Definition of responsibility	5
A.2.3 Data sources and changing	10
A.3 Electronic obstacle data	11
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A.3.2 Definition of responsibility	11
A.3.3 Data sources and changing	17
A.1 INTRODUCTION	
A.1.1 Purpose and scope of this document	
<i>(This document provides the policy for (Name of State) relating to the collection, processing and provision of electronic Terrain and Obstacle Data (TOD). This document is not a regulation, but an approach, plan and set of actions adopted and agreed to by the parties participating and included in this policy.)</i>	



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National TOD Policy content

Part I: Scope



Part II:
Responsibilities



Part III: Costs





National TOD Policy - Part I: Scope definition

- Objective: to determine
 - a) required quality/numerical requirements and collection surfaces
 - b) Involved Stakeholders
 - Applicable regulations affecting T&O
 - International (determine applicability)

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User requirements

- National (exist or should be updated to reflect TOD?)
- Policy for aerodrome safeguarding
- Obstacle authorisation process
- Policy for assignment of obstacle identification

Appendix A National TOD Policy template

(This appendix of the National TOD Policy template and not intended to be modified or substituted. It shall not change to reflect public domain content or be modified or substituted in any way.)

Not to be used as a basis for the text which could be published in the public. Technical or legal requirements to be included for the development of the TOD Policy of the State. Not to print nor to be used in production of any way.

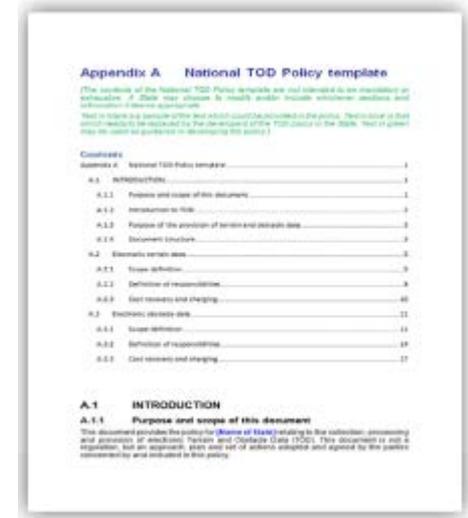
Contents:	
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A.2 Elements certain data	1
A.2.1 Scope definition	1
A.2.2 Definition of responsibility	1
A.2.3 Civil recovery and charging	11
A.3 Electronic obstacle data	11
A.3.1 Scope definition	11
A.3.2 Definition of responsibility	11
A.3.3 Civil recovery and charging	17
A.1 INTRODUCTION	
A.1.1 Purpose and scope of this document	
<small>This document provides the policy for (Name of State) relating to the collection, processing and provision of electronic Obstacle Data (EOD). This document is not a regulation, but an appendix. It is not a set of enforceable rules and is subject to the public consultation and approval of the State.</small>	



National TOD Policy - Part I: Scope definition

- Based on applicable regulations, determine:
 - Collection surfaces in State (vertical and horizontal)
 - Area 1 (100m or 60m?)
 - Area 2 (TOFP area & OLS or 2b,c,d?)
 - Area 3 (recommended practice, only when AMD?)
 - Area 4 (vertical collection surface?) ICAO does not specify!

- List aerodromes required to provide T & O
 - Area 2: as minimum all AD with AOC Type A/B
 - Area 3: AD with planned AMD
 - Area 4: ILS CAT II/III operations RWY





National TOD Policy - Part I: Scope definition

- Quality/numerical requirements
 - Same as Annex 15
 - Different National requirements
 - Based on user requirements (e.g. terrain Area 1 with Area 2 accuracy)

- Current compliance
 - Existing data (per type and Area)
 - Meets numerical/quality requirements
 - Data not available
 - Available data does not meet numerical/quality requirements

Appendix A National TOD Policy template

This appendix of the National TOD Policy template and intended to be modified or customized. A State may choose to modify, delete, include additional or remove and re-arrange the content.

Not to be used as a basis for the text which could be published in the public. Technical or legal requirements to be used for the development of the TOD Policy of the State. Not to print this document in electronic or printed form.

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A.3.1 Scope definition	11
A.3.2 Definition of responsibility	11
A.3.3 Data sources and changing	11
A.1 INTRODUCTION	
A.1.1 Purpose and scope of this document	
<i>This document provides the policy for (Name of State) relating to the collection, processing and provision of electronic Terrain and Obstacle Data (TOD). This document is not a regulation, but an agreement. It sets out a set of uniform standards and agreed by the parties concerned and included in this policy.</i>	



National TOD Policy - Part I: Scope definition

■ Involved Stakeholders:
functions required per type and Area:

■ E.g. obstacle data Area 2

Regulation

Data Source : Obstacle owner/Data originator

Obstacle assessment : CNS, AD & procedure design

Verification and validation

Data repository

Data provision

Oversight

Appendix A National TOD Policy template

(The contents of the National TOD Policy template are not intended to be mandatory or definitive. It shall not be used to modify public aviation information and to be used for the purpose of the National TOD Policy.)

(Not to be used as a basis for the National TOD Policy template. Technical and other information to be included in the National TOD Policy is the subject of the National TOD Policy.)

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A.2.3 Data sources and charging	1
A.3 Electronic obstacle data	11
A.3.1 Scope definition	11
A.3.2 Definition of responsibility	11
A.3.3 Data sources and charging	11

A.1 INTRODUCTION

A.1.1 Purpose and scope of this document

This document provides the policy for (Name of State) relating to the collection, processing and provision of electronic Terrain and Obstacle Data (TOD). This document is not a regulation, but an agreement, that all set of airborne obstacle and applied by the parties concerned and included in this policy.



National TOD Policy - Part II: Definition of responsibilities

- Regulation
 - Who will develop /update the national civil aviation regulatory framework to ensure the collection, processing and provision of electronic T & O data for each Area
 - List regulations to be updated/created
 - By when
- Data source (initial baseline)
 - Who will originate obstacles (Area 1, Area 2, Area 3, Area 4)?
 - Who will originate terrain (Area 1, Area 2, Area 3, Area 4)?
 - List existing data sources
 - Formal arrangements
 - Maintenance : Who will update T & O data for each Area

Appendix A National TOD Policy template

This template of the National TOD Policy identifies and sets out the structure and content of the policy. It is intended to be used as a guide for the development of a National TOD Policy. The text in this document is intended to be replaced by the text of the National TOD Policy. The text in this document is intended to be replaced by the text of the National TOD Policy.

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A.2.2 Definition of responsibilities	2
A.2.3 Civil resources and staffing	2
A.2.4 Evaluation, review and change	2
A.2.5 Scope definition	2
A.2.6 Definition of responsibilities	2
A.2.7 Civil resources and staffing	2
A.1 INTRODUCTION	
A.1.1 Purpose and scope of this document	

This document provides the outline for (State of Issue) relating to the collection, processing and provision of electronic Terrain and Obstacle Data (TOD). This document is not a regulation, but an agreement, plan and set of actions adopted and agreed by the parties concerned and included in the policy.



National TOD Policy - Part II: Definition of responsibilities

- Obstacles assessment
 - Who will assess the effects of objects penetrating the obstacle collection surfaces on the aviation infrastructure ?
- Based on
 - Policy for aerodrome safeguarding
 - Obstacle authorization process
- Requires expertise of various aviation domains, i.e. military, CNS infrastructure, aerodrome safeguarding authority, airspace and instrument procedure designers
- Verification and validation : Who will V & V existing and new electronic T & O data for each Area? Methods for V & V
- Repository
- Who will store electronic T & O data for each Area?

Appendix A National TOD Policy template

This template of the National TOD Policy template and not intended to be modified or abbreviated. It shall remain constant to ensure uniformity, consistency and comparability.

This is a template to provide a clear and concise overview of the policy. The content of this template is intended to be adapted to the needs of the State. The content of this template is intended to be adapted to the needs of the State.

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A.2.1 Scope definition	1
A.2.2 Definition of responsibilities	1
A.2.3 Civil resources and staffing	1
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A.2.4.1 Scope definition	1
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A.1 INTRODUCTION

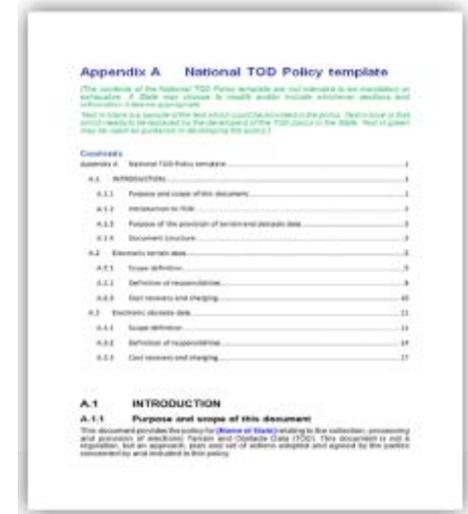
A.1.1 Purpose and scope of this document

This document provides the policy for (State of Issue) relating to the collection, processing and provision of electronic Terrain and Obstacle Data (TOD). This document is not a regulation, but an approach, plan and set of actions adopted and agreed by the parties concerned and included in the policy.



National TOD Policy - Part II: Definition of responsibilities

- Provision
 - Who will provide electronic T & O data for each Area to next-intended user?
 - Formats to be used (e.g. GeoTIFF, shape for terrain)
 - Obstacles (AIXM | xml), Media/means
- Cross-border data exchange
 - Who will negotiate / agree with adjacent State on exchange of cross-border data ?
 - Principles for exchange and harmonization of common
 - TOD with neighboring States
- Oversight
 - Who will monitor the implementation of electronic T & O data for each Area?





National TOD Policy - Part III: Cost recovery and charging

- Placeholder section should identify how the defined functions will finance their defined responsibilities and the charging mechanisms (to be put) in place
- State specific – no harmonized guidance
- ICAO Doc 9082 “ICAO’s Policies on Charges for Airports and Air Navigation Services”
- ICAO Doc 9562 “Airport Economics manual”
- ICAO Doc 9161 “Manual on Air Navigation Services Economics”
- EUROCONTROL Doc 15.60.01 “Principles for Establishing the Cost-Base for En-Route Charges and the Calculation of the Unit Rates”?

Appendix A National TOD Policy template

This is a placeholder for the National TOD Policy template and not intended to be used as a reference. It shall not contain any specific content, but only serve as a guide for the structure and content of the National TOD Policy template.

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A.1 INTRODUCTION	
A.1.1 Purpose and scope of this document	
<i>This document provides the policy for (Name of State) relating to the collection, processing and provision of electronic Terminal Area Charges (TACs). This document is not a regulation, but an approach, plan and set of administrative objectives and approved by the parties concerned and included in the policy.</i>	



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