



भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA

AERONAUTICAL SURVEY & CARTOGRAPHY MANUAL

Procedure for OLS Survey and Aeronautical Maps & Charts

ED/ATFM/2025/V1.02/MASC - SURVCART
Version 1.02
April 2025

**AIRPORTS AUTHORITY OF INDIA
RAJIV GANDHI BHAWAN NEW DELHI -110003
(INDIA)**



AERONAUTICAL SURVEY & CARTOGRAPHY MANUAL

VERSION 1.02

(ED/ATFM/2025/V1.02-MASC-SURVCART)

APRIL, 2025

Controlled Copy Number



If the Number is in **RED** Colour

--It is "Controlled Copy"

If the Number is in **BLACK** Colour

--It is "Uncontrolled Copy"

Document Approving Authority

Executive Director (ATFM)

Airports Authority of India Corporate Headquarters

Safdarjung Airport

New Delhi -110003

TABLE OF CONTENTS

| Chapter No. | Topic | Page No. |
|---|-------------------------------------|----------|
| | Preface | 10 |
| | List Of Acronyms | 11-12 |
| | Glossary Of Terms | 13-15 |
| Part I : Survey Areas and Identification of Obstacles | | |
| Chapter 1 : Introduction | | 17 |
| 1.1 | Purpose | 20 |
| 1.2 | Survey Philosophy | 21 |
| 1.3 | Publication Structure | 21 |
| 1.4 | Mandatory Requirements | 22-31 |
| 1.5 | Reserved | 32 |
| 1.6 | Survey Periodicity | 32 |
| 1.7 | Survey Procedures | 33-34 |
| 1.8 | Data Management | 35 |
| 1.9 | Survey Declaration Form | 35 |
| 1.10 | Qualifying Surveying Companies. | 35 |
| 1.11 | Accuracy | 36 |
| 1.12 | Survey Package | 36 |
| 1.13 | Conversion Factors | 37 |
| 1.14 | Standard Documents | 38 |
| 1.15 | Guidance and Policy | 38 |
| Chapter 2 : Aerodrome Master Plan Survey Area | | 39 |
| 2.1 | Purpose | 39 |
| 2.2 | Survey Specification | 39 |
| 2.3 | Aerodrome Layout / Grid map Content | 39 |
| 2.4 | Airfield features | 39 |
| 2.5 | Other aerodrome facilities | 40-41 |
| 2.6 | Digital Data | 42 |
| Chapter 3 : Obstacle Limitation Surfaces and Survey Area | | 44 |
| 3.1 | Purpose | 44 |
| 3.2 | Survey Specification | 44-45 |
| 3.3 | Digital Data | 45 |
| Attachment I to Chapter 3 : Dimensions of the airport survey area | | 46-60 |

| | | |
|---|---|-------|
| Chapter 4 : General Survey Procedure | | 61 |
| 4.1 | General | 61 |
| 4.2 | Horizontal Control | 61 |
| 4.3 | Vertical Control | 61 |
| 4.4 | Instrumentation | 62 |
| 4.5 | Methodology Of Obstacle Survey | 62 |
| 4.6 | Obstacles to be Heighted | 62-63 |
| 4.7 | Presentation Of Obstacles | 63-64 |
| 4.8 | Frangible Objects | 64-65 |
| 4.9 | Obstruction Selection | 65-66 |
| Chapter 5 : Dominant Obstacle Survey Areas | | 67 |
| 5.1 | Purpose | 67 |
| 5.2 | Survey Specification | 67-68 |
| 5.3 | Digital Data | 69 |
| Chapter 6 : Aerodrome Obstacle Chart - ICAO Type A Survey Area | | 71 |
| 6.1 | Purpose | 71 |
| 6.2 | Survey Specification | 71 |
| 6.3 | Digital Data | 72 |
| Chapter 7 : Precision Approach Procedure Survey Area | | 74 |
| 7.1 | Purpose | 74 |
| 7.2 | Survey Specification | 74 |
| 7.3 | Digital Data | 75 |
| Attachme nt I to chapter 7 | Methodology of Modelling Obstacles for ILS CRM | 76-80 |
| Chapter 8 : Precision Approach Terrain Chart Survey Area | | 81 |
| 8.1 | Purpose | 81 |
| 8.2 | Survey Specification | 81 |
| 8.3 | Survey Chart Presentation | 81 |
| 8.4 | Published Chart | 82 |
| 8.5 | Chart Maintenance | 82 |
| Chapter 9 : PAPI / APAPI Site Survey Area | | 84 |
| 9.1 | Purpose | 84 |
| Part II : Implementation of WGS- 84 coordinate System | | |
| Chapter 1 : Introduction | | 86 |

| | | |
|---|---|---------|
| 1.1 | Effects Of Using Differing Coordinate Reference Systems In Aviation | 86 |
| 1.2 | Magnitude Of The Problem | 87 |
| 1.3 | Navigational Implications | 88 |
| 1.4 | Approved Solution To The Problem | 89 |
| Chapter 2 : Accuracy , Resolution And Integrity Of Aeronautical Data | | 91 |
| 2.1 | General | 91 |
| 2.2 | Type And Classification Of Positional Data | 91 |
| 2.3 | Source Of Survey / Positional Data | 92 |
| 2.4 | Accuracy Requirements | 93 |
| 2.5 | Resolution Requirements | 94 |
| 2.6 | Integrity | 95-97 |
| Chapter 3 : The Global WGS-84 Coordinate System | | 98 |
| 3.1 | Definition Of The WGS84 Coordinate System | 98 |
| 3.2 | Realization Of The WGS84 Coordinate System | 99 |
| 3.3 | Accuracy Of WGS84 Coordinates | 101 |
| Chapter 4 : A Guide To Obtain WGS-84 Coordinates | | 102 |
| 4.1 | General | 102 |
| 4.2 | Case 1: Coordinates in a local reference frame are available | 102-105 |
| 4.3 | Case 2 : When sufficiently accurate coordinates are not available | 105-107 |
| 4.4 | Case 3 : Digitized coordinates from maps are available | 108-110 |
| Chapter 5 : Surveying Guidance | | 111 |
| 5.1 | Introduction | 111 |
| 5.2 | General Specifications | 113-116 |
| 5.3 | Survey Requirements For Aerodrome / Heliport Navigation Elements | 116-119 |
| 5.4 | Aerodrome / Heliport Survey Report Requirement | 120 |
| 5.5 | Survey Requirement For Navigational Aids | 120 |
| 5.6 | En-route Survey Report Requirement | 120 |
| 5.7 | Use Of Software | 120 |
| 5.8 | Digital Format For Delivery Of Survey Data | 120 |
| Attachments | | 121 |
| Attachment A Monumentation | | 121-123 |
| Attachment B Description of geographical positions | | 124-137 |
| Attachment C Survey reports | | 138-139 |

| | | |
|---|--|---------|
| Chapter 6 : Quality assurance and integrity | | 140 |
| 6.1 | Quality Definitions | 140 |
| 6.2 | QA Implementation | 142-147 |
| Chapter 7 : Deliverables and presentations | | 148 |
| 7.1 | Survey Reporting Requirements | 148 |
| 7.2 | Basic Reporting Structure | 148 |
| 7.3 | Formats, Standard Algorithms and Working Practices | 150-155 |
| 7.4 | Data Management | 156-157 |
| 7.5 | Presentations | 158-160 |
| Part III : | | |
| Appendix A : Survey Declaration Form | | 162 |
| Appendix B : Digital Data Specification | | 163-167 |
| Appendix C : Surveying Methods | | 168-169 |
| Appendix D : International Terrestrial Reference System (ITRS) | | 170 |
| Appendix E : Differential GPS (DGPS) | | 171-172 |
| Appendix F : Earth As Geoid Model | | 173 |
| Appendix G : OLS Surfaces | | 174 |
| Appendix H : Digital Data Error detection technique | | 175 |
| Appendix I : Mechanism of Integrity of Aeronautical Data | | 176 |
| Appendix J : Quality Management system of Aeronautical Chart development | | 177 |
| Appendix K : Procedure for Aeronautical Charts made are comprehensive and accurate. | | 178 |
| Appendix L : Procedure for Verification & Validation of Aeronautical data | | 179-182 |
| Appendix M : Organization structure, Job Description and Duty and Responsibility of Survey & Carto. Section. | | 183-188 |

Part IV: GIS CIRCULAR

| | |
|--|---------|
| GIS Circular No. 01 of 2023 for Periodicity of OLS survey | 189-191 |
| GIS Circular No. 01 of 2024 for Verification & Validation charges | 192-197 |
| GIS Circular No. 02 of 2024, Charges for Aeronautical Survey & Cartography work. | 198-199 |

Part V: CARTOGRAPHY, AERONAUTICAL CHARTS 200-295

| | |
|----------------------|---------|
| Marginal Note Layout | 284 |
| Symbols and Colour | 285-295 |
| Sample Maps (Survey) | 296-301 |

LIST OF FIGURES

| Part I | | |
|--------------------------|---|----|
| Fig. I- 2-1 | Illustration of declared distances | 42 |
| Fig. I- 2-2 | Aerodrome plan area | 43 |
| Fig. I- 3-A2-1 | RWY strip and transitional surfaces | 57 |
| Fig. I- 3-A2-2 | Obstacle limitation surfaces (plan view) | 58 |
| Fig. I- 3-A2-3 | Obstacle limitation surfaces (profile view) | 58 |
| Fig. I- 3-A3-1 | Obstacle free zone (OFZ) plan view | 59 |
| Fig. I- 3-A3-2 | Obstacle free zone (OFZ) profile view | 59 |
| Fig. I- 4-1 | Transverse and longitudinal obstacle | 66 |
| Fig. I- 5-1 | Non precision instrument approach area | 69 |
| Fig. I- 5-2 | Visual manoeuvring area | 69 |
| Fig. I- 5-3,1-5-4 | Departure area 1 and 2, Visual Manoeuvring (Circling) | 70 |
| Fig. I- 6-1 | Take- off flight path area | 73 |
| Fig. I- 7-1 | Basic ILS surfaces | 75 |
| Fig. I- 7-A1-1 | Spike and wall obstacles as required by ILS CRM | 77 |
| Fig. I- 7-A1-2 | Modelling of obstacle for ILS CRM | 78 |
| Fig. I- 7-A1-3 | Examples of irregular shaped obstacle | 78 |
| Fig. I- 7-A1-4 | Partitioning of continuous obstacle (building) | 79 |
| Fig. I- 7-A1-5 | Partitioning of continuous obstacle (hills) | 79 |
| Fig. I- 7-A1-6 | Partitioning of continuous obstacle railway) | 80 |
| Fig. I- 8-1 | Precision approach terrain chart | 83 |
| | | |

| PART II | | |
|-----------------------|---|-----|
| Fig II- 1-1 | Datum problem in air navigation | 86 |
| Fig II- 3-1 | The WGS 84 coordinate system definition | 100 |
| Fig II- 3-2 | Realization of origin and orientation of WGS 84 | 100 |
| Fig II- 4-1 | Error propagation in datum transformation | 105 |
| Fig II- 4-2 | From terrestrial surveying data to WGS 84 coordinates | 106 |
| Fig II- 4-3 | From photogrammetric flights to WGS 84 coordinates | 108 |
| Fig II- 5-A-1 | Survey marker | 122 |
| Fig II- 5-A-2 | Survey marker | 123 |
| Fig II- 5-B-1 | Threshold planimetric position to be surveyed | 124 |
| Fig II- 5-B-2 | Threshold planimetric position to be surveyed | 125 |
| Fig II- 5-B-3 | Threshold planimetric position to be surveyed | 126 |
| Fig II- 5-B-4 | TLOF and FATO planimetric position to be surveyed | 127 |
| Fig II- 5-B-5 | FATO planimetric Threshold position to be surveyed | 128 |
| Fig II- 5-B-6 | ILS localizer | 129 |
| Fig II- 5-B-7 | DVOR/DME | 129 |
| Fig II- 5-B-8 | NDB | 130 |
| Fig II- 5-B-9 | RWY and taxiway intersection to be surveyed | 130 |
| Fig II- 5-B-10 | RWY and taxiway intersection to be surveyed | 131 |
| Fig II- 5-B-11 | RWY holding position to be surveyed | 132 |
| Fig II- 5-B-12 | Taxiway intersection to be surveyed | 133 |
| Fig II- 5-B-13 | Simple nose wheel lead-in line | 134 |
| Fig II- 5-B-14 | Offset nose wheel lead-in line | 134 |

| | | |
|-----------------------------|---|-----|
| Fig II- 5-B-15 | Simple nose wheel lead-out line | 135 |
| Fig II- 5-B-16 | Simple nose wheel lead-out line | 135 |
| Fig II- 5-B-17 | Simple nose wheel lead-out line | 135 |
| Fig II- 5-B-18 | Turning lines | 136 |
| Fig II- 5-B-19/20/21 | Offset nose wheel lead-out line | 137 |
| Fig II- 6-1 | QA loop (basic structure of a Quality system) | 143 |
| Fig II- 6-2 | Model of a State Quality Plan | 144 |
| Fig II- 7-1 | UDDF format for navigational aid data | 154 |
| PART III | | |
| Fig. III- C-1 | Spirit Levelling | 169 |
| Fig. III- E-1 | Differential GPS real time positioning | 172 |
| Fig. III- F-1 | Earth as a Geoid model | 173 |




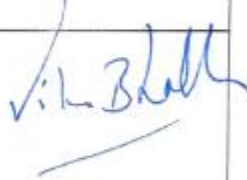
| AERONAUTICAL SURVEY MAPS (SAMPLE CHART) | | |
|--|-----------------------------|-----|
| Fig. REF-1 | Airport Map | 296 |
| Fig. REF-2 | Approach Charts Runway 05 | 297 |
| Fig. REF-3 | Approach Charts Runway 23 | 298 |
| Fig. REF-4 | Vertical Significance Chart | 299 |
| Fig. REF-5 | Obstacle free zone (OFZ) | 300 |
| Fig. REF-6 | Contour Map | 301 |

LIST OF TABLES

| PART I | | |
|-----------------------|--|----|
| Tab. I- 1-1 | Type of Surveying flow chart | 23 |
| Tab. I- 1-3 | Minimum survey accuracy and integrity requirement | 37 |
| Tab. I- 1-4 | Conversion factors | 37 |
| Tab. I- 3-A1-1 | Take-off surface | 51 |
| Tab. I- 3-A1-2 | Approach surface | 52 |
| Tab. I- 3-A1-3 | Approach surface non instrument runway | 53 |
| Tab. I- 3-A1-4 | Inner horizontal surface | 54 |
| Tab. I- 3-A1-5 | Dimensions and slopes of obstacle limitation surfaces (OLS) for Runway | 60 |

| PART II | | |
|---------------------|--|---------|
| Tab. II- 1-1 | Air navigation coordinates of interest | 90 |
| Tab. II- 2-1 | Type and classification of positional data | 92 |
| Tab. II- 2-2 | Accuracy and probability | 94 |
| Tab. II- 2-3 | RNP types | 94 |
| Tab. II- 2-4 | Aeronautical data quality requirement | 96 - 97 |
| Tab. II- 3-1 | Primary parameters of WGS 84 | 99 |
| Tab. II-5-1 | Accuracy and Integrity requirement of navigational element | 112 |
| Tab. II- 7-1 | Integrity and CRC length | 154 |

Document Approval

| Sr. No. | Role | Name & Designation | Signature |
|---------|----------------|---|---|
| 1. | Prepared by | Lajpat Rai Consultant (Survey & Carto.) |  |
| 2. | Checked by | Manish Kumar Sr. Manager (ATM – Survey & Carto.) |  |
| 3. | Recommended by | Sandip Mukhopadhyay GM (ATM – Survey & Carto.) |  |
| 4. | Approved by | Vikas Bhalia ED (ATM - ATFM) |  |

PREFACE

Aeronautical surveying and Aeronautical Mapping/Charting work is a highly specialized type of Surveying & Mapping. Aeronautical Survey/Mapping programme provides critical information about airport features, obstructions & navigational aids. This data is needed for safe aircraft operation and therefore is safety critical. Airport surveying/mapping needs extensive knowledge of ICAO documents related to aerodromes and its environs in respect of the operational areas, obstacle limitation surfaces, navigational facilities, PANS-OPS surfaces etc. Surveyors & Cartographer must also have the knowledge of ICAO requirement of accuracies and integrity of the data collected and the adoption of the World Geodetic System--1984 as standard geodetic reference system for international civil aviation.

Manual of Aerodrome Survey & Carto. Maps & Charts has been prepared by Airports Authority of India and includes the details of survey requirements and presentation required by the Director General of Civil Aviation (DGCA) to ensure Aerodrome Operators comply with their legal responsibilities under Civil Aviation Requirement. The information in this specification document is intended as guidance for the surveying and collection of airfield information and data. This document addresses requirements for Global Navigation and Satellite System (GNSS)/DGPS navigation specifications and accuracies and would assist the qualified surveyors to conduct the aeronautical survey of the aerodromes and the specified areas outside the aerodrome boundaries for identification of obstacles and preparation of the all the charts as required by ICAO Annex 15. It also furnishes guidance on the provision of geographic coordinates and vertical component values referenced to the WGS- 84 datum in order to implement the ICAO SARPs as contained in: Annex 4, Annex 11, Annex 14, Doc WGS-84 and Annex 15.

This manual is updated version (V 1.02) of original survey manual (V 1.01 of 2012). The various modification and changes are incorporated as per latest documents of CAR and DGCA recommendations. Since the Survey & Carto. section is under single administrative head, both the Survey and Aeronautical Chart Manual is combined in single document.

List of ACRONYMS

| | |
|----------|--|
| AIP | Aeronautical Information Publications |
| AIS | Aeronautical Information Service |
| AOC | Airport Obstruction Chart |
| ARINC | Aeronautical Radio INC, provides secretariat and technical staff for Various airline committees. The ARINC 424 is a format for transfer of data from one data base to another. |
| ARP | Aerodrome Reference Point |
| ATC | Air Traffic Control |
| ATS | Air Traffic Services |
| BIH | Bureau International de l'Heure |
| C/A Code | Coarse/Acquisition-Code |
| CAD | Computer Aided Design |
| CTA | Control Area |
| CTP | Conventional Terrestrial Pole |
| CTZ | Control Zone |
| CTS | Conventional Terrestrial System |
| DGPS | Differential GPS |
| DME | Distance Measuring Equipment |
| E-AIP | Electronic AIP |
| ECEF | Earth Centred, Earth Fixed |
| EDM | Electronic Distance Measurement |
| EGM | Earth Gravity Field Model |
| ETRF | European Terrestrial Reference Frame |
| EUREF | European Geodetic Reference System |
| FAA | Federal Aviation Administration (USA) |
| FACF | Final Approach Course Fix |
| FAF | Final Approach Fix |
| FIR | Flight Information Region |
| FMS | Flight Management System |
| GIS | Geographical Information Systems |
| *GLONASS | Global Navigation Satellite System |
| *GNSS | Global Navigation Satellite System |
| GP | Generating Polynomial |
| *GPS | Global Positioning System |
| GRS 80 | Geodetic Reference System 1980 |
| IAG | International Association of Geodesy |
| ICAO | International Civil Aviation Organization |

| | |
|---------|--|
| IERS | International Earth Rotation Service |
| IFP | Instrument Flight Procedure |
| INS | Inertial Navigation System |
| IRM | IERS Reference Meridian |
| IRP | IERS Reference Pole |
| ISO | International Organization for Standardization |
| ITRF | International Terrestrial Reference Frame |
| ITRS | International Terrestrial Reference System |
| LAN | Local Area Network |
| MAPt | Missed Approach Point |
| MCS | Master Control Station |
| MSL | Mean Sea Level |
| NAVSTAR | Navigation System with Time And Ranging |
| NDB | Non-directional Beacon |
| NNSS | Navy Navigation Satellite System |
| OCS | Operational Control System |
| P-Code | Precision-Code |
| PPS | Precise Positioning Service |
| PRN | Pseudo-Random Noise |
| RNAV | Area Navigation |
| RNP | Required Navigation Performance |
| RTCA | Radio Technical Commission for Aeronautics |
| S/A | Selective Availability |
| SARPS | Standards and Recommended Practices |
| SAVVAN | Système Automatique de Vérification en Vol des Aides a la Navigation, i.e. Automatic In-flight Navigation Aids Checking System |
| SID | Standard Instrument Departure |
| SLR | Satellite Laser Ranging |
| SPS | Standard Positioning Service |
| STAR | Standard Instrument Arrival |
| UDDF | Universal Data Delivery Format |
| UTM | Universal Transverse Mercator |
| VLBI | Very Long Base-Line Interferometry |
| VOR | Very High Frequency Omni-directional Range |
| WGS 84 | World Geodetic System 1984 |

*Refer Glossary of terms for explanation

GLOSSARY OF TERMS

Aerodrome Elevation: The elevation of the highest point of the landing area (ICAO Annex 4)

Aerodrome Reference Point (ARP): The designated geographical location of an aerodrome (ICAO Annex 4)

AGA: Aerodromes, Air Routes and Ground Aids (ICAO Definition)

Aircraft stand. A designated area on an apron intended to be used for parking an aircraft.

Apron. A defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fueling, parking or maintenance.

Cyclic Redundancy: A mathematical algorithm applied to the digital **Check** expression of data that provides a level of assurance loss or alteration of data. (ICAO Annex 4)

Contour line. A line on a map or chart connecting points of equal elevation.

Culture. All man-made features constructed on the surface of the Earth, such as cities, railways and canals.

Catenary: The curve theoretically formed by a perfectly flexible, uniformly dense and thick inextensible cable suspended from two points. Also a cable suspended between two points and having the approximate shape of a catenary

Control Station: A point on the ground whose position and/or elevation is used as a basis for obtaining positions and/or elevations of other points

Certified aerodrome: An aerodrome whose operator has been granted an aerodrome certificate.

Displaced threshold: A threshold not located at the extremity of a runway.

Data quality: A degree or level of confidence that the data provided meet the requirements of the data user in terms of accuracy, resolution and integrity

Datum. Any quantity or set of quantities that may serve as a reference or basis for the calculation of other quantities (ISO 19104).

Digital Elevation Model (DEM). The representation of terrain surface by continuous elevation values at all intersections of a defined grid, referenced to common datum.

Note: Digital Terrain Model (DTM) is sometimes referred to as DEM.

Declared distances:

- a) Take-off run available (TORA):** The length of runway declared available and suitable for the ground run of an aeroplane taking off.
- b) Take-off distance available (TODA):** The length of the take-off run available plus the length of the clearway, if provided.
- c) Accelerate-stop distance available (ASDA):** The length of the take-off run available plus the length of the stopway, if provided.
- d) Landing distance (LDA) :** The length of runway which is declared available and suitable for the ground run of an aeroplane landing

Ellipsoid Height: The height related to the reference ellipsoid, measured along the ellipsoidal outer normal through the point in question (ICAO Annex 14)

Frangible object: An object of low mass designed to break, distort or yield on impact so as to present the minimum hazard to aircraft.

Geoid: The equipotential surface in the gravity field of the Earth which coincides with the undisturbed mean sea level (MSL) extended continuously through the continents. (ICAO Annex 14)

Geoid undulation: The distance of the geoid above (positive) or below (negative) the mathematical reference ellipsoid.

Global navigation satellite system (GNSS): A worldwide position and time determination system that includes one or more satellite constellations, aircraft receivers and system integrity monitoring, augmented as necessary to support the required. The satellite navigation system operated by the Russian Federation navigation performance for the intended operation

Global positioning system (GPS): The satellite navigation system operated by the United States.

Glide path: A descent profile determined for vertical guidance during a final approach.

Global navigation satellite system (GLONASS): The satellite navigation system operated by the Russian Federation.

Integrity (aeronautical data): A degree of assurance that an aeronautical data and its value has not been lost nor altered since the data origination or authorized amendment.

Landing Area: That part of a movement area intended for the landing or take-off of aircraft. (ICAO Annex 14)

Obstacle : All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above defined surface intended to protect aircraft in flight (ICAO Annex 14)

Obstacle free zone (OFZ) : The airspace above the inner approach surface, inner transitional surfaces, and balked landing surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacle other than a low-mass and frangibly mounted one required for air navigation purposes.

Orthometric Height: Height of a point related to the geoid, Generally presented as MSL elevation. (ICAO Annex 14)

Reference Ellipsoid: A geometric figure, usually determined by rotating an ellipse about its shorter (polar) axis, used as a surface reference for geodetic surveys. The reference ellipsoid closely approximates to the dimensions of the geoid, with certain ellipsoids fitting geoid more closely for various area of the earth.

Runway: A defined rectangular area on a land airport prepared for the landing and take off run of aircraft along its length. Runways are normally numbered in magnetic direction rounded off to the nearest 10 degree, e.g. Runway 10, Runway 25.

Runway Length: The straight line distance between runway end points This line does not account for surface undulations between points. Official lengths are normally computed from runway end coordinates and elevations.

Runway strip: A defined area including the runway and stopway, if provided, intended to:

- a) reduce the risk of damage to aircraft running off runway; and
- b) Protect aircraft flying over it during take-off or landing operations.

Stopway: An area beyond the takeoff runway, no less wide than the runway and centered upon to extended centerline of the runway able to support the airplane during an aborted takeoff, without causing structural damage to the airplane, designated by the airport authorities for use in decelerating the airplane during an aborted takeoff

Survey Date: The date that fieldwork was carried out to obtain data for the survey. Where fieldwork was completed over more than one day the end date of fieldwork shall be used

Threshold : The beginning of that portion of the runway usable for landing. (ICAO Annex 14)

Displaced threshold (THR): A threshold not located at the extremity of a runway.

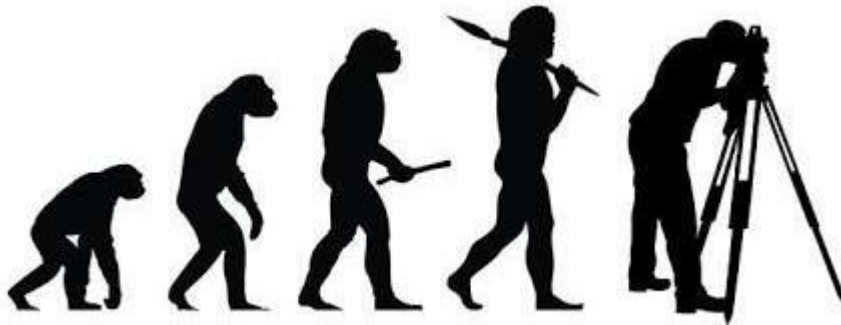
Touchdown zone : The portion of a runway, beyond the threshold, where it is intended landing aeroplanes first contact the runway, normally first 3000ft of runway beginning from threshold.

PART I : Survey Areas and Identification of Obstacles

Chapter 1: INTRODUCTION

History

It is quite probable that surveying had its origin in ancient Egypt. The Great Pyramid of Khufu at Giza was built about 2700 BCE, 755 feet (230) long and 481 feet (147) high. Its nearly perfect squareness and north–south orientation affirms the ancient Egyptians' command of surveying.



Evidence of some form of boundary surveying as early as 1400 BCE has been found in the fertile valleys and plains of the Tigris, Euphrates, and Nile rivers. Clay tablets of the Sumerians show records of land measurement and plans of cities and nearby agricultural areas. Boundary stones marking land plots have been preserved. There is a representation of land measurement on the wall of a tomb at Thebes (1400 BCE) showing head and rear chainmen measuring a grainfield with what appears to be a rope with knots or marks at uniform intervals. Other persons are shown. Two are of high estate, according to their clothing, probably a land overseer and an inspector of boundary stones.

There is some evidence that, in addition to a marked cord, wooden rods were used by the Egyptians for distance measurement. There is no record of any angle-measuring instruments of that time, but there was a level consisting of a vertical wooden A-frame with a plumb bob supported at the peak of the A so that its cord hung past an indicator, or index, on the horizontal bar. The index could be properly placed by standing the device on two supports at approximately the same elevation, marking the position of the cord, reversing the A, and making a similar mark. Halfway between the two marks would be the correct place for the index. Thus, with their simple devices, the ancient Egyptians were able to measure land areas, replace property corners lost when the Nile covered the markers with silt during floods, and build the huge pyramids to exact dimensions.



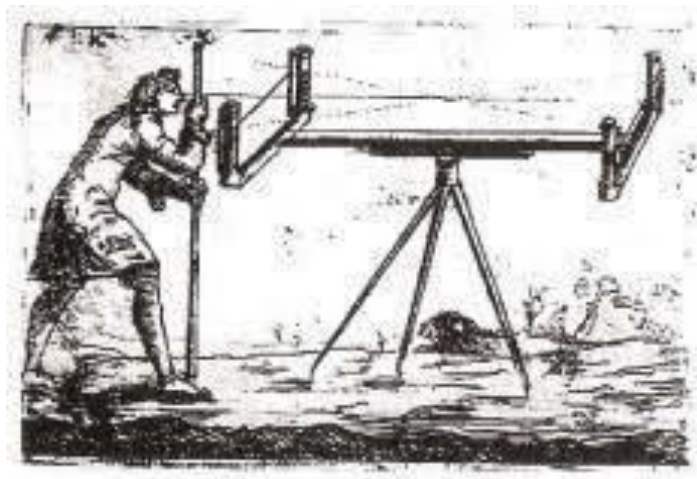
The Greeks used a form of log line for recording the distances run from point to point along the coast while making their slow voyages from the Indus to the Persian Gulf about 325 BCE. The magnetic compass was brought to the West by Arab traders in the 12th century CE. The astrolabe was introduced by the Greeks in the 2nd century BCE. An instrument for measuring the altitudes of

stars, or their angle of elevation above the horizon, took the form of a graduated arc suspended from a hand-held cord. A pivoted pointer that moved over the graduations was pointed at the star. The instrument was not used for nautical surveying for several centuries, remaining a scientific aid only.

The Greeks also possibly originated the use of the groma, a device used to establish right angles, but Roman surveyors made it a standard tool. It was made of a horizontal wooden cross pivoted at the middle and supported from above. From the end of each of the four arms hung a plumb bob. By sighting along each pair of plumb bob cords in turn, the right angle could be established. The device could be adjusted to a precise right angle by observing the same angle after turning the device approximately 90° . By shifting one of the cords to take up half the error, a perfect right angle would result.

About 15 BCE the Roman architect and engineer Vitruvius mounted a large wheel of known circumference in a small frame, in much the same fashion as the wheel is mounted on a wheelbarrow; when it was pushed along the ground by hand it automatically dropped a pebble into a container at each revolution, giving a measure of the distance travelled. It was, in effect, the first odometer.

The water level consisted of either a trough or a tube turned upward at the ends and filled with water. At each end there was a sight made of crossed horizontal and vertical slits. When these were lined up just above the water level, the sights determined a level line accurate enough to establish the grades of the Roman aqueducts. In laying out their great road system, the Romans are said to have used the plane table. It consists of a drawing board mounted on a tripod or other stable support and of a straightedge—usually with sights for accurate aim (the alidade) to the objects to be mapped—along which lines are drawn. It was the first device capable of recording or establishing angles. Later adaptations of the plane table had magnetic compasses attached.



Plane tables were in use in Europe in the 16th century, and the principle of graphic triangulation and intersection was practiced by surveyors. In 1615 Willebrord Snell, a Dutch mathematician, measured an arc of meridian by instrumental triangulation. In 1620 the English mathematician Edmund Gunter developed a surveying chain, which was superseded only by the steel tape beginning in the late 19th century.

The study of astronomy resulted in the development of angle-reading devices that were based on arcs of large radii, making such instruments too large for field use. With the publication of logarithmic tables in 1620, portable angle-measuring instruments came into use. They were called topographic instruments, or theodolites. They included pivoted arms for sighting and could be used for measuring both horizontal and vertical angles. Magnetic compasses may have been included on some.

The Vernier, an auxiliary scale permitting more accurate readings (1631), the micrometre microscope (1638), telescopic sights (1669), and spirit levels (about 1700) were all incorporated in theodolites by about 1720. Stadia hairs were first applied by James Watt in 1771. The development of the circle-dividing engine about 1775, a device for dividing a circle into degrees with great accuracy, brought one of the greatest advances in surveying methods, as it enabled angle measurements to be made with portable instruments far more accurately than had previously been possible.



Modern surveying can be said to have begun by the late 18th century. One of the most notable early feats of surveyors was the measurement in the 1790s of the meridian from Barcelona, Spain, to Dunkirk, France, by two French engineers, Jean Declarer and Pierre Méchain, to establish the basic unit for the metric system of measurement.

Many improvements and refinements have been incorporated in all the basic surveying instruments. These have resulted in increased accuracy and speed of operations and opened up possibilities for improved methods in the field. In addition to modification of existing instruments, two revolutionary mapping and surveying changes were introduced: photogrammetry, or mapping from aerial photographs (about 1920), and electronic distance measurement, including the adoption of the laser for this purpose as well as for alignment (in the 1960s). Important technological developments starting in the late 20th century include the use of satellites as reference points for geodetic surveys and electronic computers to speed the processing and recording of survey data.

1.1 PURPOSE

1.1.1 The aeronautical surveys covered in this document provide information critical to the operation within the Indian airspace of civil airports. Most of this information source data being acquired by field survey.

Information furnished under these standard includes:

- a) Geodetic control data for permanent survey monuments.
- b) Runway and Stopway data including runway end, stopway end, displaced threshold position and elevation. Runway geodetic azimuth, touchdown elevation and runway / stopway profile.
- c) Navigation aid data, including navaid position and elevation, type, distance from runway end and runway centerline.
- d) Obstruction data, including obstruction description, position and elevation, extent of penetration of the obstacle limitation surfaces.

1.1.2 The purpose of aerodrome survey information is to enable Aerodrome Operators to meet their safety responsibilities and provide the data required by the AAI to enable:

- a) consider aerodrome licensing issues;
- b) develop instrument approaches including the RNAV(GNSS) procedures and departure procedure;
- c) certify airport for certain types of operations –determine maximum take-off weight for civil aircraft;
- d) provide geodetic control for engineering projects related to runways / taxiways construction, Nav-aids siting, road building, obstruction clearing and other airport improvement and constructions;
- e) assist in airport planning and land use studies in the airport vicinity including the future expansion of the aerodrome/ runway;

- f) support the miscellaneous activities such as aircraft accident investigation and special purpose one-time projects:
- i) Prepare charts; and
- ii) Conduct safety evaluations.

1.1.3 Following these processes, selected information shall be published in the Aeronautical Information Publication (AIP) and other associated documents.

1.2 SURVEY PHILOSOPHY

1.2.1 The basic survey philosophy applied in this publication is to provide master lists of all aerodrome facilities (i.e. runways, taxiways, parking stands, navigation aids, etc.) and features identified as obstacles for each aerodrome constrained obstacle filtering (using obstacle identification surfaces) and analysis for Instrument Flight Procedures (IFP) design.

1.2.2 The challenge placed upon surveying teams/companies is to identify appropriate features to survey in creating these “Master lists”. It will be totally impracticable and costly to survey all features. Therefore, it is important for surveying teams/companies to understand the tasks and requirements of the end users for development of Aeronautical Charts and Data base, designing of instrument approach procedures, Aerodrome Inspections (by auditing and regulatory authorities) and Aerodrome License (with regard to Safeguarding), in achieving their individual objectives. From an IFP design perspective the appropriate surveyed area and “real world” obstacle representation (“Master Obstacle list”) forms the critical baseline for successful IFP design.

1.3 PUBLICATION STRUCTURE

This document is structured to assist the following logical steps:

PART I

- a) Choosing the relevant aerodrome survey classification.
- b) Determining the areas and facilities within the aerodrome boundaries to be surveyed.
- c) Surveying the areas required as per Annex 14 for safeguarding the aerodromes, surveying areas required for designing the instrument approach procedures, preparation of Type A chart, pre-threshold terrain chart.
- d) Populating Aerodrome Facilities and Master Obstacle data lists.
- e) Producing plans and filtering obstacle data as required.

PART II

Information regarding implementation of WGS-84 coordinate system and various methods for determining the WGS-84 coordinates:

- a) Surveying methodologies.
- b) Quality assurance, accuracy and integrity of survey data.
- c) Producing a survey report.

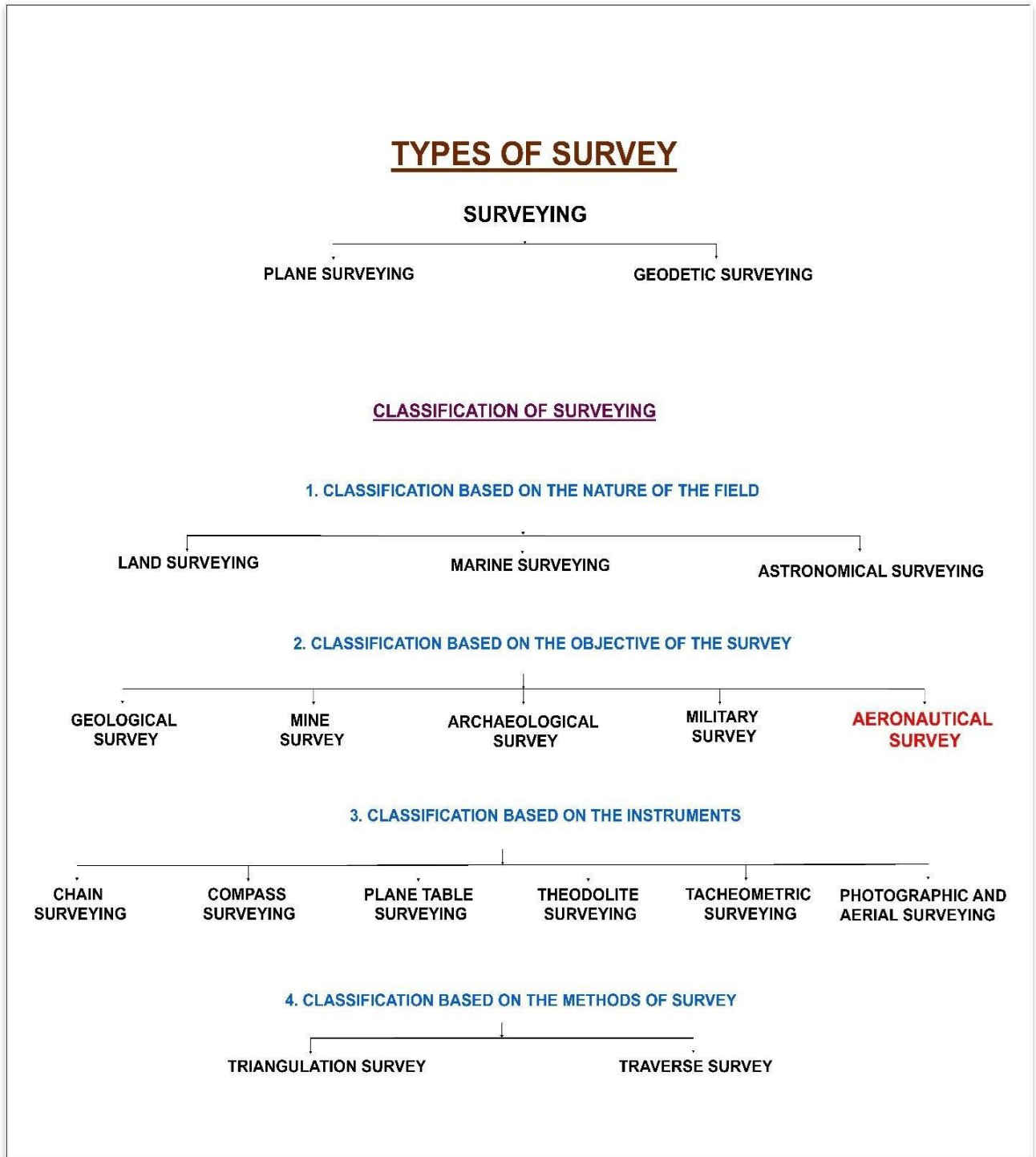
Part III: APPENDICES

- a) Survey declaration form
- b) Presentation of data in the electronic format
- c) Guidance material
- d) Specimen charts

1.4 MANDATORY REQUIREMENTS

- 1.4.1 This document strives to minimize the cost to Aerodrome survey requirement while providing the minimum prescribed safety standards. It is fully recognized that each individual Aerodrome is governed by its own operational needs and therefore the level of survey required should be appropriate and economical for the type of operation intended for its purpose.
- 1.4.2 Aerodrome operators including aerodrome owned by Airports Authority of India, shall provide accurate survey information of their aerodrome and environs according to the type of operation identified by aerodrome survey classification required as prescribed in Flow chart I-I-1 and shall be carried out to measure any changes at the periodic intervals as per GIS circular 01/2023.
- 1.4.3 Aerodrome operator is expected to keep all the records of No Objection Certificates (NOC) issued during the period, when the last survey was conducted. List of the NOC cases located within the survey areas should be provided to the survey team so that it may be taken into the consideration for verification. More-over any change in the location of Nav- aids, threshold or parking stand shall be provided to the survey team.

1.4.4 Type of Survey

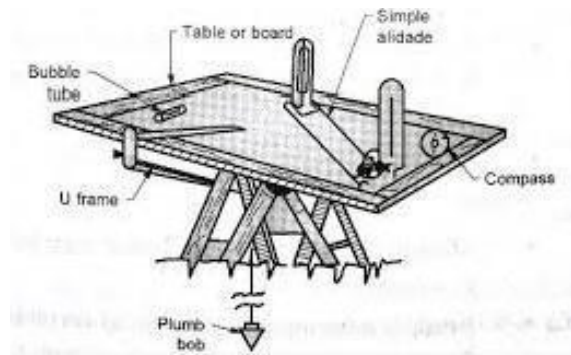


Flow chart- I- 1-1

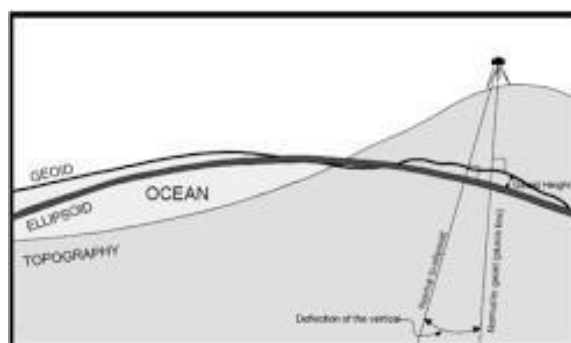
Surveying is primarily classified as under:

- a) **Plane surveying**
- b) **Geodetic Surveying**

a) **Plane Surveying** is that type of surveying in which the mean surface of the earth is considered as a plane and the spheroidal shape is neglected. All triangles formed by survey lines are considered plane triangles. The level line is considered straight and all plumb lines are considered parallel. In everyday life we are concerned with small portion of earth's surface and the above assumptions seems to be reasonable in light of the fact that the length of an arc 12 kilometres long lying in the earth's surface is only 1cm greater than the subtended chord and further that the difference between the sum of the angles in a plane triangle and the sum of those in a spherical triangle is only one second for a triangle at the earth's surface having an area of 195 sq. km.



b) **Geodetic Surveying** is that type of surveying in which the shape of the earth is taken into account. All lines lying in the surface are curved lines and the triangles are spherical triangles. It therefore, involves spherical trigonometry. All Geodetic surveys include work of larger magnitude and high degree of precision. The object of geodetic survey is to determine the precise position on the surface of the earth, of a system of widely distant points which form control stations to which surveys of less precision may be referred.



1.4.5 Classification of surveying

Surveys may be secondarily classified under no. of headings which define the uses or purpose of resulting maps.

- 1.4.5.1 Classification based upon nature of field
- 1.4.5.2 Classification based on objective
- 1.4.5.3 Classification based on instruments used
- 1.4.5.4 Classification based on methods used

1.4.5.1 Classification based upon nature of field:

There are three types of surveying based upon the nature of field which are as follows:

Land Surveying: Land surveying is the technique, profession, and science of accurately determining the terrestrial or three-dimensional position of points and the distances and angles between them, commonly practiced by licensed surveyors, and members of various building professions. These points are usually on the surface of the Earth, and they are often used to establish land maps and boundaries for ownership, locations (building corners, surface location of subsurface features) or other governmentally required or civil law purposes (property sales). It generally deals with natural or artificial features on land such as rivers, streams, lakes, wood, hills, roads, railways, canals, towns, water supply systems, buildings & properties etc. It can be further classified as

- i) Topographical survey
- ii) Cadastral Survey
- iii) City Survey.

i) **Topographical Survey:** A Detail Survey is about defining the location and heights of any number and variety of features on a site. Topographical plans can show contours along with the physical features located. This type of survey is regularly used when designing for roads, buildings, extensions and other new infrastructure. They can be carried out by all types of surveyors, however it should be noted that only Registered Land Surveyors are legally able to depict details of cadastral boundaries on detail plans.



ii) **Cadastral Survey:** Cadastral surveying is the discipline of land surveying that relates to the laws of land ownership and the definition of property boundaries. It involves

interpreting and advising on boundary locations, on the status of land ownership and on the rights, restrictions and interests in property, as well as the recording of such information for use on plans, maps, etc. It also involves the physical delineation of property boundaries and determination of dimensions, areas and certain rights associated with properties, whether they are on land, water or defined by natural or artificial features. Cadastral surveys are generally performed to subdivide land into parcels for ownership under a land title and to re-establish boundaries of previously surveyed properties to determine the physical extent of ownership or to facilitate the transfer of the property title.



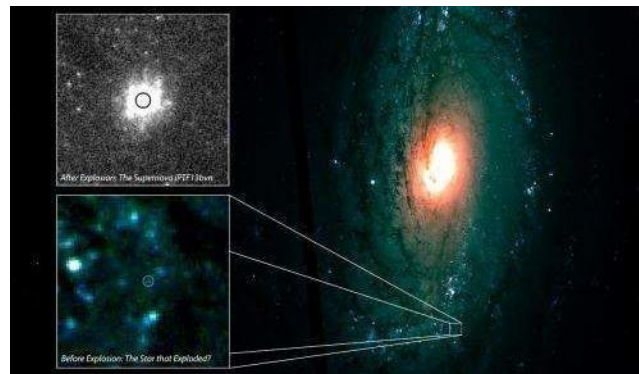
iii) **City Survey:** To build a new city or Township, surveying is to be done by considering all development works necessary for the city. The development works like street roads, property boundaries, water and sanitary pipes location, electrical lines, telephone lines etc. are involved in the city surveying.



Marine Surveying: Marine or hydrographic survey deals with bodies of water for purpose of navigation, water supply, harbour works or for determination of mean sea level. The work consists in measurement of discharge of streams, making topographic survey of shores and banks, taking and locating soundings to determine the depth of water and observing the fluctuations of the ocean tide.



Astronomical Surveying: The astronomical survey offers the surveyor means of determining the absolute location of any point or the absolute location of and direction of any line on the surface of the earth. This consists in observations to the heavenly bodies such as the sun or any fixed star.



1.4.5.2 Classification based on objective:

Geological Surveying: A systematic investigation of an area determining the distribution, structure, composition, history, and interrelations of rock units. Its purpose may be either purely scientific or economic with special attention to the distribution, reserves, and potential recovery of mineral resources



Mine Surveying: Mine surveying is the practice of determining the relative positions of points on or beneath the surface of the earth by direct or indirect measurements of distance, direction & elevation.



Archaeological surveying: In archaeology, survey or field survey is a type of field research by which archaeologists (often landscape archaeologists) search for archaeological sites and collect information about the location, distribution and organization of past human cultures across a large area (e.g. typically in excess of one hectare, and often in excess of many km²).



Military surveying: Military Survey is carried out by every country in the world. Military survey is based on a broader spectrum. It helps in determining the points of strategic importance for the country. Military Survey is required to meet mapping requirements of the Army, Navy and the Air Force. It also provides maps to the Para Military Forces, Central Armed Police Forces and Police units on demand from the Ministry of Home Affairs.



Aeronautical Surveying: Aeronautical surveying is a highly specialized type of surveying. It provides critical information about airport features, obstructions & navigational aids needed for safe aircraft operation and therefore is safety critical.



1.4.5.3 Classification based on instruments used:

Chain surveying: Chain survey is the simplest method of surveying. In this survey only measurements are taken in the field, and the rest work, such as plotting calculation etc. are done in the office. This is most suitable adapted to small plane areas with very few details. If carefully done, it gives quite accurate results. The necessary requirements for field work are chain, tape, ranging rod, arrows and sometime cross staff.



Compass surveying: Compass surveying is a type of surveying in which the directions of surveying lines are determined with a magnetic compass, and the length of the surveying lines are measured with a tape or chain or laser range finder. The compass is generally used to run a traverse line.



Plane table surveying: The plane table surveying is the fast method of surveying. In this type of surveying plotting of the plan and field observations can be done simultaneously. In case of plane table surveying Geometrical conditions of site are manuscript in the map sheet using plane table and alidade after that topographic details are arranged on the map.



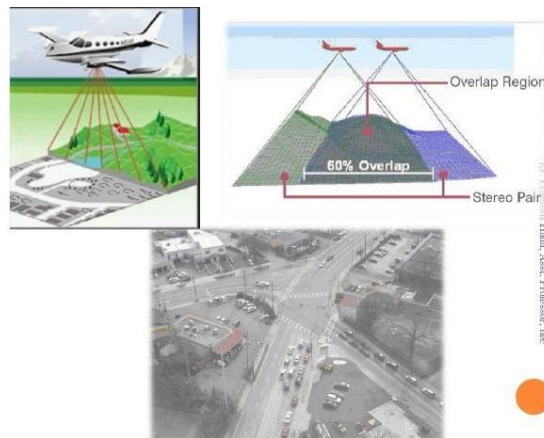
Theodolite surveying: Theodolite is an instrument used in surveying to measure horizontal and vertical angles. It is also used for levelling, indirect measure of distances and prolonging a line etc. The line of sight of theodolite can be rotated through 180° in vertical plane about its horizontal axis.



Tachometric surveying: Tachometry or tachometry or telemetry is a branch of angular surveying in which the horizontal and vertical distances of points are obtained by optical means as opposed to the ordinary slower process of measurements by tape or chain. The method is very rapid and convenient. • It is best adapted in obstacles such as steep and broken ground, deep revines, stretches of water or swamp and so on, which make chaining difficult or impossible.

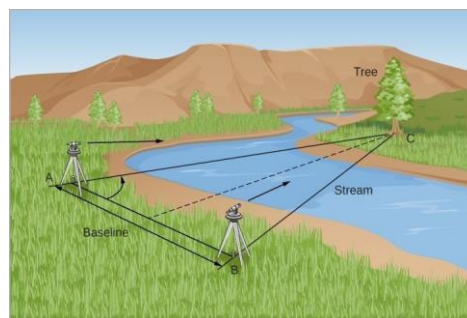


Photographic surveying: Photographic surveying also called photographing is a method of surveying in which plans or maps are prepared from photographs taken at suitable camera stations or photographic is the science of making measurement from photographs.



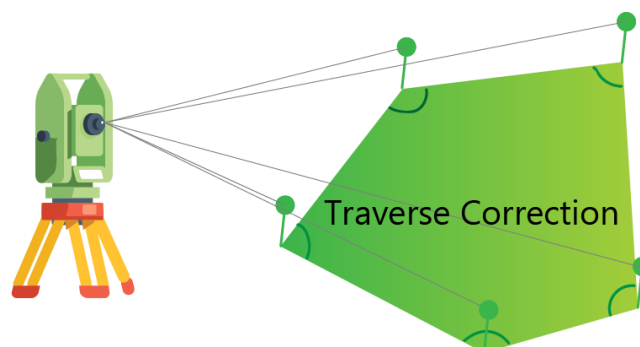
1.4.5.4 Classification based on methods used:

Triangulation surveying: Triangulation surveying is the tracing and measurement of a series or network of triangles to determine distances and relative positions of points spread over an area, by measuring the length of one



side of each triangle and deducing its angles and length of other two sides by observation from this baseline.

Traverse surveying: Traverse is a method in the field of surveying to establish control networks. It is also used in geodesy. Traverse networks involve placing survey stations along a line or path of travel, and then using the previously surveyed points as a base for observing the next point.



1.5 Reserved

1.6 SURVEY PERIODICITY

Surveys shall be undertaken for all Survey Areas required to measure any changes at the periodic intervals prescribed:

Survey Requirement:

I. Full (detailed) survey

- a) The procedures for a full survey includes the geodetic connections of airport, airport facilities including navigation aids, and obstacle survey of obstacle limitation surfaces (OLS) within 20 km around the airport.
- b) Full (detailed) survey shall be conducted at the initial commissioning of the aerodrome and thereafter it is required to get an airport resurveyed after every 4 years for IFR and 5 years for VFR airports.

II. Check Survey

- a) Check survey is to identify any changes in the aerodrome lay out such as addition/modifications of new stands, shifting of threshold or holding positions, new locations/trans-installation of nav. aids, addition or removal of obstacles including significant tree growth or reduction, since the previous survey.
- b) The check surveys may also be conducted on the specific request of Airport Director/Airport Operator whenever commissioning of a new facility (i.e. parking stand, new or displaced threshold, nav-aids etc) at the airport is needed for the purpose of certification.
- c) Check survey may be restricted to the particular area of aerodrome or to a particular runway in case of any extension.
- d) Check survey may also be conducted if the operations from a particular runway needs to be upgraded, i.e. non-instrument to instrument, or, non-precision to precision.
- e) All Check Survey requirement shall be communicated by Airport Director /Airport operator to Survey & Cartography section, AAI, CHQ.
- f) However, as per Aerodrome Advisory Circular No. 1 of 2006 and Aerodrome Manual Part-4 Para-4.13, all Airport Director/Airport operator Shall be responsible for**
 - i) Monitoring the obstacle limitation surface and Type A chart take-off surface for obstacles.
 - ii) Controlling obstacles within the authority of the operator.
 - iii) Monitoring buildings or structure development in relation to their height within the boundaries of the obstacle limitation surface.
 - iv) The control of new developments in the vicinity of aerodromes.

NOTE: Refer GIS Circular 01/2023

1.7 SURVEY PROCEDURES

1.7.1 Geodetic Connection

- a) The method of referencing a local (i.e. relative) and sufficiently accurate GPS aerodrome survey to WGS-84 by simply measuring the coordinate difference between one aerodrome point to a known and monumented WGS station is called direct geodetic connections.
- b) The procedures for a geodetic connection are detailed in ICAO Doc 9674 and included in the Part II of this document.
- c) The geodetic connection date shall be included with the submission of a Survey Declaration Form (see Part-III, Appendix – A).
- d) Geodetic Connection Report (recommended for full surveys) should include the following:

1. Quality Records/Metadata Records listing (can refer to the Survey Report):

- The data originator - Surveying organization;
- Date of survey;
- Name of the persons or organizations that have interacted with the data and when;
- Method of survey and equipment used;
- Equipment calibration information and method of checking the survey;
- Evidence that the accuracy requirements have been met including details of the error budget analysis;
- amendments made to the data;
- details of any validation and verification of the data that has been performed;
- effective start date and time of the data;
- the earth reference model used;
- the coordinate system used;
- the statistical accuracy of the measurement or calculation technique used;
- the resolution;
- the confidence level as required by the ICAO standards;
- details of any functions applied if data has been subject to conversion/transformation;

- details of any limitations on the use of the data.

2. Details of the connection of the aerodrome control network to the geodetic network
3. Aerodrome control network plan
4. Survey stations descriptions
5. Transformation parameters

1.7.2 Full Survey

- a) The procedures for a full survey includes the geodetic connections of airport, airport facilities including navigation aids, and obstacle survey of obstacle limitation surfaces (OLS) within 20 km around the airport.
- b) Full (detailed) survey shall be conducted at the initial commissioning of the aerodrome and thereafter it is required to get an airport resurveyed after every 4 years for IFR and 5 years for VFR airports.
- c) All full surveys shall be notified by the submission of a Survey Declaration Form (see Part-III, Appendix - A).

1.7.3 Check Survey

- a) The check survey is to identify any changes in the aerodrome lay out such as addition/modifications of new stands, shifting of threshold or holding positions, new locations/trans-installation of nav. aids, addition or removal of obstacles including significant tree growth or reduction, since the previous survey.
- b) The check surveys may also be conducted on the specific request of Airport operator/Airport operator whenever commissioning of a new facility (i.e. parking stand, new or displaced threshold, nav-aids etc) at the airport is needed for the purpose of certification.
- c) Check survey may be restricted to the particular area of aerodrome or to a particular runway in case of any extension.
- d) Check survey may also be conducted if the operations from a particular runway needs to be upgraded, i.e. non-instrument to instrument, or, non-precision to precision.
- e) All check surveys shall be notified by Airport operator/Airport operator to Survey/Cartography section, CHQ, AAI.
- f) **However, as per Aerodrome Advisory circular no. 1 of 2006 and aerodrome manual Part-4 para 4.13, all Airport operator shall be responsible for:**
 - ❖ Monitoring the obstacle limitation surface and Type A chart take off surface for obstacles.
 - ❖ Controlling obstacle within the authority of the operator.
 - ❖ Monitoring building or structure development in relation to the height within the boundaries of obstacle limitation surface.

- ❖ Control of new development in the vicinity of the aerodrome.
- ❖ Notifying the DGCA of the nature and location of obstacles and any subsequent addition or removal of obstacle for necessary including amendment of the AIS publications.

1.8 DATA MANAGEMENT

1.8.1 Proper data management is crucial during the entire survey and subsequent declaration process. Survey teams should implement rigorous data handling processes and practices to eliminate erroneous data submission. Each surveyed entity and associated attributes should be dealt with as a single data record stream. Any change to an existing data record stream identified during a subsequent check survey shall necessitate a re-issue of the entire data record with a new record number

For example: If a check survey is carried out on an existing mast (e.g. data record number 1023) and is found to be higher or lower than previously declared, data record 1023 will be deleted in to and a new data record declared together with a new unique data record number (e.g. 2056). The surveyor shall declare the deleted and new record and the reason(s) for change. The old record shall be deleted irrespective if the new record is the same mast located at the same position.

1.8.2 If no changes were found to all attributes in an existing record, the record shall retain its original record number and survey date.

1.8.3 If later, a full survey is submitted following an initial full survey, all previous data records shall be declared as obsolete and a new list of survey data records shall be declared with new record numbers and new survey dates.

1.9 SURVEY DECLARATION FORM

1.9.1 A "Survey Declaration Form" (see Part-III, Appendix - A) shall accompany all full and check survey submissions. Completion of this Form confirms that the survey submitted information meets the requirements and accuracies detailed in this document, their operational requirements and the type of survey undertaken, i.e. full or check survey. For the airports being managed by AAI, it is the responsibility of Airport-in-charge/Airport Director to keep the record of survey of the airport and make a request to CHQ as and when need for check survey arises. The surveyor is required to state the change or no change status for each survey area.

1.9.2 Submission of a check Survey Declaration form is needed to maintain the validity of the relevant published chart.

1.10 QUALIFYING SURVEYING COMPANIES

1.10.1 The Airports Authority of India / Aerodrome operator of private aerodromes shall satisfy itself as to the competence of the surveyors it employs for aerodrome surveys if the survey is being conducted by a team other than AAI. The following is a list of characteristics that should be considered:

- Accredited to an ISO 9001:2008 standards or operate an equivalent professionally qualified surveyors and project managers to oversee the survey. Field survey staff

competent in aerodrome surveying techniques and experienced at working in an operational aerodrome environment.

- Competency to prepare the charts as specified in this document or in other relevant ICAO documents.
- Professional indemnity cover.

1.10.2 Credentials of all surveying companies intending to carry out survey work for aerodromes with IFPs should be verified by AAI, particularly in case of a company intending to take up the assignment for the first time. A proper system for selection should be in place. The qualification of the surveyors, their knowledge of the subject and the type of equipment must be examined. Subsequently the company may be empanelled with AAI. Empanelment ensures that surveyors are informed of changes to policy or procedures and is NOT a select list of approved companies. Applicants should apply in writing, giving relevant credentials, to Executive Director (ATM), AAI, Rajiv Gandhi Bhawan, New Delhi – 110003.

1.11 ACCURACY

Appropriate survey methods shall be applied to qualify the accuracy and integrity of the data provided. Survey methodology shall be clearly demonstrated in the Survey Report. Requirements are stated in ICAO DOC 9674-AN/946 (WGS-84 Manual) and the most stringent survey accuracy shall apply as prescribed in **Table I-1-3**.

1.12 SURVEY PACKAGE

1.12.1 The completed survey package shall consist of the following:

- a) Two electronic copies on CD-ROM to include the Survey Report and Survey Plans in Adobe PDF format and accompanying Digital Data in Appendix - B format (when provided).
- b) One original signed copy of completed Survey Declaration Form (* For acceptability of other formats refer to paragraph 1.15).

1.12.2 Hard copies in duplicate of survey package, comprising report, plans, data and declaration form

Table I-1-3 Minimum Survey Accuracy and Integrity Requirements

| | Horizontal Accuracy | Vertical Accuracy | Integrity Classification |
|--|----------------------------|--------------------------|---------------------------------|
| Aerodrome Control Network | 1.0 m (*) | 1.0 m (*) | 1×10^{-8} |
| Aerodrome Facilities | 0.5 m (#) | 0.25 m (#) | 1×10^{-8} |
| Obstacles and Off Aerodrome Facilities | 3.0 m (#) | 0.3 m (#) | 1×10^{-5} |

(*) Accuracy with respect to the appropriate geodetic reference frame (#) Accuracy relative to the aerodrome control network

The more detailed list of accuracies and integrity is provided at the Part II of this document.

1.12.3 The Aerodrome Operator is responsible for ensuring that records of all copies of survey information along with Survey Declaration Form are maintained up to date and same has to be provided to DGCA as and when required: to Directorate of Aerodrome Licensing, Opposite S.J. Airport, NEW DELHI.

1.12.4 Proper justification may be provided in case survey report fails to conform to the requirement stated in this document.

1.12.5 Ownership and copyright of survey data resides with the Aerodrome Operator or Airports Authority of India as the case may be. However, relevant data shall be provided to Dte. of ATM, AAI for preparation/revision/modifications of instrument approach procedures/charts and publication of data in the AIP as per requirement of Annex 15.

1.13 CONVERSION FACTORS

ICAO Annex 5 is used as the standard for the application of all conversion factors.

Table I-1-4 Conversion factors

| Non-SI Units | SI Units |
|---------------------|-----------------|
| 1NauticalMile(nm) | 1.852 kilo (km) |
| 0.5nm | 1 km |
| 1Foot(ft) | 0.3048 (m) |
| 3.2808ft | 1 m |
| 1nm | 6076 ft |

1.14 STANDARD DOCUMENTS

- i. ICAO DOC 9674-AN/946 World Geodetic System - 1984 (WGS-84) Manual
- ii. ICAO Annex 4 (Aeronautical Charts)
- iii. ICAO Annex 5 (Units of Measurement to be Used in Air and Ground Operations)
- iv. ICAO Annex 14 (Aerodromes) Vol.- I
- v. ICAO Annex 11 (Air traffic Services)
- vi. ICAO Annex 15 (Aeronautical Information Services)
- vii. ICAO DOC 8168 - OPS/611(PANS OPS)
- viii. Aerodrome Survey Information CAP 232
- ix. FAA order 405
- x. Doc 9137 – AN/898 Part-6 (Airport Service Manual)
- xi. Doc 8697 – Aeronautical Chart Manual - ICAO

1.15 GUIDANCE AND POLICY

For guidance and clarification on points that are not covered within this Document or any other related issues should be sought from Executive Director (Air Traffic Management), AAI, R.G. Bhawan, New Delhi - 110003.

Chapter 2: AERODROME MASTER PLAN SURVEY AREA

2.1 PURPOSE

The Aerodrome Plan is part of the Aerodrome Manual which airport operator are required to maintain for licensing and safeguarding purposes. The Aerodrome Plan is a working document that gives an accurate picture of the aerodrome configuration and integral facilities

2.2 SURVEY SPECIFICATION

The survey specification for the Aerodrome Layout / Grid map is covered in ICAO DOC 9674 - AN/ 946 1st Edition 1997(WGS 84 Manual) and is included in the Part II of this document. All features listed in paragraph 2.4 shall be surveyed.

2.3 AERODROME LAYOUT / GRID MAP CONTENT

- 2.3.1 The scale shall be 1:5000. The accepted format of the plan is covered in Chapter 2 Figure I-2-2 (Extract of Part of Aerodrome Layout / Grid map).
- 2.3.2 The area of the plan shall show the limits of the aerodrome boundary and the locations of installations that are considered integral to the operational procedures of the aerodrome. Insets may be required to show off-site facilities.
- 2.3.3 All aerodrome characteristics as described in Annex 14 and relevant buildings shall be shown on the plan. Surveyed features shall be represented by an appropriate symbol and labelled by survey identification number. The operational runway(s) shall be shown by a solid line, the runway markings and approach lighting arrays shall be shown true to scale.
- 2.3.4 The height above local ground level (AGL) and elevation AMSL to the highest point of the feature in and feet are required for all features surveyed that are greater than 0.9m above local ground level within the runway strip
- 2.3.5 WGS- 84 co-ordinates and orthometric elevation AMSL and height AGL (where applicable) shall be shown on the plan for the following features.

2.4 AIRFIELD FEATURES

A. **Runway Points:** The 3-dimensional positions of the runway ends, thresholds (or the displaced threshold), end and start of TORA, end of TODA, end of ASDA, the touchdown zone elevation (TDZE) and a vertical profile of runway.

In the TDZ, vertical profile points must be measured at 30m (100-feet) for the entire length between the thresholds.

Note: Refer the figure Attachment I for the illustration of declared distances for any clarification. Aerodrome operator shall be responsible for providing the exact details of the declared distances.

B. Terminal Navigation Aids: The 3-dimensional positions of the following Terminal Navigation Aids will be surveyed:

- VOR/DME
- ILS Localizer, Glide path, antennae and collocated DME.
- ILS Middle and Outer Markers (where applicable show as inset on plan)
- IRVR
- NDB (Locator)
- Radar antenna
- UHF and VHF transmitters.

Information regarding the location and List of the facilities should be obtained from airport operator.

C. Visual NAVAIDs: The latitude and longitude of all Visual NAVAIDs must be determined e.g. Precision Approach Path Indicator (PAPI), Visual Approach Slope Indicator (VASI), Runway End Indicator Lights (REILS), Approach Lights, Rotating Beacon, etc.

D. Glide Slope abeam Point: The abeam point can be a calculated location but the preferred method is direct measurement. It is defined as the point on the runway centreline at which the physical location of the point of survey on the Glide Slope device lies perpendicular to the runway centreline. The height of this point may be interpolated from the vertical profile information as appropriate.

E. Runway Crown and Airport Elevation: The highest point on each must be determined.

2.5 OTHER AERODROME FACILITIES

- ❖ Aircraft stand points
- ❖ Wind Direction Indicator (WDI)
- ❖ ARP
- ❖ ATC tower

- ❖ Runway edge lights
- ❖ Runway holding positions

2.5.1 The co-ordinates and associated data shall be in a schedule format within the margin of the plan (see Figure I- 2-2).

2.5.2 Additional information may be required; this shall be at the request of the Aerodrome Operator and may include the following:

- Fire service accommodation.
- Emergency access/egress gates and routes.
- Emergency water supply tanks.
- Facility safeguarding (fences).
- ROP to runway edge lights distances (If available).

2.6 DIGITAL DATA

All surveyed features shall form part of the 'Aerodrome Facilities listing' depicted in Part III Appendix B

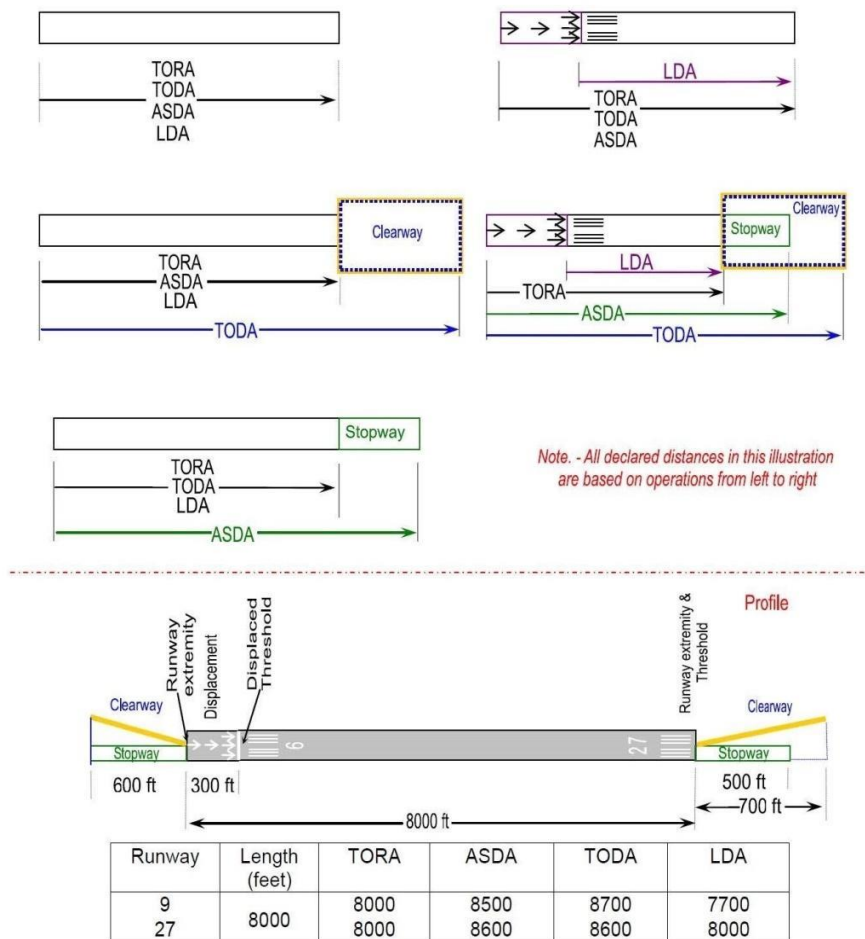


Figure I-2-1 Illustration of declared distances

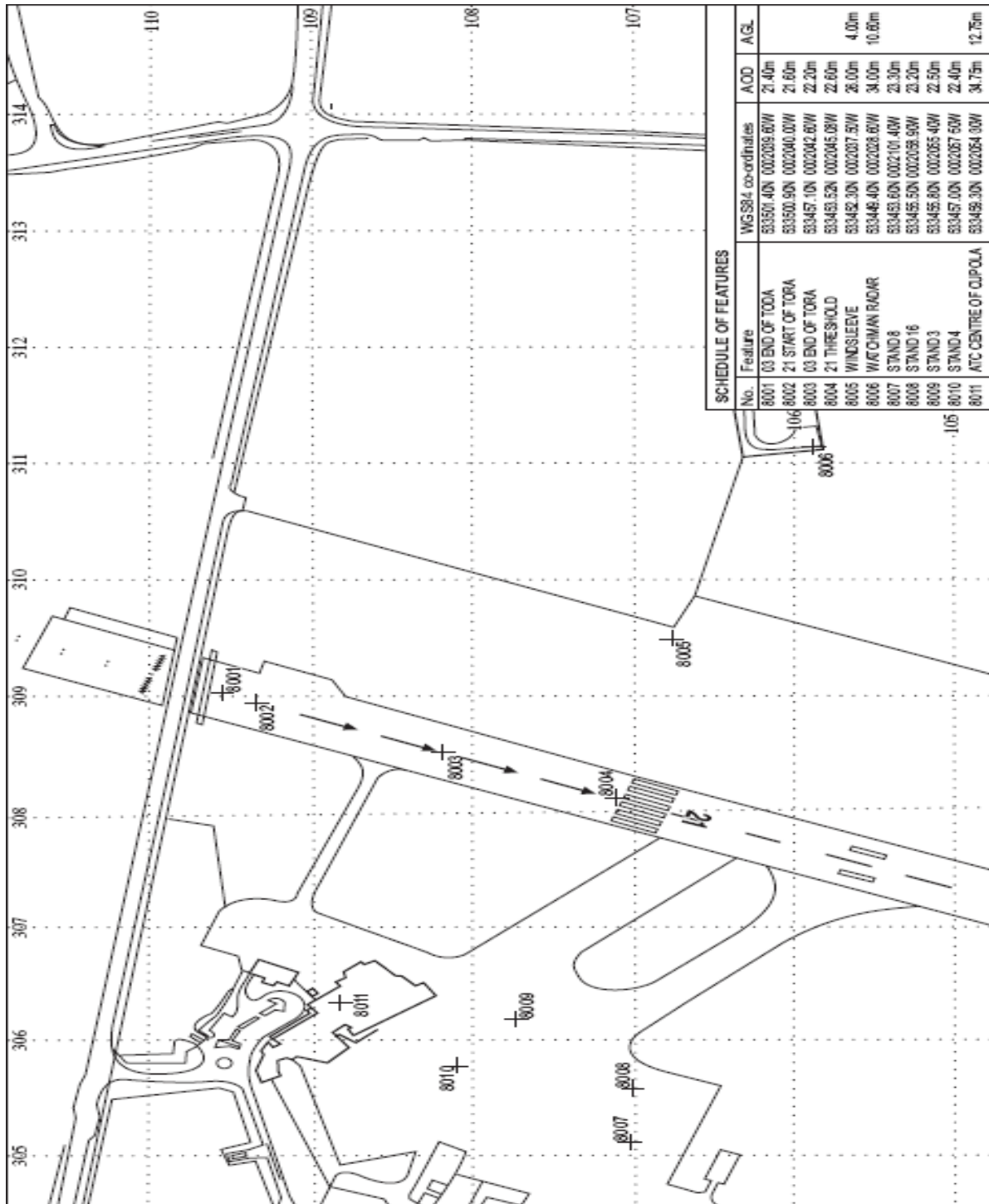


Figure I-2-2 Extract of Part of an Aerodrome Layout / Grid map

Chapter 3: OBSTACLE LIMITATION SURFACES AND SURVEY AREAS

3.1 PURPOSE

3.1.1 The purpose of the survey obstacle limitation surfaces is to identify all obstacles that infringe along with the extent of penetration of the prescribed obstacle limitation surfaces appropriate to the existing or proposed runway coding.

3.1.2 The survey data enables the Aerodrome operator to make safety evaluations and assists the DGCA to make assessments for the grant, retention or modification of an Aerodrome Licence.

3.1.3 It is the Aerodrome Operators' responsibility to promulgate selected significant obstacles within the AGA approach, take-off climb and circling areas in the Aeronautical Information Publication (AIP) as per ICAO requirement. The survey report would ensure that the list of obstacles that infringe the surfaces including extent infringement is provided. For guidance, the following shall be identified and reported,

- i. First obstacles in the Take-Off Climb Surfaces
- ii. Lines of trees/pylons close to the aerodrome in the Approach/Take-Off Climb Surfaces
- iii. High ground that may affect the circuit height
- iv. Obstacles (chimney, mast, etc.) within the circling area that are significantly higher than the aerodrome elevation
- v. Lit aerodrome features or large single objects that may not necessarily be infringement

3.2 SURVEY SPECIFICATION

3.2.1 The AGA obstacle limitation surfaces are listed below:

- i. Runway Strip*
- ii. Clearway (when applicable) *
- iii. Take-Off Climb Surface*
- iv. Approach Surface*
- v. Transitional Surface*

- vi. Inner Horizontal Surface*
- vii. Conical Surface*
- viii. Outer Conical Surface
- ix. Outer transitional surface
- x. Outer Horizontal Surface
- xi. Obstacle Free Zone Surface, comprising the inner approach, inner transitional and balking landing surfaces (precision approach and LPV approach only).

3.2.2 The dimensions and slopes of the surfaces are provided at Attachment I to Chapter 3 and the illustrations at Attachment II to Chapter 3.

3.2.3 Aerodrome Operators of airfields that have visual runways only without Instrument Flight Procedures (IFP) may limit their survey to the asterisked items at 3.2.1, within the limit of abbreviated requirements given at Chapter 2, paragraph 1 (to be amended). The Aerodrome Operator before the start of work will give the data on the declared distances so that surveyor may determine the origin of each surface, relative to a particular runway.

3.2.4 The dimensions and slopes of the various surfaces as defined and illustrated in **GSR 751 (E) and GSR 770 (E)** are provided in Attachment 1 of this chapter

3.2.5 The survey requirement is to height all obstacles within the AGA obstacle limitation surfaces area that infringe the limitation surfaces.

3.2.6 Special care must be exercised in the near environs of the approach and take-off climb area to ensure complete obstacle coverage.

3.3 DIGITAL DATA

All surveyed obstacles shall form part of the “Master Obstacles listing” depicted in Part III Appendix B

Attachment I to Chapter 3

DIMENSIONS OF THE AIRPORT SURVEY AREAS

1.1 RUNWAY STRIP

1.1.1 A runway and any associated stopways shall be included in a strip.

A. Length of runway strips

A strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least:

- ❖ 60 m where the code number is 2, 3 or 4;
- ❖ 60 m where the code number is 1 and the runway is an instrument one; and.
- ❖ 30 m where the code number is 1 and the runway is a non-instrument one.

*For non-instrument runway refer Annex 14 chapter 4.

Note: Irrespective of the actual size of the strip at the airport the presentation of the strip shall be made on the standard dimensions for the instrument runway and the obstacles identified accordingly.

B. Width of runway strips

A strip including a precision approach runway shall, wherever practicable, be extend laterally to a distance of at least:

- ❖ 140 m where the code number is 3 or 4; and
- ❖ 70 m where the code number is 1 or 2;

On each side of the centre line of the runway and its extended centre line throughout the length of the strip.

C. A strip including a non-precision approach runway should extend laterally to a distance of at least:

- ❖ 140 m where the code number is 3 or 4; and
- ❖ 70 m where the code number is 1 or 2;

On each side of the centre line of the runway and its extended centre line throughout the length of the strip.

D. A strip including a non-instrument runway should extend on each side of the centre line of the runway and its extended centre line throughout the length of the strip, to a distance of at least:

- ❖ 75 m where the code number is 3 or 4;
- ❖ 40 m where the code number is 2; and
- ❖ 30 m where the code number is 1.

E. Objects on runway strips

An object situated on a runway strip which may endanger aeroplanes shall be regarded as an obstacle and shall, as far as practicable, be removed.

Note 1: *Consideration will have to be given to the location and design of drains on a runway strip to prevent damage to an aeroplane accidentally running off a runway.*

Suitably designed drain covers may be required. For further guidance, see the Aerodrome Design Manual (Doc 9157), Part 1.

Note 2: *Where open-air or covered storm water conveyances are installed, consideration will have to be given to ensure that their structure does not extend above the surrounding ground so as not to be considered an obstacle. See also Note 1 to 3.4.16.*

Note 3: *Particular attention needs to be given to the design and maintenance of an open-air storm water conveyance in order to prevent wildlife attraction, notably birds. If needed, it can be covered by a net. Procedures on wildlife management are specified in the PANS-Aerodromes (Doc 9981). Further guidance can be found in the Airport Services Manual (Doc 9137), Part 3.*

1.1.2 No fixed object, other than visual aids required for air navigation or those required for aircraft safety purposes and which must be sited on the runway strip, and satisfying the relevant frangibility requirement in para 5 of this CAR, shall be permitted any part of on a runway strip of a precision approach runway delineated by the lower edges of the inner transitional surfaces. No mobile object shall be permitted on this part of the runway strip during the use of the runway for landing or take-off.

Grading of runway strips

That portion of a strip of an instrument runway within a distance of at least:

- ❖ 75 m where the code number is 3 or 4; and
- ❖ 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line shall provide a graded area for aeroplanes which the run-way is intended to serve in the event of an aeroplane running off the runway.

Note: *Guidance on grading of a greater area of a strip including a precision approach runway where the code number is 3 or 4 is given in para 8 of Attachment A of the CAR section 4, Series 'B' Part-I.*

1.1.3 That portion of a strip of a non-instrument runway within a distance of at least:

- ❖ 75 m where the code number is 3 or 4;
- ❖ 40 m where the code number is 2; and
- ❖ 30 m where the code number is 1;

From the centre line of the runway and its extended centre line shall provide a graded area for aeroplanes which the run-way is intended to serve in the event of an aeroplane running off the runway.

1.1.4 The surface of that portion of a strip that abuts a runway, shoulder or stopway shall be flush with the surface of the runway, shoulder or stopway.

1.1.5 That portion of a strip to at least 30 m before the start of a runway shall be prepared against blast erosion in order to protect a landing aeroplane from the danger of an exposed edge.

Note 1: The area provided to reduce the erosive effects of jet blast and propeller wash may be referred to as a blast pad.

Note 2: Guidance on protection against aeroplane engine blast is available in the Aerodrome Design Manual (Doc 9157), Part 2.

1.1.6 Where the areas in 1.1.5 have paved surfaces, they should be able to withstand the occasional passage of the critical aeroplane for runway pavement design.

1.2 Slopes on runway strips

1.2.1 Longitudinal slopes

A longitudinal slope along that portion of a strip to be graded shall not exceed:

- ❖ 1.5 per cent where the code number is 4;
- ❖ 1.75 per cent where the code number is 3; and
- ❖ 2.0 per cent where the code number is 1 or 2.

1.2.2 Longitudinal slope changes

Slope changes on that portion of a strip to be graded shall be as gradual as practicable and abrupt changes or sudden reversals of slopes avoided.

1.2.3 Transverse slopes

Transverse slopes on that portion of a strip to be graded shall be adequate to prevent the accumulation of water on the surface but shall not exceed:

- ❖ 2.5 per cent where the code number is 3 or 4; and
- ❖ 3 per cent where the code number is 1 or 2;

Except that to facilitate drainage the slope for the first 3 m outward from the runway, shoulder or stopway edge shall be negative as measured in the direction away from the runway and may be as great as 5 per cent.

1.2.4 The transverse slopes of any portion of a strip beyond that to be graded shall not exceed an upward slope of 5 per cent as measured in the direction away from the runway.

Note 1: *Where deemed necessary for proper drainage, an open-air storm water conveyance may be allowed in the non-graded portion of a runway strip and would be placed as far as*

practicable from the runway.

Note 2: *The aerodrome RFF procedure would need to take into account the location of open-air water conveyances within the non-graded portion of a runway strip.*

1.2.5 Strength of runway strips

That portion of a strip of an instrument runway within a distance of at least:

- ❖ 75 m where the code number is 3 or 4; and
- ❖ 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line shall be so prepared or constructed as to minimize hazards arising from differences in load bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

Note: *Guidance on preparation of runway strips is given in the ICAO Aerodrome Design Manual, Part 1.*

1.2.6 That portion of a strip containing a non-instrument runway within a distance of at least:

- ❖ 75 m where the code number is 3 or 4;
- ❖ 40 m where the code number is 2; and
- ❖ 30 m where the code number is 1;

From the centre line of the runway and its extended centre line shall be so prepared or constructed as to minimize hazards arising from differences in load bearing capacity to aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

1.2.7 Runway End Safety Areas

1.2.7.1 A runway end safety area shall be provided at each end of a runway strip where:

- ❖ the code number is 3 or 4; and
- ❖ the code number is 1 or 2 and the runway is an instrument one.

Note: *Guidance on runway end safety areas is given in para 10 of Attachment A of this CAR.*

1.2.7.2 A runway end safety area should be provided at each end of a runway strip where the code number is 1 or 2 and the runway is a non-instrument one.

1.2.7.3 Dimensions of Runway End Safety Areas

A runway end safety area shall extend from the end of a runway strip to a distance of at least 90 m where:

- ❖ The code number is 3 or 4; and
- ❖ The code number is 1 or 2 and the runway is an instrument one.

If an arresting system is installed, the above length may be reduced, based on the design specification of the system, subject to acceptance by the DGCA.

Note: Guidance on arresting systems is given in Attachment A, Section 10.

1.2.7.4 A runway end safety area, as far as practicable, should extend from the end of a runway strip to a distance of at least:

- ❖ 240 m where the code number is 3 or 4; or a reduced length when an arresting system is installed;
- ❖ 120 m where the code number is 1 or 2. and the runway is an instrument one; or
a reduced length when an arresting system is installed; and
- ❖ 30 m where the code number is 1 or 2 and the runway is a non-instrument one.

1.2.7.5 The width of a runway end safety area shall be at least twice that of the associated runway.

1.3 DIMENSIONS AND SLOPES OF OBSTACLE LIMITATION SURFACES

1.3.1 Take-off climb surface

1.3.1.1 Take-off climb surface is an inclined plane located beyond the end of the take-off run available or the end of the clearway where it is provided. The limits of the take-off climb surface shall comprise:

- a.) an inner edge horizontal and perpendicular to the centre line of the runway and located either at a specified distance beyond the end of the runway or at the end of the clearway when such is provided and its length exceeds the specified distance.
- b) two sides originating at the ends of the inner edge, diverging uniformly at a specified rate from the take-off track to a specified final width and continuing thereafter at that width for the remainder of the length of the take-off climb surface;
- c) an outer edge horizontal and perpendicular to the specified take-off track.

1.3.1.2 The elevation of the inner edge shall be equal to the highest point on the extended runway centre line between the end of the runway and the inner edge, except that when a clearway is provided the elevation shall be equal to the highest point on the ground on the centre line of the clearway.

1.3.1.3 In the case of a straight take-off flight path, the slope of the take-off climb surface shall be measured in the vertical plane containing the centre line of the runway.

1.3.1.4 In the case of a take-off flight path involving a turn, the take-off climb surface shall be a complex surface containing the horizontal normal to its centre line, and the slope of the centre line shall be the same as that for a straight take-off flight path.

1.3.1.5 The dimensions of the take-off climb surface shall not be less than the dimensions specified in the table given below except that if a runway is meant for takeoff, a lesser length may be adopted for the takeoff climb surface where such lesser length would be consistent with procedural measures adopted to govern the outward flight of aero planes.

Dimensions and Slopes of Obstacle Limitation Surfaces (Runways Meant for Take-Off)

Fig. I-3-AI-1

| Surface and dimension * | Code Number | | |
|--------------------------|-------------|-------------|------------------------------|
| | 1 | 2 | 3 or 4 |
| (1) | (2) | (3) | (4) |
| TAKE OFF CLIMB | | | |
| Length of inner edge | 60 metres | 80 metres | 180 metres |
| Distance from runway end | 30 metres | 60 metres | 60 metres |
| Divergence (each side) | 10% | 10% | 12.5% |
| Final width | 380 metres | 580 metres | 1200 metres 1800 metres** |
| Length | 1600 metres | 2500 metres | 15000 metres |
| Slope | 5% | 4% | 2% |

* All dimensions are measured horizontally.

**When the intended track includes changes of heading greater than 15 degree for operations conducted in IMC, VMC by night.

1.3.2 Transitional Surface

1.3.2.1 The outer limit of the transitional surface is determined by its intersection with the plane containing inner horizontal surface and the slopes of transitional surfaces are as given below, namely: -

- ❖ Precision Approach Runway 14.3% (1:7)
- ❖ Non-Precision Runway 14.3% (1:7) for code 3 & 4
20.0% (1:5) for code 1 & 2
- ❖ Non-Instrument Runway 14.3% (1:7) for code 3 & 4
20.0% (1:5) for code 1 & 2;

1.3.2.2 The slope of the transitional surface shall be measured in a vertical plane at right angles to the centre line of the runway. The elevation of a point on a lower edge shall be:

- a) along the side of approach surface, equal to the elevation of approach surface at that point; and
- b) along the strip, equal to the elevation of nearest point on the centre line of the Runway or its extension;

1.3.3 Approach Surface

1.3.3.1 Approach surface is an inclined plane or combination of planes preceding the threshold. The limits of the approach surface shall comprise:

- a) a horizontal inner edge of specified length perpendicular to the extended centre line of the runway at a distance of 60m before the threshold except in case of visual runways where the code number is 1 the distance is 30m;
- b) two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the runway; an outer edge parallel to the inner edge; and
- c) The above surfaces shall be varied when lateral offset, offset or curved approaches are utilized, specifically, two sides originating at the ends of the inner edge and diverging uniformly at a specified rate from the extended centre line of the lateral offset, offset or curved ground track.

1.3.3.2 The elevation of the inner edge shall be equal to the elevation of the mid-point of the threshold.

1.3.3.3 The slope(s) of the approach surface shall be measured in the vertical plane containing the centre line of the runway. An approach surface for an instrument runway is horizontal beyond the point at which it intersects a horizontal plane 150m above the threshold elevation.

1.3.3.4 The approach surface is established for each runway strip in the direction of intended landing of the aeroplanes. The limits and slopes are given in table.

1.3.3.5 Instrument Runway

Inner Edge of Approach Surface:

| | |
|------------------------------------|--|
| Length of Inner edge | - 140 metres for Code No. 1 and 2 - 280 metres for Code No. 3 and 4 |
| Distance from runway threshold | - 60 metres |
| Divergence | -15% on either side |
| Length & Slope of Approach Surface | as given in table below |

Approach Surface Slope of Instrument Runway

| Runway | | Precision Approach Runway | | | Non-Precision Approach Runway | | |
|----------|--|--------------------------------------|---------------------------------------|----------------------------|--------------------------------------|---------------------------------------|----------------------------|
| Code No. | Aeroplane Reference Field Length (meter) | First Section Length (meter) & slope | Second Section Length (meter) & slope | Horizontal Section (meter) | First Section Length (meter) & slope | Second Section Length (meter) & slope | Horizontal Section (meter) |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 1 | <800 | 3000 2.5% | 12000 3% | - | 2500 3.33% | - - | - |
| 2 | 800<1200 | 3000 2.5% | 12000 3% | - | 2500 3.33% | - - | - |
| 3 | 1200<1800 | 3000 2% | 3600 2.5% | 8400 | 3000 2% | 3600 2.5% | 8400 |
| 4 | 1800 and above | 3000 2% | 3600 | 8400 | 3000 2% | 3600 2.5% | 8400 |

Fig. I-3-AI-2

* Total length of approach surface for runway code number 3 and 4 with precision and non-precision shall be 15000 metres.

** Total length of approach surface for Precision approach Runway Code number 1 and 2 shall be 15000 metres.

1.3.3.6 **Non-Instrument runway**

Inner Edge of Approach Surface:

Length of Inner edge - 60 metres for Code No. 1

80 metres for code No. 2

150 metres for Code No. 3 and 4

Distance from runway threshold - 30 metres for code 1

60 metres for code No. 2, 3 and 4

Divergence -10% on either side

Length & Slope of Approach Surface as given in table

Approach Surface Slope of Non-Instrument Runway

| Runway | | Length and slope of approach surface | |
|----------|--|--------------------------------------|---------------|
| Code No. | Aerodrome Reference Field Length (meter) | Length (Meter) | Section Slope |
| 1. | <800 | 1600 | 5% |
| 2. | 800<1200 | 2500 | 4% |

| | | | |
|----|--------------|------|-------|
| 3. | 1200<1800 | 3000 | 3.33% |
| 4. | 1800 & above | 3000 | 2.5% |

Fig. I-3-AI-3

- 1.3.3.7 Aerodrome where there are more than one runway with over-lapping approach areas and associated surface, most stringent of the two would be the applicable criteria.
- 1.3.3.8 For determining the approach, the physical extremities of the runway shall only be considered. In case of displaced threshold the permissible height shall be calculated based on approach surface and transitional surface with respect to the runway extremity or displaced threshold whichever is more restrictive.
- 1.3.3.9 At Aerodromes, where the proposals for runway extension exist, the requisite surface shall be determined from the proposed extension as well as from the existing runway strip/associated clearway, as applicable and the lower of the two elevations shall be permitted. The elevation of the associated runway extremity/displaced threshold/proposed extension of runway shall be the datum for approach surface.
- 1.3.3.10 The slope of the approach surface shall be measured in a vertical plane containing the centerline of the runway.

1.3.4 Inner Horizontal Surface

- 1.3.4.1 Dimensions and permissible heights of Inner Horizontal Surface are given in the table below:

| Dimensions and Permissible Heights of Inner Horizontal Surface | | | | | |
|---|--|----------------|----------------|----------------|--|
| Runway | | Instrument | | Non-Instrument | |
| Code No. | Aerodrome Reference Field Length (meter) | Radius (Meter) | Height (Meter) | Radius (Meter) | Height above Aerodrome Elevation (Meter) |
| 1. | <800 | 3500* | 45 | 2000* | 45 |
| 2. | 800<1200 | 3500* | 45 | 2500* | 45 |
| 3. | 1200<1800 | 4000** | 45 | 4000** | 45 |
| 4. | 1800 and Above | 4000** | 45 | 4000** | 45 |

Fig. I-3-AI-4

*For runway code number 1 and 2, radius of IHS shall be measured from the Aerodrome Reference Point (ARP).

** For runway code number 3 and 4, radius of IHS shall be measured from the runway extremity.

- 1.3.4.2 The reference datum for Inner-Horizontal Surface shall be the aerodrome elevation

as defined in clause (g) of the Explanation to this notification.

- 1.3.4.3 For Runway code 3 and 4, the Inner Horizontal Surface shall be a composite pattern, which consists of two circular areas centered at the two ends with a radius of 4000 metres. These areas shall be joined tangentially to form an elliptical shape as shown in Appendix-A of Schedule VIII.
- 1.3.4.4 Where it is required to protect two or more widely spaced long runways, a more complex pattern involving four or more circular areas are formed. These areas should be joined tangentially by straight lines and the Inner Horizontal Surface shall be defined by the external limits of the resulting pattern (Refer Appendix -A of Schedule VIII).
- 1.3.4.4 When two aerodromes are close to each other with overlapping circuits the Inner Horizontal Surface will be drawn as prescribed in para 1.3.4.4. The inner horizontal surface of these two aerodromes shall be joined tangentially to form one common Inner Horizontal Surface.
- 1.3.4.5 In case of common horizontal surface serving two aerodromes, the elevation of the Inner Horizontal Surface will be referenced to the lower of the two aerodromes.

1.3.5 Conical Surface

- 1.3.5.1 The conical surface shall be projected upwards and outwards from the periphery of the Inner Horizontal Surface. The slope 5% (1:20) of the conical surface shall be measured in a vertical plane perpendicular to the Inner Horizontal Surface and shall continue upto a height of 300 metres. The reference datum for Conical Surface shall be the aerodrome elevations.

The reference datum for Conical Surface shall be the aerodrome elevation.

Note :- It may be observed from above that a part of inner horizontal surface and conical surface lies below the approach/ take-off climb surface. In such cases the permissible heights shall be the lowest of the applicable surfaces for the purpose of NOC calculations. For the purpose of instrument approach/departure procedures actual height of applicable surface shall be calculated.

1.3.6 Outer Transitional Surface

In order to avoid abrupt vertical changes in surfaces, the surfaces beyond the conical surfaces will slope laterally at 1:7 from edges of the approach surface between the permissible heights of 150m to 300m.

1.3.8. Outer Horizontal Surface

- 1.3.8.1 The Outer Horizontal Surface shall extend to 15000 metres from the Aerodrome Reference Point for Aerodrome with runway code 3 and 4.
- 1.3.8.2 In case of Aerodrome with runway Code 2, the Outer Horizontal Surface shall extend

to 14740 metres from Aerodrome Reference Point for Instrument runways and 13740 metres for Non- Instrument runways.

1.3.8.3 Where combined Outer Horizontal Surface is established for two Aerodromes, the Outer Horizontal Surface shall be centered on the Aerodrome Reference Point of the Aerodrome of higher category.

1.3.8.4 Outer Horizontal Surface for Aerodrome with runway code No.1 shall not be established.

1.3.8.5 The Outer Horizontal Surface, would be defined such that the Conical Surface may continue to be extended at 5% slope to a point wherein the permissible maximum height of *300 metres (above aerodrome elevation) is reached and thereafter this surface is maintained upto 15 kilometres from Aerodrome Reference Point. Construction(s) protruding above these surfaces shall normally not be permitted. Obstructions existing in the area should be marked or lighted.

1.3.8.6

**Note: In case of Defence Aerodromes, the permissible maximum height in conical and OHS shall be 150 metres above aerodrome elevation.*

1.3.8.7 The datum for Outer Horizontal Surface shall be the aerodrome elevation.

1.3.8.8 The Inner Approach, Inner Transitional and Balked Landing Surfaces (collectively referred as Obstacle Free Zone or OFZ)

1.2.9 Obstacle Free Zone (OFZ)

1.2.9.1 **Obstacle free zone (OFZ)** : The airspace above the inner approach surface, inner transitional surfaces, and balked landing surface and that portion of the strip bounded by these surfaces, which is not penetrated by any fixed obstacle other than a low-mass and frangibly mounted one required for air navigation purposes.

1.2.9.2 An OFZ is intended to protect aeroplanes from fixed and mobile obstacles during Category I, II or III operations when approaches are continued below decision height and during any subsequent missed approach or balked landing with all engines operating normally. It is not intended to supplant the requirement of other surfaces or areas where these are more demanding.

1.2.9.3 An OFZ shall be established for each precision instrument approach Category II or III runway and shall be maintained during operations conforming to those categories. An OFZ should be established for precision instrument approach Category I runways, and should be maintained during operations conforming to this category.

Note :- OFZ for Runway Code No. 1 & 2 are not established.

1.2.10 The dimensions and slopes of the OFZ (Code 3 & 4)

1.2.10.1 Inner approach surface

| | |
|-------------------|---|
| Width | - 120 mtrs(155 mtrs in case of Code F) |
| Distance from THR | - 60 mtrs |
| Length | - 900 mtrs |
| Slope | - 2% |

1.2.10.2 Inner transitional surface

| | |
|-------|---------|
| Slope | - 33.3% |
|-------|---------|

1.2.10.3 Balked landing Surface

| | |
|----------------------|--|
| Length of Inner edge | - 120 mtrs (155 mtrs in case of Code F) |
| Distance from THR | - 1800mtrs or end of Rwy whichever is less |
| Divergence | - 10% |
| Slope | - 3.33% |

1.2.10.4 The upper limit of OFZ surfaces is 45 m above aerodrome elevation

Attachment II to Chapter 3

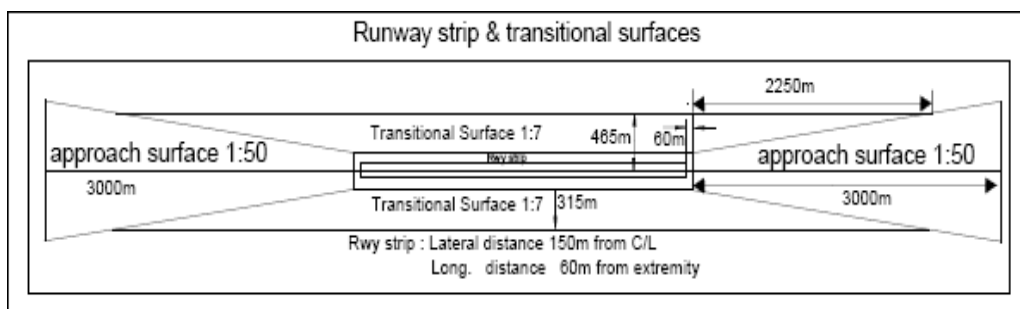


Figure I-3-A2-1

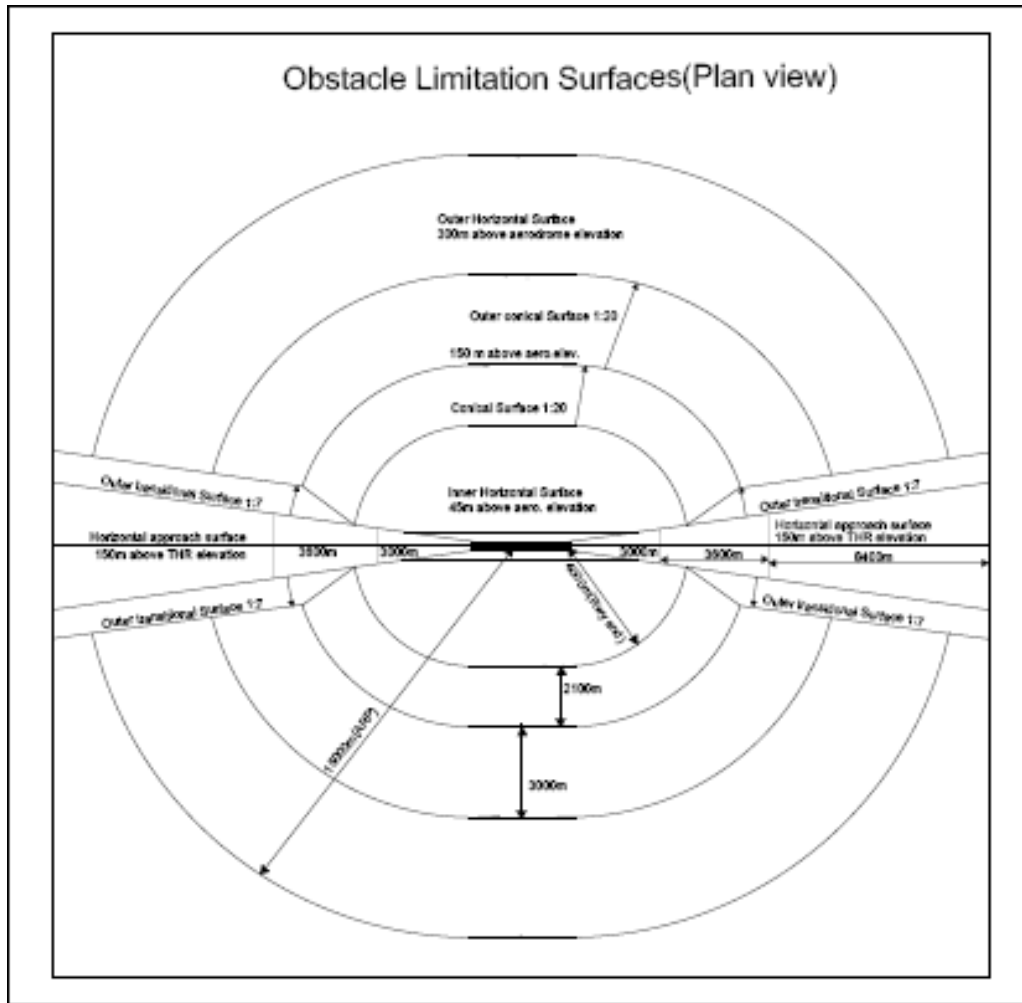


Figure I-3-A2-2

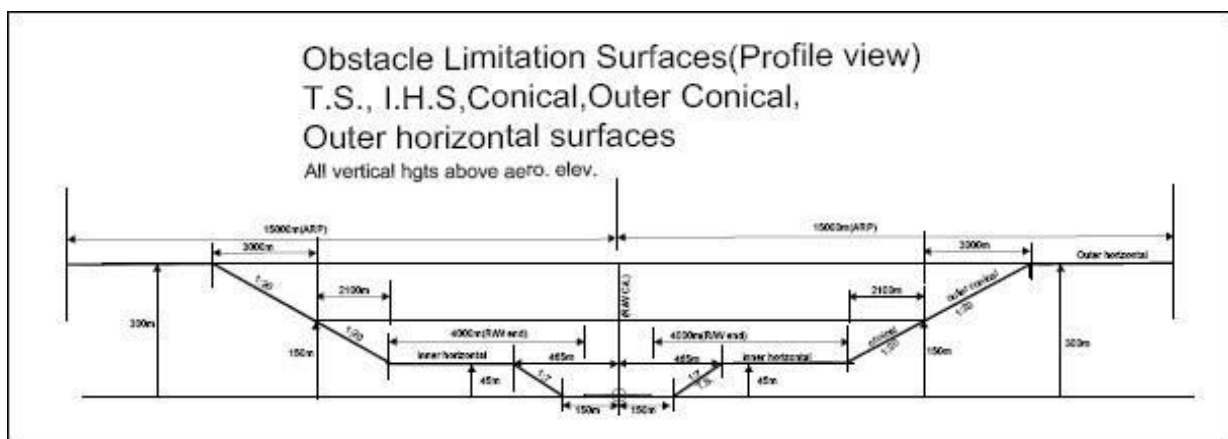


Figure I-3-A2-3

Attachment III to Chapter 3

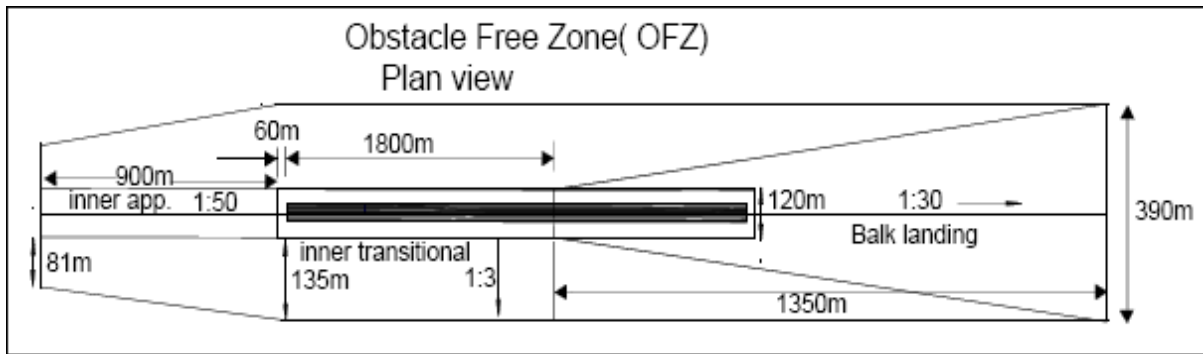


Figure I-3-A3-1

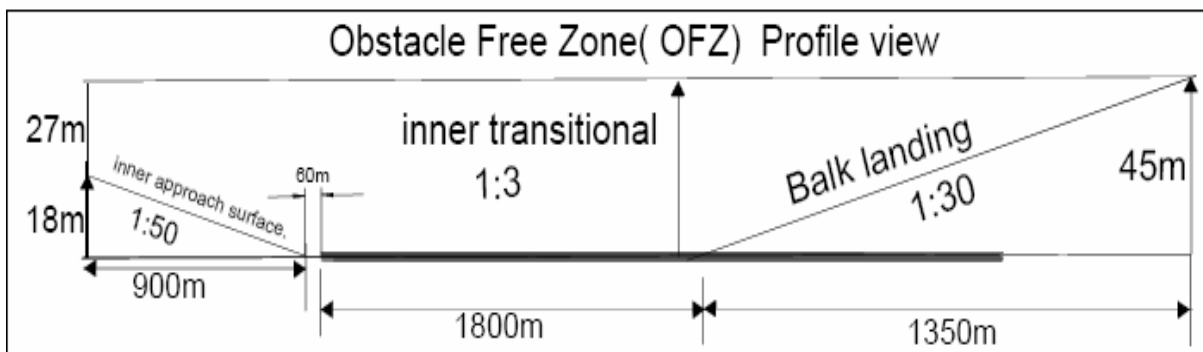


Figure I-3-A3-2

Dimensions and slopes of obstacle limitation surfaces - Approach Runways

| Surface and dimensions ^a | RUNWAY CLASSIFICATION | | | | | | | | | |
|-------------------------------------|----------------------------|---------|---------|---------|------------------------------------|---------------------|---------------------|-----------------------------|--------------------------|----------------------|
| | Non-instrument Code number | | | | Non-precision approach code number | | | Precision approach category | | |
| | | | | | | | | I Code number | II or III Code number | |
| | 1 | 2 | 3 | 4 | 1,2 | 3 | 4 | 1,2 | 3,4 | 3,4 |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| CONICAL | | | | | | | | | | |
| Slope | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% | 5% |
| Height | 35 m | 55 m | 75 m | 100 m | 60 m | 75 m | 100 m | 60 m | 100 m | 100 m |
| INNER HORIZONTAL | | | | | | | | | | |
| Height | 45 m | 45 m | 45 m | 45 m | 45 m | 45 m | 45 m | 45 m | 45 m | 45 m |
| Radius | 2 000 m | 2 500 m | 4 000 m | 4 000 m | 3 500 m | 4 000 m | 4 000 m | 3 500 m | 4 000 m | 4 000 m |
| INNER APPROACH | | | | | | | | | | |
| Width | - | - | - | - | - | - | - | 90 m | 120 m ^e | 120 m ^e |
| Distance from threshold | - | - | - | - | - | - | - | 60 m | 60 m | 60 m |
| Length | - | - | - | - | - | - | - | 900 m | 900 m | 900 m |
| Slope | - | - | - | - | - | - | - | 2.5% | 2% | 2% |
| APPROACH | | | | | | | | | | |
| Length of inner edge | 60 m | 80 m | 150 m | 150 m | 140 m | 280 m | 280 m | 140 m | 280 m | 280 m |
| Distance from threshold | 30 m | 60 m | 60 m | 60 m | 60 m | 60 m | 60 m | 60 m | 60 m | 60 m |
| Divergence (each side) | 10% | 10% | 10% | 10% | 15% | 15% | 15% | 15% | 15% | 15% |
| First section | | | | | | | | | | |
| Length | 1 600 m | 2 500 m | 3 000 m | 3 000 m | 2 500 m | 3 000 m | 3 000 m | 3 000 m | 3 000 m | 3 000 m |
| Slope | 5% | 4% | 3.33% | 2.5% | 3.33% | 2% | 2% | 2.5% | 2% | 2% |
| Second section | | | | | | | | | | |
| Length | - | - | - | - | - | 3 600m ^b | 3 600m ^b | 12 000m | 3 600m ^b | 3 600 m ^b |
| Slope | - | - | - | - | - | 2.5% | 2.5% | 3% | 2.5% | 2.5% |
| Horizontal section | | | | | | | | | | |
| Length | - | - | - | - | - | 8 400m ^b | 8 400m ^b | - | 8 400m ^b | 8 400 m ^b |
| Total length | - | - | - | - | - | 15 000m | 15 000m | 15 000m | 15 000m | 15 000 m |
| TRANSITIONAL | | | | | | | | | | |
| Slope | 20 % | 20% | 14.3% | 14.3% | 20% | 14.3% | 14.3% | 14.3% | 14.3% | 14.3% |
| INNER TRANSITIONAL | | | | | | | | | | |
| Slope | - | - | - | - | - | - | - | 40% | 33.3% | 33.3% |
| BALKED LANDING SURFACE | | | | | | | | | | |
| Length of inner edge | - | - | - | - | - | - | - | 90 m | 120 m ^e | 120 m ^e |
| Distance from threshold | - | - | - | - | - | - | - | c | 1800 m ^d | 1800 m ^d |
| Divergence (each side) | - | - | - | - | - | - | - | 10% | 10% | 10% |
| Slope | - | - | - | - | - | - | - | 4% | 3.33% | 3.33% |

a. All dimensions are measured horizontally unless specified otherwise.
 b. Variable length (see 4.2.9 or 4.2.17).
 c. Distance to the end of strip.
 d. Or end of runway whichever is less.
 e. Where the code letter is F (Column (3) of Table1-1), the width is increased to 140m except for those aerodromes that accommodate a code letter f. aeroplane equipped with digital avionics that provide steering commands to maintain an established track during the go around manoeuvre.

Note: See ICAO circular 301, 345 and chapter 4 of the PANS -AERODROMES part 1 (Doc 9981) for further information.

Fig. I-3-A1-5

Chapter 4: GENERAL SURVEY PROCEDURE

(Presentation and survey of obstacles)

The provisions of this chapter are based on the text contained in Part II Chapter 5. Therefore, both the chapters may be referred for better appreciation and understanding.

4.1 GENERAL

4.1.1 The accuracy and integrity requirements for the geodetic connection and surveyed data are stated in ICAO DOC 9674 and are included in Part II of this manual.

4.1.2 Aerodromes without Instrument Flight Procedures do NOT need to undertake surveys to the accuracy and quality assurance requirements stated in the ICAO DOC 9674-AN/946 (WGS-84 Manual). The Aerodrome operator is responsible for ensuring the accuracy of information required for Aerodrome Layout / Grid map and AGA survey areas.

4.2 HORIZONTAL CONTROL

4.2.1 Co-ordinates will be required in WGS-84 format (required format for published data) and appropriate National Grid (for plotting and design on topographical charts).

4.2.2 Survey control points shall conform to the ICAO DOC 9674-AN/946 (WGS-84 Manual) as provided in Part II of this document.

4.2.3 WGS-84 geodetic control and format requires that the methods deployed must prove that the accuracy for the various surveys has been met. Survey teams/parties undertaking these surveys shall be responsible for the accuracy of the control data and any transformation sets used an analysis of the accumulated error, evidence confirming the required accuracies have been met and the transformation parameters used shall be included in the Survey Report.

4.3 VERTICAL CONTROL

4.3.1 Orthometric and ellipsoidal elevations are required.

4.3.2 The variable separation between the geoid and the reference ellipsoid may give rise to inaccuracies greater than the allowable specified. For the computation to transform ellipsoidal to orthometric elevations a geoid model should be used. If a geoid model is not available extra care must be taken to ensure good geometry of the initial control points. In all cases appropriate survey checks shall be applied to prove the quality of vertical control. These checks shall be included within the survey report.

4.3.3 Standard survey practice shall be used to produce the elevation to the required specification accuracy and the integrity of the control points used shall be proved.

4.4 INSTRUMENTATION

4.4.1 All survey equipment shall have a current calibration certificate and be able to perform to the accuracy appropriate to the requirements of the surveys.

4.5 METHODOLOGY OF OBSTACLE SURVEY

4.5.1 All permanent control stations that are established within the aerodrome boundary shall be documented and traceable. Airport operator shall be responsible for keeping the record of control stations as described in Part II.

4.5.2 Office appreciation using contour maps can aid in the process of defining the probable extent of the survey and the likely position of obstacles.

4.5.3 New obstacle data shall be proved by two independent measurements and their resultant elevations and positions shall satisfy the appropriate survey criteria.

4.5.4 Obstacles heighted on previous surveys need only to be checked to confirm their height and position without the rigour afforded to new obstacles. Particular attention should be paid to structures and trees whose height may change. An appreciation of the effects of vertical angles over variable distances is necessary to give good height accuracies.

4.6 OBSTACLES TO BE HEIGHTED

4.6.1 Surveying teams should take note that when surveying a prescribed area, a situation might arise where the highest obstacle within that area might not necessarily be the dominant obstacle for that particular phase of flight. Therefore, surveyors should always declare an obstacle in the Master Obstacle list if any doubt exists to its validity as an obstacle.

4.6.2 Obstacles include terrain, vegetation and structures.

4.6.3 Where there are a large number of obstacles to be heighted it will be impractical to survey, for example, every tree in a wooded area and therefore the surveyor should consult with the Aerodrome Operator and the Instrument Flight Procedure (IFP) designers where necessary.

4.6.4 Due consideration must be taken when observing transverse and longitudinal obstacles in close proximity to the runway because their leading edge may have greater significance than the highest point. (It must be appreciated that the highest object might not be the most important for consideration, see Figure I-4-1)

4.6.5 Fine obstacles such as lightning conductors or aerials that surmount the object may not be visible over a distance. Therefore, care must be taken when observing distant obstacles to ensure that the highest point is heighted.

4.6.6 Temporary obstacles encountered at the time of survey should be included and

identified as temporary. A statement should be included in the Survey Report stating the temporal extent of all such obstacles.

4.6.7 When submitting the report, the surveyor should include details of all obstacles surveyed, whether they penetrate the relevant surfaces or not.

4.6.8 The location of the obstacle shall be provided as lateral, longitudinal distance along with top elevation with respect the associated runway threshold.

4.7 PRESENTATION OF OBSTACLES

4.7.1 Definitions

Obstacle: All fixed (whether temporary or permanent) and mobile objects, or parts thereof, that are located on an area intended for the surface movement of aircraft or that extend above a obstacle limitation surface defined in Annex 14 / S.O 84(E) intended to protect aircraft in flight except where no obstruction penetrates the OIS/OLS; it shall be the highest object within the area.

The controlling obstacles as defined for existing approach/departure procedures must be surveyed to the absolute accuracy specified in Part II of this document.

4.7.2 SPECIAL CASES

4.7.2.1 Catenaries

In most cases, the position and elevation of supporting towers will adequately represent catenaries. These towers shall be treated as any other potential obstruction. However, if one or both towers are outside the limits of the Obstacle Identification Surface (OIS), the catenary itself may become a significant obstruction. In these cases, a position and elevation shall be provided on the imaginary straight line connecting the tops of the two adjacent catenary support towers at the highest point within the OIS. The elevation of this point shall be carried as an estimated maximum elevation (EME).

4.7.2.2 Vehicular Traverse Ways

In general, a vehicular traverse way shall be treated as any other potential obstruction, except that the appropriate vehicle height allowance must be included in the elevation. (See "Obstruction Exemptions" in this subsection for possible exemptions that may apply to vehicular traverse ways and Subsection 10, for additional requirements concerning vehicular traverse ways as Vehicle Height Allowances follow:

- State roads 5.0 Metre
- Railroads 7.62 Metre

4.7.2.3 Mobile Obstructions

Representative obstructions that are mobile within a defined area (except vehicles on roads and railroads, which are treated under separate headings) shall have their obstructing travel limits determined. An estimated maximum elevation (EME) shall be furnished for each of these obstructing mobile object areas. If a non-obstructing mobile object is outward from the runway end, is the highest object in the first 2,000 feet of an approach, and is higher than the runway end, an EME point shall be provided at the point nearest to the runway centerline end. Travel limits need not be determined. The word "MOBILE," which always implies an EME, shall be included in the object name, such as, "MOBILE CRANE". (See Subsection 10 and Figure 2.7 & Figure 2.8 for proper depiction of mobile objects on AOC survey products).

4.7.2.4 Obstructions under Construction

Representative objects that are under construction should be identified as being under construction, such as, "BUILDING UNDER CONSTRUCTION". The elevation at the time of the survey shall be carried. However, if a construction crane extends above the feature under construction, it is necessary and sufficient to carry the elevation and position of the crane.

4.7.2.5 Obstruction Exemptions

The following obstructions are not required to be measured:

- Annual vegetation, such as annual weeds, corn, millet, and sugar cane
- Frangible objects under the control of airport authorities within locations fixed by function. Examples are runway & taxiway signs, and many approach light structures
- Construction equipment and debris, including dirt piles and batch plants, that are:
 - ✓ temporary in nature,
 - ✓ under control of the airport authorities, and
 - ✓ located on airport property
- Parked aircraft: The survey report will provide aircraft movement and apron areas and approximate location. However, the location and max elevation of individual parked aircraft cannot be determined and shall not be provided. This exemption does not apply aircraft permanently parked or display.

4.8 Frangible objects

4.8.1 All **frangible objects** are **not covered** under this program. Frangible objects are objects designed to breakaway such as, runway marker signs, taxiway signs, wind socks, anemometres, approach light systems, etc.

4.8.2 Frangible navigational aids (except those specified in paragraph 2, Airfield Features), meteorological apparatus, parked aircraft, and mobile or temporary objects (i.e. construction equipment, dirt/debris) need not be surveyed.

4.9 Obstruction selection

Required objects/obstructions that need to be surveyed are specified in the following paras.

4.9.1 Runway strip/clear Zone

Normally there should not be any obstacle on the strip except the frangible obstacle associated with air navigation. However, where the strip width is less than 280m there may be obstacles like hangars, trees, boundary wall, and other buildings which need to be surveyed and identified. Any obstacle of height greater than 0.9m AGL should be surveyed.

4.9.2 Approach Surface

- The highest obstruction/object that is both within the first 600 m of an approach area and higher than the runway approach end. This object may or may not penetrate the approach surface and may be a non-obstructing estimated maximum elevation (EME) point.
- All the penetrating obstruction/object in the first 3000m of an approach area. The most penetrating and the highest obstacles to be identified. **(When there are multiple obstructions/objects that penetrate the slope at an equal value highlight the one closest to the approach end of the runway).**
- All the obstacles penetrating approach surface beyond 3000m. The highest approach obstruction/object, **and the most penetrating (may also be the highest)** in: (1) 3000m - 6000m, (2) 6000m - 9000m and (3) 9000m - 12960m. **(When there are multiple obstructions/objects that penetrate each zone at an equal value, highlight the one closest to the approach end of the runway).**

4.9.3 Transitional Surfaces

This surface is located very close to the runway and may extend partly outside the airport boundary. It should not be permitted to be penetrated by any man-made obstacles. However, survey must be conducted to identify the natural as well as manmade highest and most penetrating obstruction/object in each 900m (approximately) of transitional surface. If there is no penetration, the highest obstacle at the interval of 900m on the either side of runway centre line from the beginning of the runway will be identified. **(When there are multiple**

Obstructions/objects that penetrate the transition surface at an equal value, depict the one closest to the runway)

4.9.4 Inner Horizontal, Conical, Outer Conical and Outer Horizontal Surfaces

- All the obstacles penetrating the inner horizontal, conical / outer conical or outer horizontal surface to be identified and indicated.
- If no penetration takes place, the highest obstacle in respect of each surface **to be specially identified** in each quadrant of the runway area as defined by the meridian and parallel intersecting at the center point of the runway.

4.9.5 Outer Transitional Surfaces

- All obstruction/object penetrating the outer transitional surface and the most penetrating (may also be the highest) to be specially identified. If no penetration takes place, the highest obstacle to be identified.

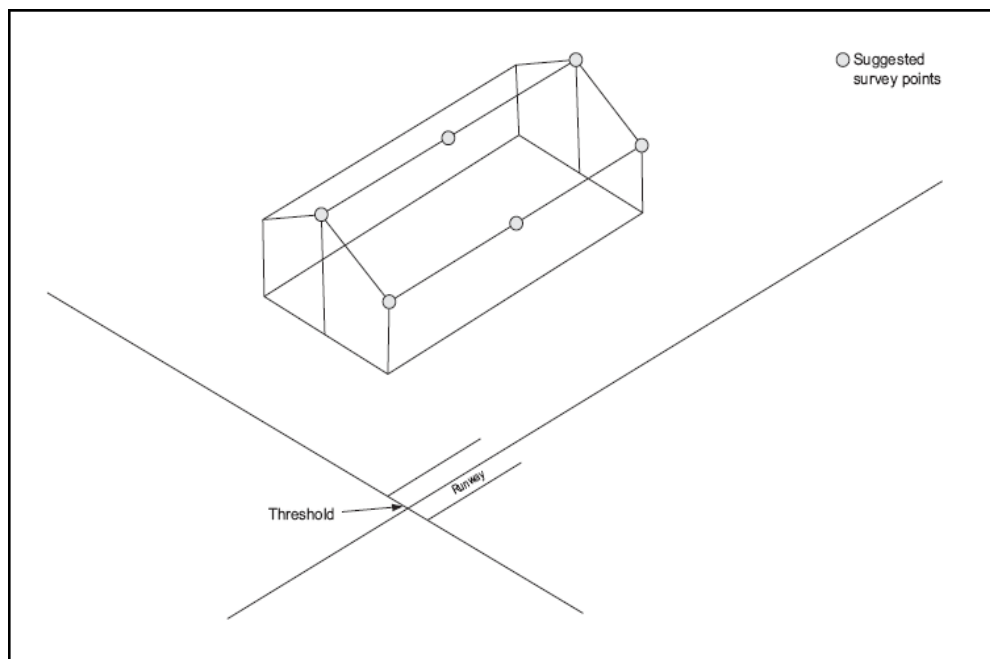


Figure I-4-1 Transverse and longitudinal obstacles

Chapter 5: DOMINANT OBSTACLE SURVEY AREAS

5.1 PURPOSE

The purpose of dominant obstacle survey areas is to provide obstacle information to the instrument flight procedure designer for the assessment of obstacles in the areas listed below:

- i. Final and missed approach areas of Non-Precision Instrument Approach Procedures applicable to:
 - Surveillance Radar - termination range 2 NM
 - NDB (Non-directional Radio Beacon),
 - VOR and VOR/DME,
 - RNAV(LNAV, LNAV/VNAV)
- ii. Visual Manoeuvring (Circling) Areas.
- iii. Departure Areas 1 and 2.

5.2 SURVEY SPECIFICATION

5.2.1 Non-Precision Instrument Approach Area

5.2.1.1 The survey area is divided into a mosaic of tiles as illustrated in Figure I-5-1. The optimum tile size is 0.5 km x 1 km. However, the survey team may select a tile dimension larger than the optimum after consultation with the procedure designer. The total area has been designed to allow the IFP designer the flexibility to adjust the final approach and missed approach path to gain the best operational advantage in terms of OCH with regard to the local terrain and/or airspace restrictions, against the design criteria laid down in PANS-OPS Doc 8168 Vol II.

5.2.1.2 Obstacles exceeding the height of 45 m above the aerodrome elevation shall only be marked in the each tile. The optimum requirement is to height the three highest obstacles in each tile, thus allowing the IFP designer to calculate the most advantageous Minimum Descent Altitude/Height (MDA/H). However, in analysing the three highest obstacles in any one tile, consideration must be given to other obstacles within the same tile where such additional obstacles are located closer to the nominal flight path of an aircraft approaching or departing an aerodrome.

For example, if there were three chimneys adjacent to each other near the outer edge of the tile furthest from the nominal flight path and there was an office building located within the same tile closer to the nominal flight-path but marginally lower than the three chimneys, then all four obstacles should be declared. Situations may exist where more than three, four or five obstacles are declared within a tile.

5.2.1.3 If it is apparent that there are significant obstacles beyond the 10 km limit, the survey area shall be extended longitudinally to 30 km to take account of such obstacles. A significant obstacle is one that is not shielded by an obstacle closer to the runway as illustrated in Figure I-5-1.

5.2.2 Visual Manoeuvring (Circling) Areas

5.2.2.1 Applicable only at aerodromes with Instrument Flight Procedures.

5.2.2.2 The number of runways in use and the Approach Category of aircraft using the aerodrome shall determine the Visual manoeuvring (VM) areas.

5.2.2.3 The survey areas for consideration are constructed by describing arcs of the appropriate radius as detailed below, centred on the runway ends, and joined by common tangents to form an enclosed area (see Figure I-5-4).

- * Category A aircraft: 3.12 Kilo (1.68 Nautical Miles)
- Category B aircraft: 4.90 Kilo (2.66 Nautical Miles)
- Category C aircraft: 7.85 Kilo (4.20 Nautical Miles)
- Category D aircraft: 9.79 Kilo (5.28 Nautical Miles)
- * Circling area of Cat A/B shall be based on Cat B aircraft.

5.2.2.4 The procedure designer shall advise on circling Category requirements and the sectors to be avoided, if needed, due to presence of high terrain or excessively high manmade obstacles.

5.2.2.5 The survey requirement is to height the three highest obstacles in each segment defined by the extended runway centre lines and aircraft category boundaries (see Figures I-5-2 and I-5-4), thus allowing the IFP designer to calculate the most advantageous minimum OCA/H.

5.2.3 Departure Areas

5.2.3.1 Applicable to runways from which IFR departures take place

5.2.3.2 The Departure survey area is illustrated in Figure I-5-3.

NOTE: Area 2 may vary according to Departure Procedure Design Requirements

5.2.3.3 The survey requirement is to height all obstacles in this area that penetrate the 1:40 slope.

5.3 Digital Data

All surveyed obstacles shall form part of the "Master Obstacles listing" shown in Part III Appendix B.

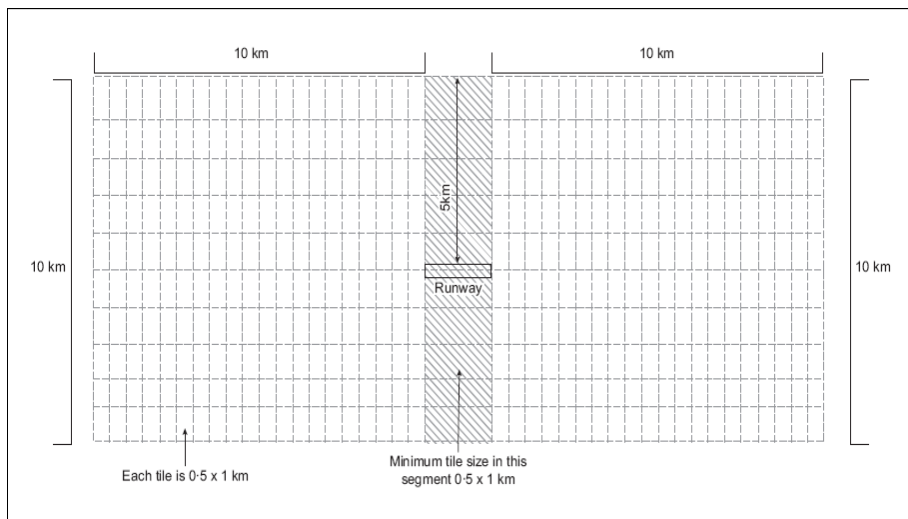


Figure I-5-1 Non - Precision Instrument Approach Area

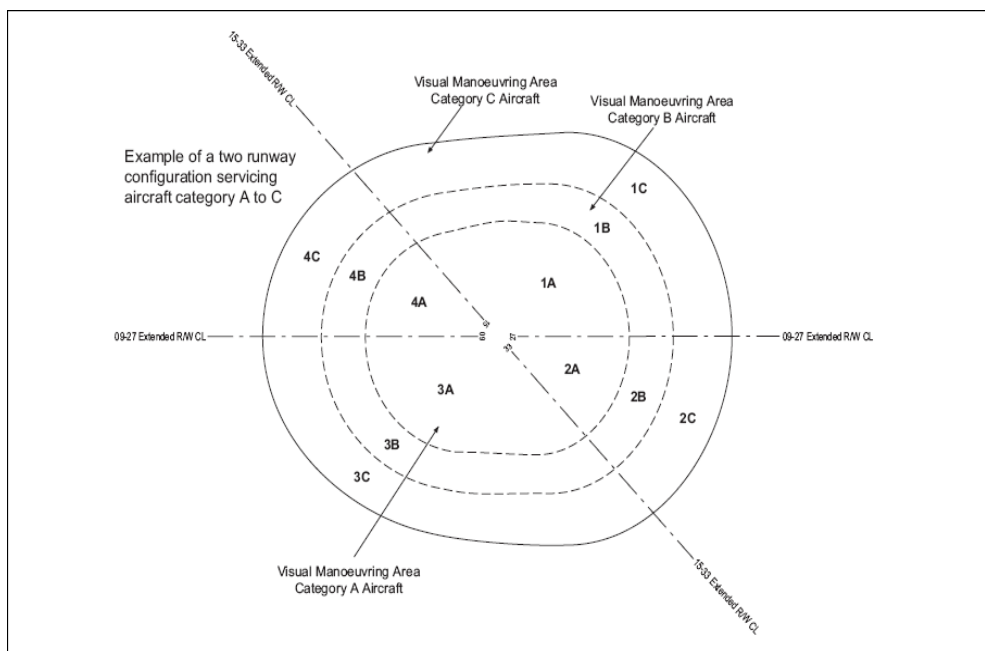


Figure I-5-2 Visual Manoeuvring (Circling) Areas Construction

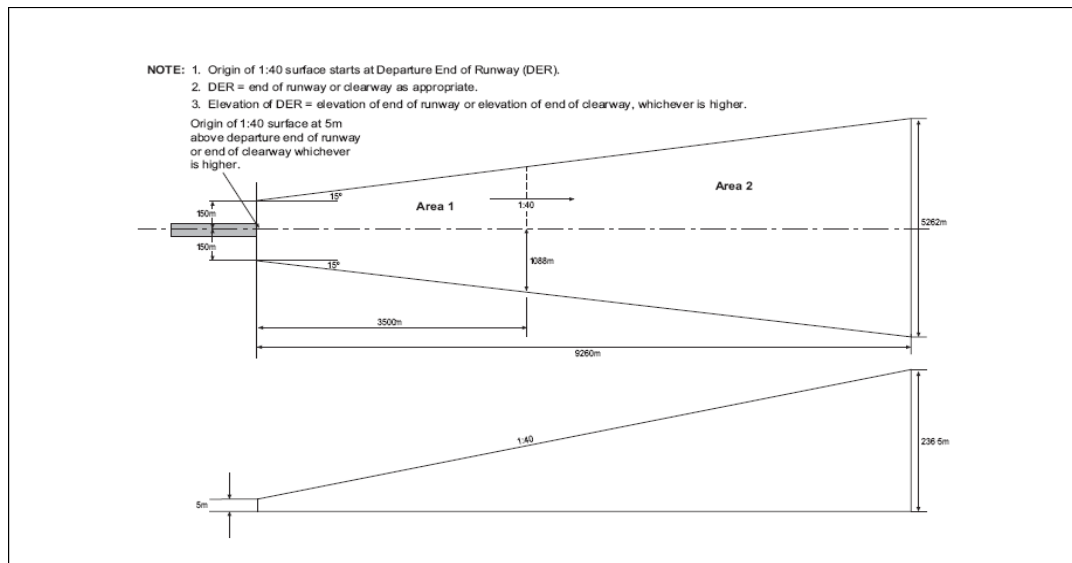


Figure I-5-3 Departure Area 1 and 2

Note: Area 2 may vary according to Departure Procedure Design requirements

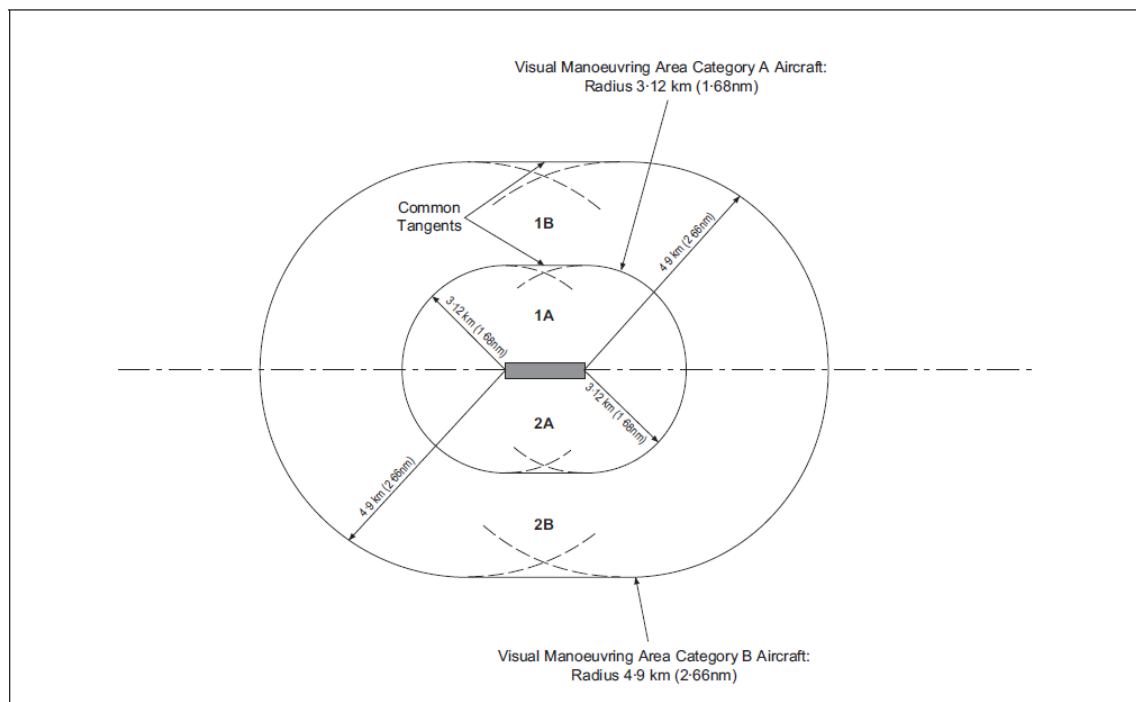


Figure I-5-4 Visual Manoeuvring (Circling) Areas Construction – Aircraft Cat. A and B.

Chapter 6: AERODROME OBSTACLE CHART - TYPE A SURVEY AREA

6.1 PURPOSE

The Type-A chart provides data necessary to enable the aircraft Operator to comply with the operating limitations of ICAO Annex 6 -Operation of Aircraft.

6.1.1 Aerodrome Obstacle Charts - ICAO Type A (Operating Limitations) shall be made available (as prescribed in ICAO Annex 4 Aeronautical Charts) for all runways used by Performance Group A aeroplanes engaged in Public Transport flights. Runways that do not have obstacles in the take-off flight path (TOFP) areas shall be recorded as not requiring a Type A chart

6.1.2 The carto section of AAI will undertake the preparation of the Type A chart from the information supplied by the survey section. No. of obstacles to be shown on the final Type A chart may be determined by the application of shadowing techniques.

6.2 SURVEY SPECIFICATION

6.2.1 Aerodrome Area

6.2.1.1 The elevation AMSL, at the start and end of TORA, end of ASDA and end of TODA, and at regular intervals (maximum 200 along the runway and clearway centreline) shall be provided.

6.2.1.2 Surveyor should be aware of the declared distances (TORA, TODA, ASDA and LDA) of the aerodrome include the same in the Survey Report. If the desired data is not available, it must be obtained from the airport operator before commencing the survey.

6.2.2 Take-Off Flight Path (TOFP) Area

6.2.2.1 The area to be surveyed originates at the end of the TODA. It is 80m at origin, symmetrical about the extended centreline and increases uniformly at a rate of 0.25D to a maximum width of 1800m, where D is the distance from origin. At a distance of 6480m it extends at the maximum width to a distance of 10000m. The elevation of the origin is the elevation declared for the end of TODA (Figure I- 6-1).

6.2.2.2 The flight path plane surface has an upward slope of 1.2% from the origin. (Figure I- 6-1).

6.2.2.3 All objects and terrain within the TOFP area shall be comprehensively analysed. All obstacles that penetrate the TOFP surface shall be surveyed except where such obstacles are in the shadow of others. The shadow of an obstacle is considered to be a plane surface

originating at a horizontal line passing through the top of the obstacle at right angles to the centreline of the TOFP, and extended to cover the complete width of the area. Frangible and mobile obstacles shall not shadow other obstacles. If the obstacle creating a shadow is likely to be removed, objects that would become dominant by its removal shall be surveyed. If the surveyor is unclear as to which obstacles are dominant then all obstacles penetrating the surface shall be surveyed.

6.2.2.4 For runways serving aircraft having operational limitations that do not preclude the use of a gradient less than 1.2%, the TOFP area is increased to 12000m and the slope of the plane surface is reduced to 1% or less. Where the plane of the 1% slope does not touch any objects, it is to be reduced until it touches the first object.

6.2.2.5 The elevation AMSL of any road, railway track or water feature capable of supporting mobile obstacles greater than 4.8m (for waterways the high and low water marks and the height of shipping) shall be surveyed at a regular interval to its full linear extent, until shadowed by the next dominant obstacle if the combined elevation penetrates the TOFP surface. The combined elevation shall be provided.

6.2.2.6 Where the TOFP is at an offset angle(max 15 deg) from the runway extended centreline in order to gain an operational advantage, the area to be surveyed shall be determined by consultation with procedure designer and annotated in the survey report.

6.3 DIGITAL DATA

All surveyed obstacles shall form part of the “Master Obstacles listing” depicted in Annex B. Positional data, and associated elevations, that determines the extent of the declared distances and runway profile shall be included in the ‘Aerodrome Facilities listing’ depicted in Part III Appendix B

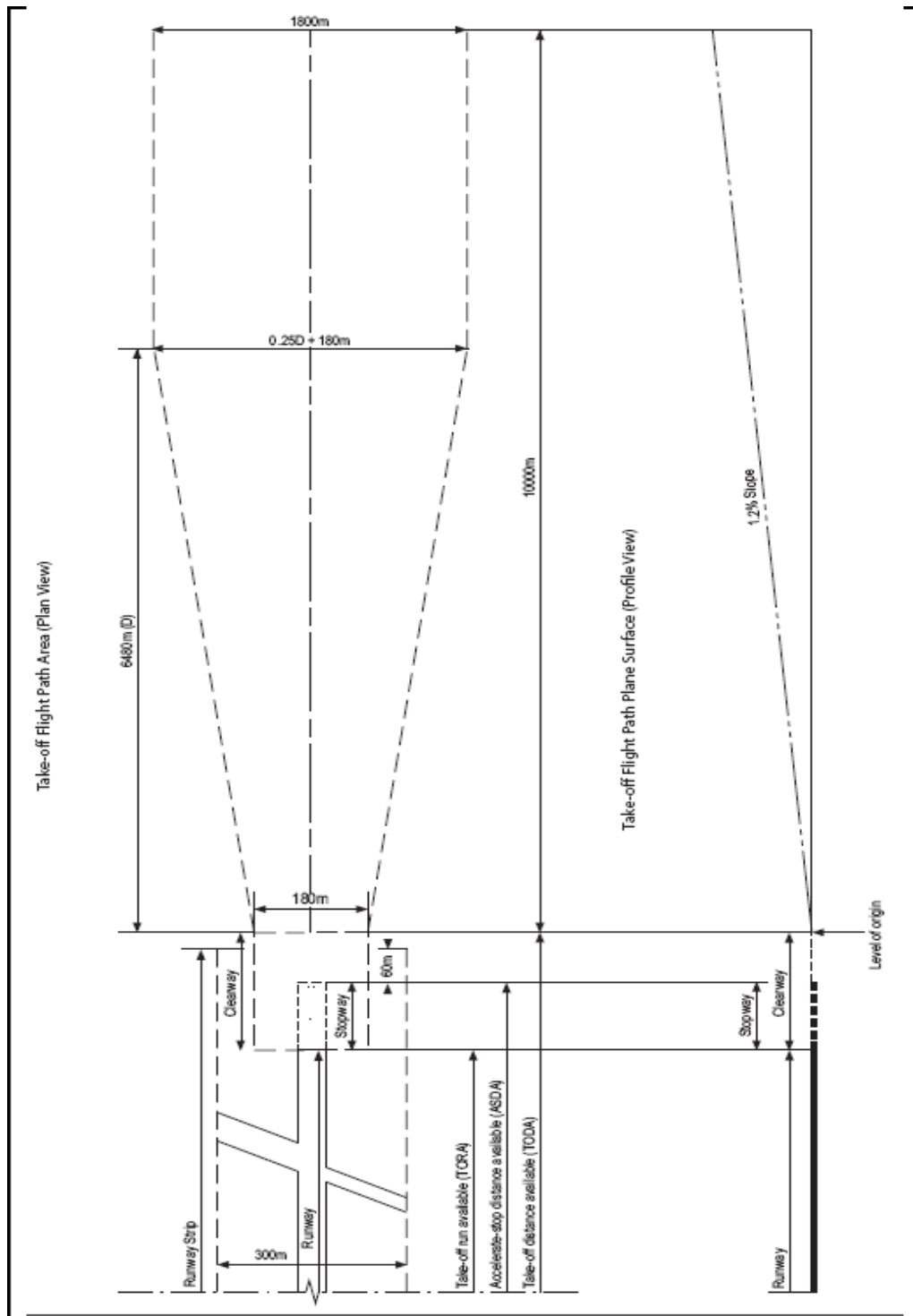


Figure I-6-1

Type A---Take off Flight path area and Plane Surface

Chapter 7: PRECISION APPROACH PROCEDURE SURVEY AREA

7.1 PURPOSE

7.1.1 The survey is to identify obstacles within the Precision Approach area. It provides important data for the safety assessment of Precision Approach procedures and the calculation of obstacle clearance heights based on the basic ILS surface. Basic ILS surfaces are the extension/modification of Annex 14 obstacle limitation surfaces and are defined in DOC 8168 Vol. II.

7.1.2 The survey provides data for use in connection with the following precision approach procedures:

- ILS (including Offset Localiser facilities)
- ILS Localiser only approach procedures
- In the case of offset* facilities (where the localiser is not aligned with the extended runway centreline), procedure designer should be consulted on the alignment of the survey area required.
(* At present there is no offset localiser installed in India)
- LPV (SBAS approaches)

7.2 SURVEY SPECIFICATION

7.2.1 The ILS Basic Surfaces area is illustrated in Figure 8. The dimensions (lateral, longitudinal and vertical) remain fixed for all the Runways and are applicable up to Cat I approaches. All the three dimensions are referenced to the Threshold of the associated runway.

7.2.2 The survey requirement is to height all obstacles in this area that penetrate the surfaces and provide the location w.r.t. threshold of associated runway as longitudinal, lateral and vertical distances. The procedure designer may identify the most critical obstacle affecting the OCA/H of the procedure and suggest the removal in order to improve the efficiency of the system.

7.3 DIGITAL DATA

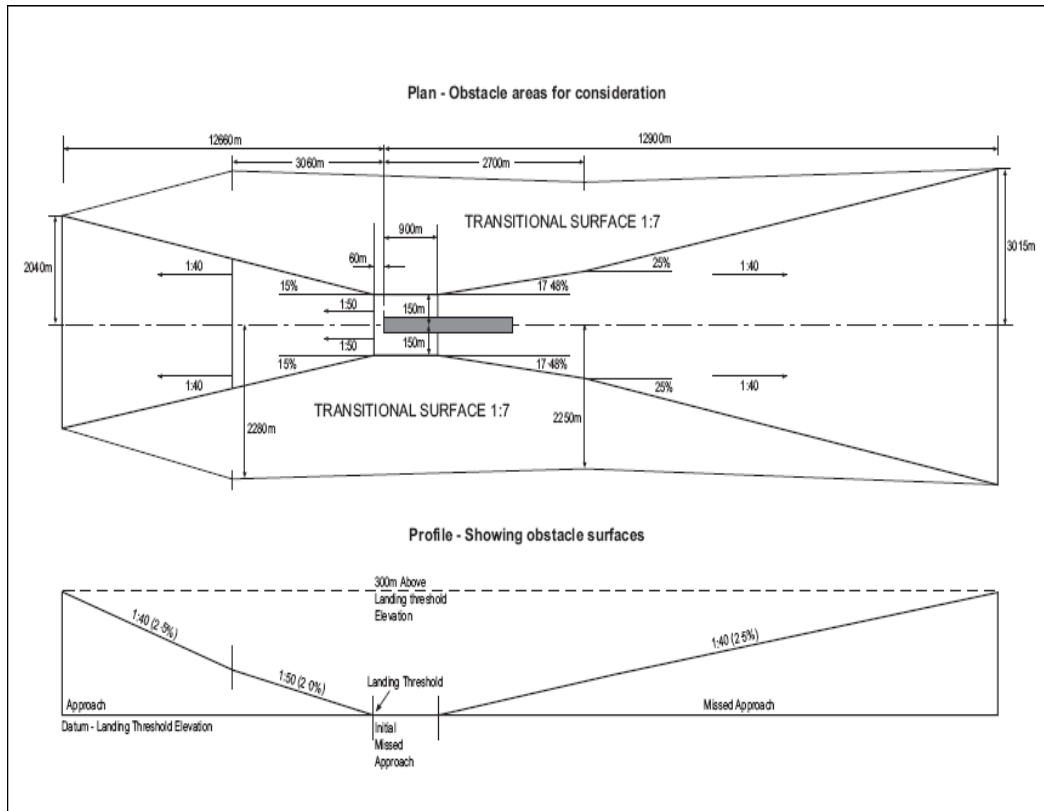


Figure I- 7-1 Basic ILS Surfaces

Attachment I to Chapter 7: METHODOLOGY OF MODELLING OBSTACLES

(For information only) for ILS CRM

1.0 INTRODUCTION

The ILS Collision Risk Model (CRM) requires position and dimension data for all relevant obstacles. The data can be entered in the co-ordinate system (x,y,z) or converted from

2.0 DESCRIPTION OF ARTIFICIAL OBSTACLE

For processing by the CRM, obstacles must be of a specific form : either as a spike or a wall as shown below (see I-7-A7-1).

For the purposes of the CRM, therefore, obstacles after adjustment (see paragraph 5) have height and width but do not have length.

3.0 SIMPLE OBSTACLE MODELLING

Obstacles are usually of a complex shape, unlikely to be orientated at right angles to the line of approach, and may well extend longitudinally for considerable distance. These can be expressed as a number of simple obstacles as spikes or a series of walls (see Figures I-7-A7-2 and I-7-A7-3). In general obstacle modelling should be as simple as possible with conservative dimensions assigned.

4.0 SOPHISTICATED OBSTACLE MODELLING

4.1 If analysis of the CRM results shows that the precise shape of an obstacle is critical with respect to the total risk, a more sophisticated obstacle model may be required as detailed below:

- i. Construct lines parallel to the x axis through y_1 and y_2 , the outer edges of the obstacle in the y axis. The perpendicular distances from these lines to the x axis are the lateral boundary dimensions,
- ii. The height (z) of the obstacle is taken to be that of the highest point above threshold elevation
- iii. The range (x) is the perpendicular distance from the obstacle boundary

point nearest to the threshold.

4.2 If a solid obstacle is modelled by spike obstacles, lateral spacing should be not more than the wing span of the largest Aircraft likely to use the airport.

4.3 If the difference between the most distant point and the nearest point of the obstacle to the threshold exceeds 100m, the obstacle should be partitioned into a series of wall obstacles separated by no more than 100m in range. The height assigned to such a "wall" obstacle should be the highest elevation of the obstacle in the area away from the runway. In cases where the obstacle height varies with distance from the centre line, each wall may be broken up into two or more adjacent walls

5.0 CONSIDERATIONS ON ACCURACY

Consideration should be given to the accuracy with which the obstacle data has been collected. Suitable adjustments should be made to take account of inaccuracies in the obstacle data; these should result in a greater height, a smaller (absolute) range, and a smaller (absolute) lateral displacement. If these adjustments lead to unacceptable operational penalties, more accurate surveying may reduce these penalties. In addition adjustments for such things as tree growth may be taken into account by adding a tolerance to the height.

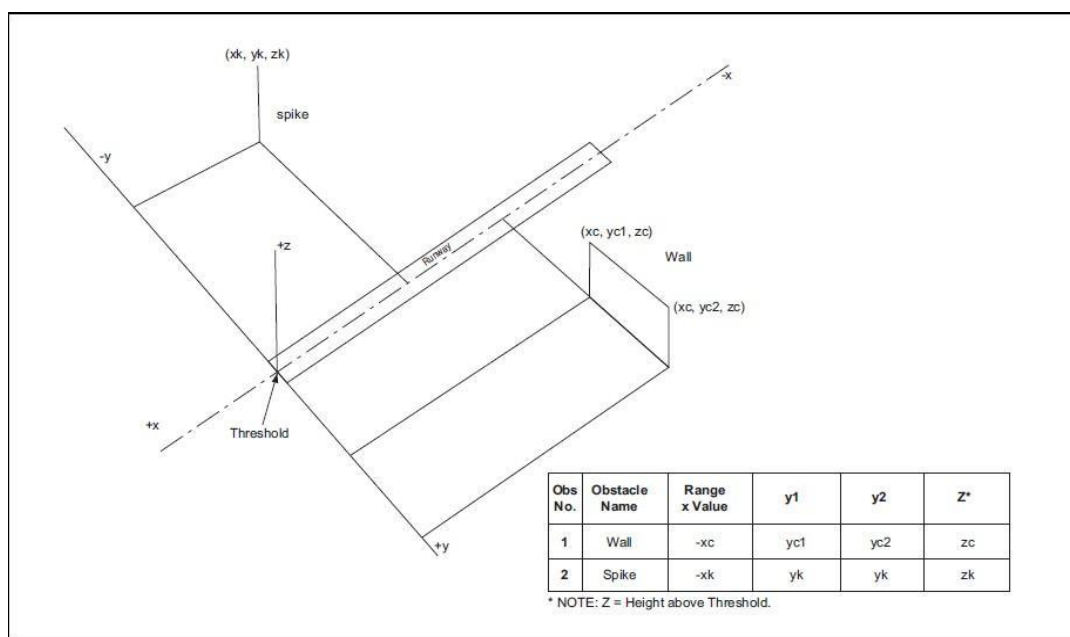


Figure I-7-A1-1 Spike and Wall Obstacle as required by ILS CRM

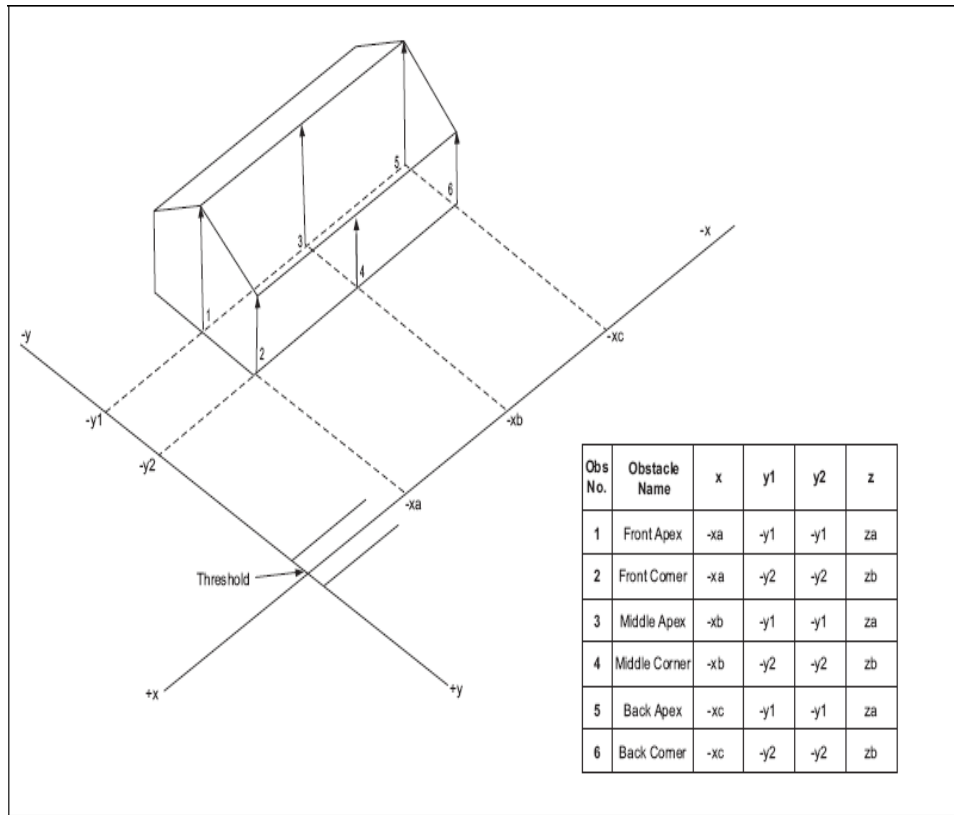


Figure I-7-A1-2 Modelling of obstacle for ILS CRM

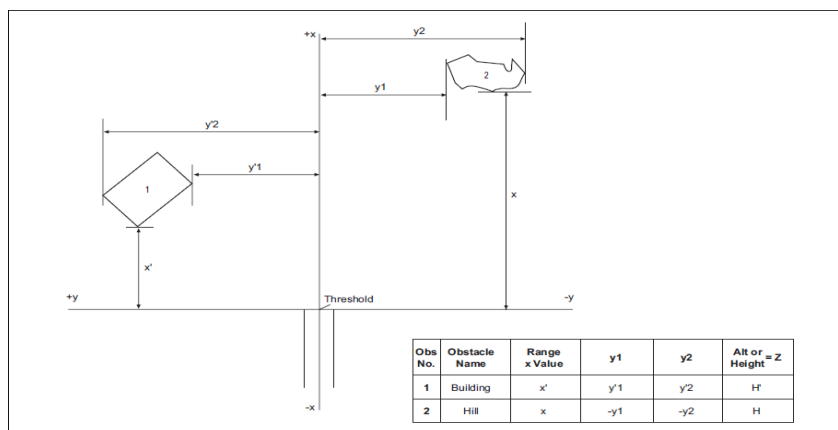


Figure I-7-A1-3 Example of irregular shaped Obstacle

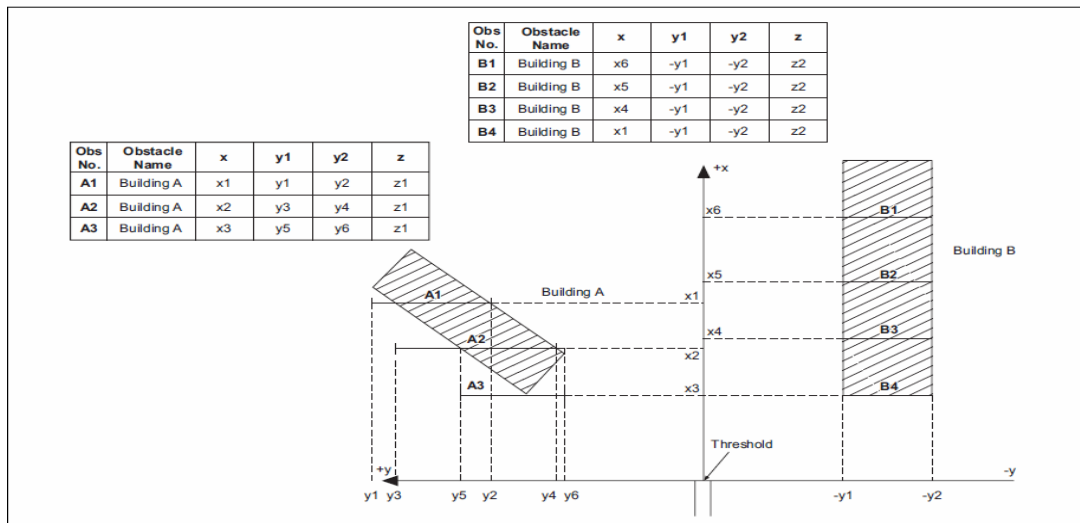


Figure I-7-A1-4 Partitioning of Continuous Obstacles (Buildings)

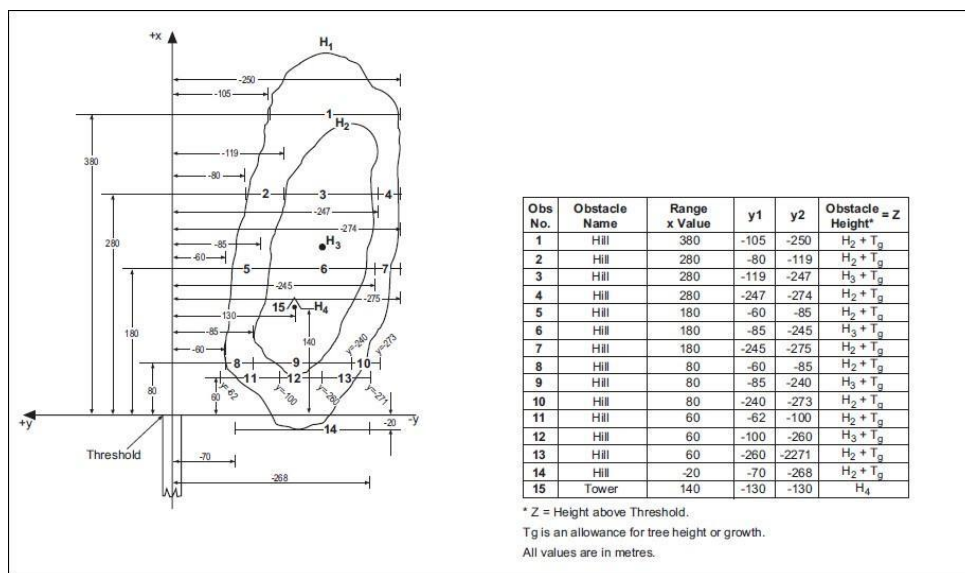


Figure I-7-A1-5 Partitioning of Continuous Obstacles (Hills)

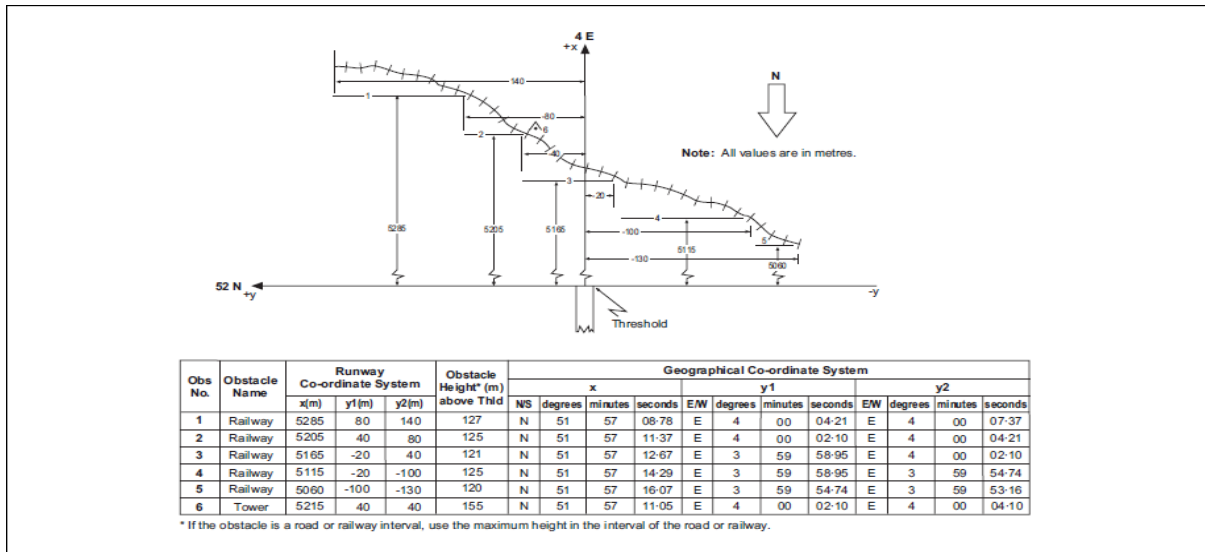


Figure I-7-A1-6 Prtitioning of Continuous Obstacles (Railways)

Chapter 8 : PRECISION APPROACH TERRAIN CHART SURVEY AREA

8.1 PURPOSE

8.1.1 The Precision Approach Terrain Chart (PATC) provides a detailed terrain profile of the final portion of a Precision Approach. It provides information to enable the evaluation of the effects of the terrain on decision height determination using radio altimeters.

8.1.2 It is a mandatory requirement for aerodromes that conduct Cat II and III precision approaches to provide data for the preparation and publication of the PATC.

8.2 SURVEY SPECIFICATION

8.2.1 The area for survey starts at the runway threshold and extends for a distance of 900m to the approach, 60m either side of the extended runway centre line (see Figure I-8-1)

8.2.2 Features to be surveyed:

- a) Runway threshold and elevation
- b) Extended runway centre line terrain profile
- c) All features including mobile features that are 10ft, or greater, above or below the extended runway centre line terrain level and with a horizontal dimension of more than 15m measured parallel to the runway centre line
- d) Terrain contours at 3ft contour intervals related to the runway threshold height
- e) Roads, railways, river or canal features shall have sufficient levels to show their surface elevation, (in the case of a body of water subject to tides, high and low tidal variations are required) and the height of the highest mobile feature that could be expected on them. The features shall include vegetation, hard, mobile and temporary object

8.3 SURVEY CHART PRESENTATION

8.3.1 The base map shall be at a scale of 1:2500 or where the area has been extended it shall be at 1:5000. The accepted format is listed in Chapter 3, paragraph 1.

8.3.2 The chart will show the survey area in plan view at either of the above scales and in cross section profile at a recommended scale of 1:500. (If the area is flat, a larger profile scale may be used).

8.3.3 The chart shall reflect the position, height and shape of all features that fall in the category as described in paragraph 8.2.2 (see Figure I-8-1) of this chapter.

8.4 PUBLISHED CHART

The survey information shall be issued to the Aerodrome Operator for verification and the data passed to AAI for preparation and publishing of final chart determining the value of decision height (DH).

8.5 CHART MAINTENANCE

8.5.1 It is the responsibility of the Aerodrome Operator to monitor any changes in the approach terrain profile. If significant changes occur the Aerodrome Operator shall notify AAI (CHQ) to take the NOTAM appropriately and amend the OCA/H and consequently decision height, if necessary.

Note: Any increase in the decision height may raise the RVR/visibility minima for the particular runway and thus adversely affecting the operations.

8.5.2 All changes in the profile that exceed the following limits shall be recorded:

- a) Changes in slope of 12.5% or more over a distance of 15m or more
- b) Changes in the contour height of 10ft or more (increase or decrease) and over 15m to the defined approach area
- c) All features as stated in paragraph 8.2.2.

NOTE: It is important that both increases and decreases in elevation are significant.

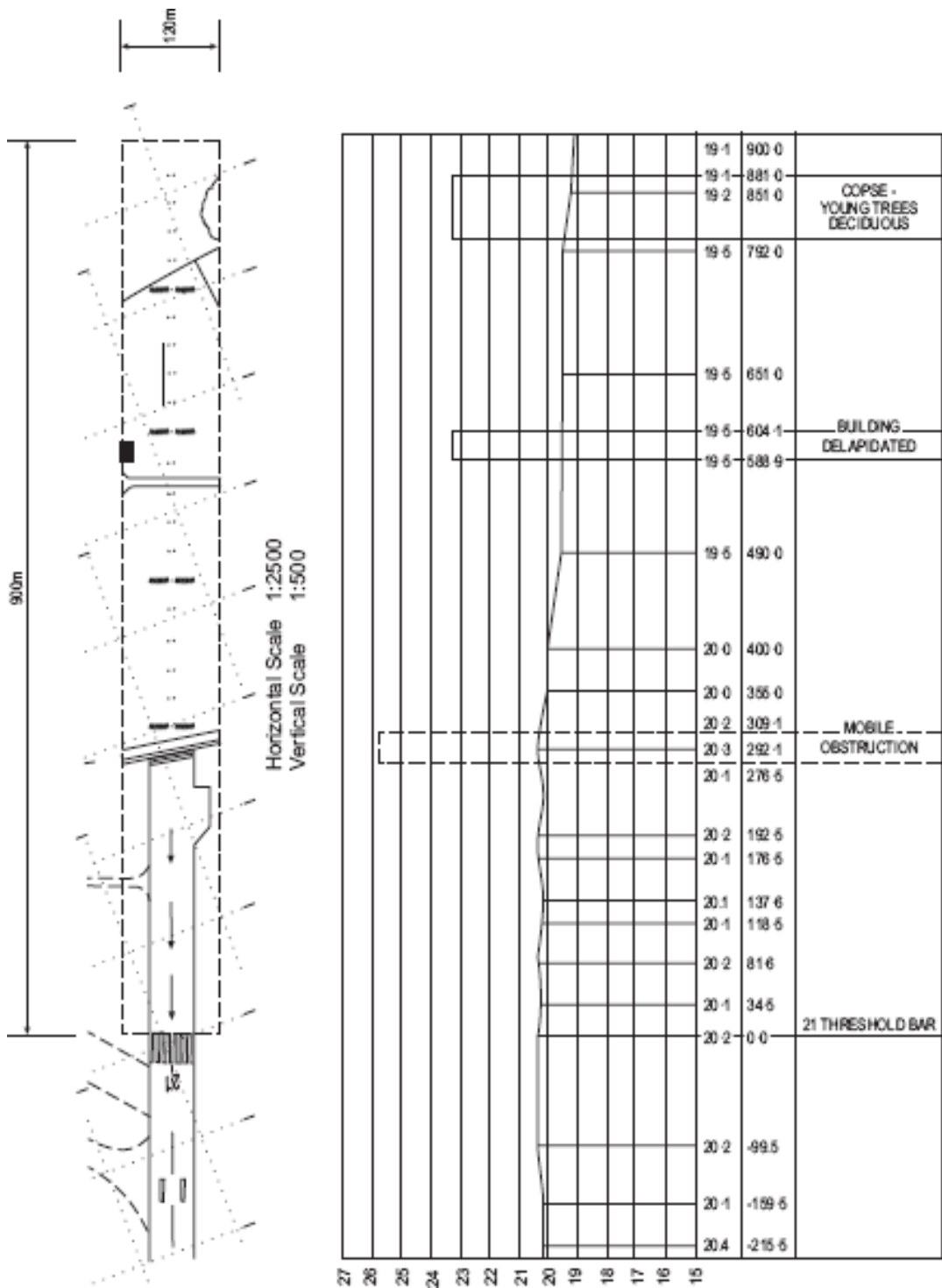


Figure I- 8-1

Precision Approach Terrain Chart

Chapter 9 : PAPI / APAPI SITE SURVEY AREA

9.1 PURPOSE

The survey is required to provide data to assist in the calculation for the siting of PAPI/APAPI units on initial installation. Full details are contained in Annex 14 and Aerodrome manual part 4. PAPI/APAPI surveys do not form part of the full and check survey procedures.

AERONAUTICAL SURVEY MANUAL

PART II: Implementation of WGS- 84 co-ordinates System

Chapter 1: INTRODUCTION

1.1 EFFECTS OF USING DIFFERING COORDINATE REFERENCE SYSTEMS IN AVIATION

1.1.1 Datum problems in air navigation were first encountered at EUROCONTROL in the early 1970's during the development of multi-radar tracking systems for the Maastricht Upper Airspace Centre (UAC), where plot data from radars located in Belgium, Germany and the Netherlands were processed to form a composite track display for air traffic controllers (ATC). Discrepancies in the radar tracks were found to be the result of incompatible coordinates.

1.1.2 In the mid-1970's, during trajectography experiments with the French SAVVAN System (Système Automatique de Verification en Vol des Aides a la Navigation, i.e. Automatic In-flight Navigation Aids Checking System) positional 'jumps' were noticed when switching between Distance Measurement Equipment (DME) transponders located in different countries. Once more, the errors could only be attributed to incompatibility of the coordinates of ground aids.

1.1.3 If a ground-based radar navigation aid is coordinated in two or more different reference frames, aircraft horizontal position determination will have two or more different sets of latitude and longitude values. In metric units the two aircraft locations could show a discrepancy of up to several hundred metres when simultaneously located and tracked by two radars: Radar 1 and Radar 2 (see Fig II-1-1). This could lead to a situation an aircraft, close to a border between two countries with different reference frames, could be seen by radars in the two countries as having different positions with the potential for misinterpreting inter-aircraft separations and clearances from restricted areas etc.

1.1.4 Thus the main source of systematic errors is the non-use of a common geodetic reference datum for quoting the radar positions and its solution is to derive the radar positions in a common system.

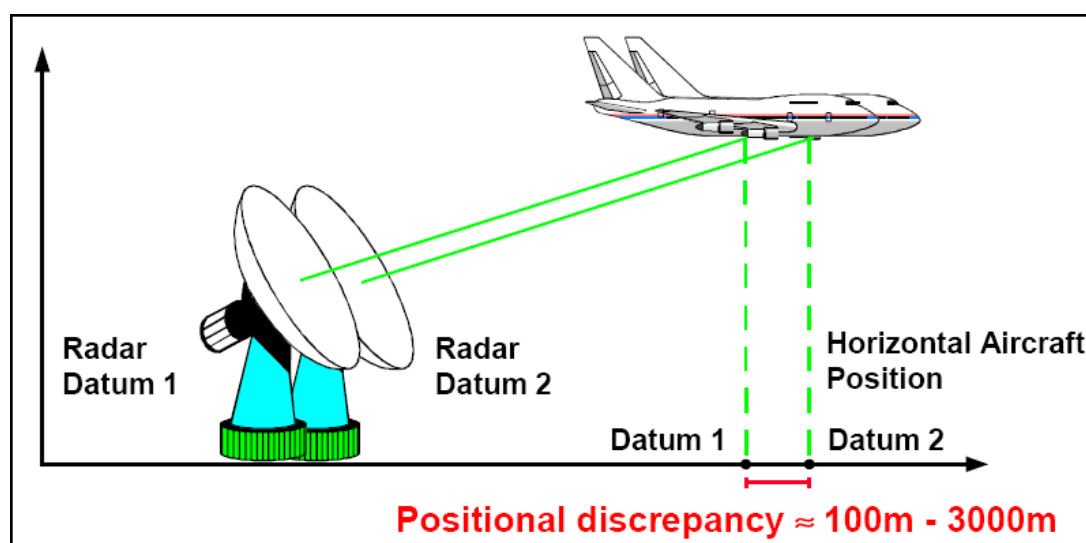


Figure II- 1-1 Datum problem in air navigation

1.1.5 There are many geodetic reference datum's in use throughout the world providing references for the charting of particular areas. Each datum has been produced by fitting a particular mathematical Earth model (ellipsoid) to the true shape of the Earth (geoid) in such a way as to minimize the differences between the ellipsoid and the geoid over the area of interest.

1.1.6 Most ellipsoids in current use were derived in the last century and were normally referenced to a local observatory. These different datums and ellipsoids produce different latitude and longitude grids and hence, different sets of geographical coordinates. Different countries developed their own geodetic datums which usually differed from those of adjacent countries. As distance requirements increased beyond national boundaries, new requirements arose from datums on at least continental scale.

1.1.7 If we look at the current situation, we have to acknowledge that in the enroute environment the use of ground-based navigation aids in different reference frames does not have any significant effect since the primary means of navigation remains the use of VOR or NDB signals to define radial tracks to or from the beacon with turning points either at the beacon or at a distance from it defined by the DME. In such circumstances the published co-ordinates do not affect the track flown by the aircraft. Nevertheless, this will change dramatically either in the approach phase or landing, or where reduced lateral aircraft separation is implemented, i.e. the future Area Navigation (RNAV) or RNP (Required Navigation Performance) systems with higher accuracy and integrity requirements. Therefore, these discrepancies will no longer be tolerable and demand the introduction of a common geodetic reference system.

1.1.8 The United States Department of Defence (World Geodetic System Committee) has defined and developed a number of geocentric reference systems, to which other geodetic networks may be referred. The continued development using increasingly available satellite information has resulted in the World Geodetic System - 1960 (WGS-60), 1966 (WGS-66), 1972 (WGS-72) and the current definition, 1984 (WGS 84).

1.2 MAGNITUDE OF THE PROBLEM

As already outlined, the datum discrepancies between one geodetic reference frame and another depend upon :

- a) Order of magnitude of the three origin shifts
- b) Magnitude of the three axial rotations
- c) Scale factor value
- d) Shape of the reference ellipsoid (if working in geographical coordinates). For

historical reasons almost all countries already have a national reference frame with a specific set of datum parameters. The datum discrepancies range from to kilo.

1.3 NAVIGATIONAL IMPLICATIONS

1.3.1 Geographical coordinates used in the aviation environment today are generally of two types, i.e. ground-derived coordinates and navigation-system derived coordinates. Ground-derived coordinates are those that are obtained through surveys, calculations and measurements. They are published by the civil aviation authorities in documents and charts made available to the public. Navigation-system derived coordinates, on the other hand, are coordinates generated by the airborne systems from accelerometers and ground-based or satellite-based signals.

1.3.2 Ground-derived coordinates (Latitude and longitude) are determined with measurements and calculations on mathematical reference models. These models represent the shape of the Earth in a particular geographic region and are called geodetic datums. For example, coordinates used by civil aviation in the United States are mathematically referenced or calculated to the North American Datum (NAD), in Japan to the Tokyo datum and in Europe to the European Datum (ED). Each of these datums use a different mathematical model that "best fits" or provides the best representations of the Earth's shape in that specific geographic region. Even though aviation documents seldom publicise a geodetic datum, it is common practice for a State to use a specific datum for all mapping, charting and geodetic activities. The mathematical parameters of these datums differ, the location of the centre of each datum differs and, except for those countries which have already converted to the use of an earth centred datum, none of the datum centres coincide with the centre of gravity of the Earth.

1.3.3 Unlike ground-derived coordinates, navigation-system derived coordinates are Earth-centred. The Inertial Navigation System (INS) uses accelerometers on a gyro or laser ring stabilized platform to sense movement and determine aircraft position. The alignment of the platform relates to the Earth's centre of mass and rotation resulting in INS-generated coordinates that are referenced to the Earth's centre. This means that published coordinates as referenced to local geodetic datums will not compare, directly, with INS-generated coordinates. Because INS is aligned with local coordinates before take-off, it is most accurate within the area defined by the local datum. Inter-datum flights up to the present, have not been hindered by which is small compared with the drift of the INS on the en-route phase of long distance flights.

1.3.4 Coordinates derived by the Global Navigation Satellite System (GNSS) airborne system from signals received from satellites will be Earth-centred because the GNSS satellites operate with an Earth-centred reference model, WGS 84. GNSS coordinates will not compare with coordinates based on local geodetic datums except in areas where coordinates have been readjusted to an Earth-centred datum. This means that the difference between the coordinates of a point referenced to a local geodetic datum and the coordinates of that same point referenced to the Earth-centred WGS 84 datum has to be taken into account.

1.4 APPROVED SOLUTION TO THE PROBLEM

1.4.1 The solution to the problems in chapter 1.1 to 1.3 is the implementation of WGS 84 as a common geodetic reference frame. The first step in the implementation of any coordinate transformation proposal will be always an inventory. In order to make an assessment of the current quality of the published geographical coordinates of aeronautical facilities required for air navigation, it is necessary to review all existing data.

1.4.2 A survey inventory questionnaire designed for this purpose has already been developed by EUROCONTROL. Information provided by the use of such a questionnaire will allow the identification of those items for which a field survey is required in order to verify positions

1.4.3 This will allow accurate estimates to be made of the survey work that will need to be carried out. Analysis of the questionnaire data will identify the navigation aids and aerodrome points and facilities which need to be re-surveyed. Where coordinates are known to the required accuracy and integrity it will allow direct transformation to the WGS-84 geodetic reference frame by mathematical means.

1.4.4 In principle there are two approaches which can be used as stand-alone or combined methods to transform a survey given in adequately precise national coordinates to WGS 84 (or to a reference frame compatible with WGS 84 being earth centred and having a sufficient accuracy. Suitable reference frames would be the International Terrestrial Reference Frame (ITRF) and a local version of this called the European Terrestrial Reference Frame (ETRF) :

- a) Surveying at least three control stations (covering the area under consideration) to obtain WGS-84 coordinates, and determining the datum parameters between the national reference frame and WGS-84
- b) Determining by a computational datum transformation WGS 84 coordinates for all remaining points.

The two general groups of air navigation points which have to be surveyed are shown in Tab.II-1-1

1.4.5 In the preceding paragraphs the horizontal element is considered as WGS-84 geodetic system. However WGS-84 is a three dimensional reference frame coordinated in X, Y, Z, or in Φ , λ and h. Geographical coordinates are expressed in Lat. Φ and Long. λ while parameter h is a geometric (ellipsoidal) height above the WGS-84 ellipsoid.

1.4.6 GNSS derived heights are referenced to the WGS-84 ellipsoid which will usually differ from the normal (orthometric) height at the same point. The difference will be of significance in the aerodrome environment when navigating with GNSS sensors. The difference between orthometric height (geoid height, elevation) and WGS-84 ellipsoidal height must therefore be made available to the aviation community. The height that separates geoid and WGS-84 ellipsoid is the geoid undulation

1.4.7 Geoid undulation is required for airport elevations, runway thresholds and touchdown and lift-off areas (TLOFs) or thresholds of final approach and take-off areas (FATOs) at the heliports.

Table II-1-1 Air navigation – related coordinates of interest

| AREA/EN-ROUTE COORDINATES | AERODROME/HELIPORT COORDINATES |
|------------------------------------|---|
| ATS/RNAV routes | Aerodrome/ Heliport Ref. Points |
| Holding points | Runway/FATO Thresholds |
| En-route Radio Nav Aids | Terminal Radio NavAids |
| Restricted/Prohibited/Danger areas | FAP, FAF and other IAP essential points |
| Obstacles - En route | Runway centrelines points |
| FIR boundaries | Aircraft standpoints |
| CTA, CTZ | Aerodrome /heliport obstacles |
| Other significant points | |

Chapter 2: ACCURACY, RESOLUTION AND INTEGRITY OF AERONAUTICAL DATA

2.1 GENERAL

2.1.1 Traditional navigation techniques have relied upon the ability to fly to or from point navigation aids. Whilst the coordinates of the navigation aids have been provided, this information has not been used as part of the navigation process. Increasing use is being made of Area Navigation (RNAV) systems which derive the aircraft position from such sources as Inertial Navigation Systems (INS), Omega, VHF Omni-directional Range (VOR)/Distance Measuring Equipment (DME), Dual or multi DME and Global Navigation Satellite Systems (GNSS). Based on these data, to enable the aircraft to follow the planned route during departure, en-route and approach phases and, potentially with the introduction of GNSS, the landing phases.

2.1.2 For such operations the track actually flown by the aircraft depends upon the coordinates defining both the track and the location of ground navigation aids. With the advent of precision RNAV (RNP 1) routes and the extension of RNAV application to Terminal Area (TMA) procedures, greater precision is required and it is necessary to ensure that the data defining the track to be flown is of an accuracy and integrity which is consistent with the RNP requirements

2.2 TYPE AND CLASSIFICATION OF POSITIONAL DATA

2.2.1 Air navigation points can be divided into two basic groups (as provided in Table II-1-1):

- a) **Area** and/or **en-route** points
- b) **Aerodrome** points

2.2.2 Besides this categorization, air navigation points can be categorized by the type of positional data. Three types of positional data have been defined: *surveyed* points, *declared* points and *calculated* points.

a) Surveyed Points : A surveyed point is a clearly defined physical point, specified by latitude and longitude, that has been determined by a survey, conducted in accordance with standards developed for the implementation of WGS84. Communication facilities; gates; nav aids; navigation check points; obstacles; obstructions and runway thresholds are usually surveyed points.

b) Declared Points : A declared point is a point in space, defined by latitude and longitude, that is not dependent upon, nor formally related to, any known surveyed point.

Airspace boundary points (e.g. FIR), restricted or danger area points and oceanic entry and

exit points are often declared points

c) Calculated Points : A calculated point is a point in space which need not be specified explicitly in latitude and longitude, but which has been derived, by mathematical manipulation, from a known surveyed point. A fix, specified by radial/bearing and range from a known surveyed point such as a nav aid, or by the intersection of a number of radial/bearings from a number of nav aids, is an example of a calculated point. En route waypoints, which are computed from the intersection of great circle routes, or cross radial fixes on great circle routes, are also calculated points, albeit that they are reported in latitude and longitude

The data types are summarized in Tab. II- 2-1.

Type and classification of positional data Tab. II- 2-1.

| TYPE | EXAMPLES |
|------------|--|
| Surveyed | Thresholds, navaids, obstructions, navigation check points, gate positions |
| Declared | FIR/UIR boundaries, reporting points, Prohibited/Restricted airspace |
| Calculated | Waypoints, FAF, FACF, MAPt, ARP |

2.3 SOURCE OF SURVEY / POSITIONAL DATA

It is normally the responsibility of nominated technical branches within the Aviation Authority of a Contracting State to ensure the origination of the raw data required to be promulgated by the AIS (Aeronautical Information Service). On receipt of the raw data, the technical branches must check, record and edit the data so that it can be released in a standard format. Raw AIS data containing positional information can originate from a number of different sources.

a) En Route : The location of navaids and communication facilities (-> surveyed) are normally provided by the owner/operator of the equipment

b) Specific aerodrome information (gate positions, obstructions, etc. -> surveyed) is normally provided by the owner/operator of the aerodrome

c) Airspace divisions and restrictions (-> declared, no survey) may be defined by the national aviation authority, national military authorities or other government

bodies. Such divisions and restrictions may be either temporary or permanent.

d) SID, STAR, Approach / Holding procedures (-> calculated, no survey). These are usually determined by the air traffic service provider responsible for the procedure, in conjunction with the appropriate technical branch responsible for the procedure design within the national aviation authorities.

2.4 ACCURACY REQUIREMENTS

2.4.1 DEFINITION OF ACCURACY: The degree of conformance between the estimated (or measured) value and the true value.

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

2.4.2 For AIS data to be useable, it must be accurate and, in this context, it can be subdivided into two distinct categories:

- a) Evaluated aeronautical data
- b) Reference aeronautical data

2.4.3 Evaluated data include such information as positional data, elevation, runway length, declared distances, platform bearing characteristics and magnetic variation; while reference data include navaid identifiers, navaid frequencies, waypoint names, Rescue and Fire Fighting facilities, hours of operation and telephone numbers.

2.4.4 The accuracy requirement for the reference data is absolute - the information is either correct or it is not. Conversely, the degree of accuracy required of the evaluated data will vary depending upon the use to which the data are to be put. It follows that it is incumbent upon the users of the data to specify the accuracy requirements. This manual only addresses evaluated positional data but many of the procedures may be applied to other evaluated data and to reference data, if required. The requirements on data, which shall be contained within the data processing procedures are explained in more detail in Chapter 5.

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

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

2.4.6 The Circular Error Probable (CEP) is the radius of the circle within which 50% of the measurements lie, that is, 1.1774 s. The radius within which 95% of the measurements lie is 2.448 d or 2.079 x CEP. The following Tab.II- 2-1 relates s error-values, probable errors and probabilities in one, two and three dimensions.

2.4.7 The RNP types (see Tab. II-2-2) specify the navigation performance accuracy of all the user and navigation system combinations within an airspace. RNP types can be used by airspace planners to determine airspace utilization potential and as an input in defining route widths and traffic separation requirements, although RNP by itself is not sufficient basis for setting a separation standard.

Tab.II- 2-2. Accuracy and probability

| Accuracy Expression | One Dim. Probability | Two Dim. Probability | Three Dim. Probability |
|---------------------|----------------------|----------------------|------------------------|
| Three Sigma | 99.7 % | 98.9 % | 97.1 % |
| Two Sigma | 95.0 % | 86.0 % | 78.8 % |
| One Sigma | 68.0 % | 39.3 % | 19.9 % |
| Probable Error | 50.0 % (0.67 s) | 50.0 % (1.18 s) | 50.0 % (1.54 s) |

Tab. II- 2-3. RNP types

| Accuracy | RNP 1 | RNP 4 | RNP 12.6 | RNP 20 |
|--|-------------------------|------------------------|--------------------------|------------------------|
| 95 % Position accuracy in the designated | ± 1.85 km (± 1.0 NM) | ± 7.4 km (± 4.0 NM) | ± 23.3 km (± 12.6 NM) | ± 37 km (± 20.0 NM) |

2.5 RESOLUTION REQUIREMENTS

2.5.1 **Definition of precision:** *The smallest difference that can be reliably distinguished by a measurement process.*

2.5.2 **Definition of resolution:** *The smallest difference between two adjacent values which can be represented in a measuring system. The number of decimal points or the scale of units to which a measured or calculated data item can be recorded, displayed or transferred.*

2.5.3 Resolution of positional data is the smallest separation that can be represented by the method employed to make the position statement. The resolution is always a rounded value as opposed to a truncated value. The order of publication resolution of aeronautical data is specified at Tables II-2-3 and II-2-4.

2.5.4 The terms 'precision' and 'resolution' are often interchangeable in general use. Here it is a measure of the data field capacities that are available within a specific system design. (Example: 54° 33' 15" is expressed to a resolution of one second). Any process that

manipulates data subsequent to the original measurement or definition cannot increase the precision to which the data were originally measured or defined, regardless of the resolution available within the system itself.

2.6 INTEGRITY

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

2.6.2 The integrity of data can be regarded as the degree of assurance that any data item retrieved from a storage system has not been corrupted or altered in any way since the original data entry or its latest authorized amendment. This integrity must be maintained throughout the data process from survey to application.

2.6.3 Integrity is expressed in terms of the probability that a data item, retrieved from a storage system with no evidence of corruption, does not hold the same value as intended. For example, an integrity of 3×10^{-8} means that an undetected corruption can be expected in no more than three data items in every 100000000 data items processed. Loss of integrity does not necessarily mean loss of accuracy. However, it does mean that it is no longer possible to prove that the data is accurate without a further verification of the data from the point at which integrity can be confirmed.

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

2.6.5 Requirement for integrity

2.6.5.1 The use to which a data item is put also forms the basis for determining its integrity requirement. A data classification is proposed which defines requirements based upon the potential risk resulting from corruption of the data:

a) Critical Data: There is a **high probability** that, as a result of using corrupted Critical Data, an aircraft would be placed in a life threatening position.

b) Essential Data: There is a **low probability** that, as a result of using corrupted Essential Data, an aircraft would be placed in a life threatening position

c) Routine Data: There is a **very low probability** that, as a result of using corrupted Routine Data, an aircraft would be placed in a life threatening position.

2.6.5.2 To each of these types of data, an integrity requirement has been assigned as follows:

a) Critical: This level is given to the runway data which defines the landing point. For these data, two levels of criticality have been defined. These have been related to the approach and landing criteria categories. The levels of integrity have been derived from the integrity requirements for autoland and are defined to ensure that the overall process, of which data is only a part, has the required integrity.

Thus: CAT I : 3×10^{-8} CAT III : 8×10^{-10}

b) Essential: This level is assigned to points which, whilst an error can in itself result in an aircraft being outside of the envelope required, this excursion does not necessarily result in a catastrophic failure. Examples include en route navigation aids. The integrity requirement is defined as: 1×10^{-5}

c) Routine: This level is assigned to data for which errors do not affect the navigation performance. These include FIR boundaries and obstructions. The reason why obstruction data can be held with a relatively low level of procedures are derived, any subsequent corruption should have no impact requirements. The integrity requirement for routine data is: 1×10^{-3}

Table II-2-4

****Aeronautical data quality requirement (latitude and longitude)**

| Latitude and longitude | Accuracy Data type | Publication resolution | Integrity Classification |
|---|-----------------------------|------------------------|------------------------------|
| ARP | 30 m surveyed / calculated | 1 sec | 1×10^{-3} routine |
| En- route NAVAIDS and fixes, Holding, STAR/SID point | 100 m surveyed / calculated | 1 sec | 1×10^{-5} essential |
| NAV AIDS located at the aerodrome/heliport | 3 M surveyed | 1/10 sec | 1×10^{-5} essential |
| Significant obstacles in approach and take off area | 3 m surveyed | 1/10 sec | 1×10^{-5} essential |
| Final approach fix and other essential fixes and points used in instrument approach procedure | 3 m calculated | 1/10 sec | 1×10^{-5} essential |
| Rwy threshold | 1 m surveyed | 1/100 sec | 1×10^{-8} critical |
| Rwy end(flight path alignment point) | 1 m surveyed | 1/100 sec | 1×10^{-8} critical |
| Rwy centreline points | 1 m surveyed | 1/100 sec | 1×10^{-8} critical |
| Taxiway centreline points | 0.5m surveyed | 1/100 sec | 1×10^{-8} critical |
| Obstacle within the circling area and at the airport/heliport | 3 M surveyed | 1/10 sec | 1×10^{-5} essential |
| Aircraft/helicopter standpoints/INS Check points | 0.5 m surveyed | 1/100 sec | 1×10^{-3} routine |
| En-route NAVAIDs and fixes, Holding, SID/STAR points | 100 m surveyed / calculated | 1 sec | 1×10^{-5} essential |

Table II-2-4

****Aeronautical data quality requirement elevation/altitude/height)**

| Elevation/altitude/height | Accuracy Data type | Publication resolution | Integrity Classification |
|--|--------------------------|------------------------|--------------------------------|
| WGS -84 geoid undulation at aerodrome/heliport elevation position | 0.5 m or 1 ft surveyed | 1m or 1 ft | 1 x 10 ⁻⁵ essential |
| WGS- 84 geoid undulation at threshold or FATO threshold, TLOF geometric centre, non precision approaches | 0.5 m or 1m surveyed | 1m or 1 ft | 1 x 10 ⁻⁵ essential |
| WGS- 84 geoid undulation at threshold or FATO threshold, TLOF geometric centre, precision approaches | 0.25 m or 1m surveyed | 0.5m or 1 ft | 1 x 10 ⁻⁸ critical |
| Obstacle within the circling area and at the airport/heliport | 1m or 1 ft surveyed | 1m or 1 ft | 1 x 10 ⁻⁵ essential |
| Threshold crossing height, precision approaches | 0.5 m or 1 ft surveyed | 0.5 m or 1 ft | 1 x 10 ⁻⁸ critical |
| Aerodrome /heliport elevation | 0.5 m or 1 ft surveyed | 1 m or 1 ft | 1 x 10 ⁻⁵ essential |
| Rwy or FATO threshold, precision approaches | 0.25 m or 1 ft surveyed | 0.5 m or 1 ft | 1 x 10 ⁻⁸ critical |
| Rwy or FATO threshold, non precision approaches | 0.5 m or 1 ft surveyed | 1 m or 1 ft | 1 x 10 ⁻⁵ essential |
| Significant obstacles in approach and take off area | 1 m or 1 ft surveyed | 1m or 1 ft | 1 x 10 ⁻⁵ essential |
| Distance measuring equipment(DME)precision | 3 m (10 ft) surveyed | 3 m (10 ft) | 1 x 10 ⁻⁵ essential |
| Distance measuring equipment (DME) elevation | 3 0m (100 ft) surveyed | 30 m (100 ft) | 1 x 10 ⁻⁵ essential |
| Minimum altitudes | 5 0m (100 ft) calculated | 5 0m (100 ft) | 1 x 10 ⁻³ routine |
| Obstacle clearance altitude/height | As specified in Doc 8168 | - | 1 x 10 ⁻⁵ essential |

** For detailed requirement of aeronautical data quality refer Annex 15 (Appendix 7) and Doc 9674 (Chapter 2)

Chapter 3 :THE GLOBAL WGS-84 CO-ORDINATE SYSTEM

3.1 DEFINITION OF THE WGS 84 COORDINATE SYSTEM

3.1.1 The World Geodetic System - 1984 (WGS 84) coordinate system is a Conventional Terrestrial System (CTS), realized by modifying the Navy Navigation Satellite System (NNSS), or TRANSIT, Doppler Reference Frame (NSWC 9Z-2) in origin and scale, and rotating it to bring its reference meridian into coincidence with the Bureau International de l'Heure (BIH) - defined zero meridian.

3.1.2 Origin and axes of the WGS 84 coordinate system are defined as following:

- **Origin** = Earth's centre of mass
- **Z-Axis** = The direction of the Conventional Terrestrial Pole (CTP) for polar motion, as defined by BIH on the basis of the coordinates adopted for the BIH stations.
- **X-Axis** = Intersection of the WGS 84 reference meridian plane and the plane of the CTP's equator, the reference meridian being the zero meridian defined by the BIH on the basis of the coordinates adopted for the BIH stations.
- **Y-Axis** = Completes a right-handed, Earth Centred, Earth Fixed (ECEF) orthogonal coordinate system, measured in the plane of the CTP equator, 90° East of the x-axis.

Note - An illustration of the WGS 84 coordinate system origin and axes, which serve also as the geometric centre and the X, Y, and Z axes of the WGS 84 Ellipsoid, is given in Fig.II- 3-1.

3.1.3 **WGS 84** is an earth-fixed global reference frame, including an earth model. It is defined by a set of primary and secondary parameters. The **primary parameters** are given in Tab. 3-1 and define the shape of an earth ellipsoid, its angular velocity, and the earth- mass which is included in the ellipsoid of reference.

3.1.4 The **secondary** parameters define a detailed Earth Gravity Field Model (EGM) of the degree and order $n=m=180$. The WGS 84 EGM through $n=m=180$ is to be used when calculating WGS 84 geoid heights, WGS 84 gravity disturbance components, and WGS 84 $1^\circ \times 1^\circ$ mean gravity anomalies via spherical harmonic expansions. Expansions to this degree and order ($n=m=180$) are needed to accurately model variations in the earth's gravitational field on or near the earth's surface. The WGS 84 EGM through $n=m=41$ is more appropriate for satellite orbit calculation (e.g. GPS navigation satellites) and prediction purposes.

Table II-3-1: Parametres of WGS-84

| Parametres | Abbreviations | WGS-84 |
|---|---------------|--|
| Semi-major axis | a | 6378137 m |
| Flattening | f | 1/298.257223563 |
| Angular velocity | w | $7.292115 \times 10^{-5} \text{ rad s}^{-1}$ |
| Geocentric gravitational constant (Mass of earth's atmosphere included) | GM | $398600.5 \text{ km}^3 \text{ s}^{-2}$ |
| Normalized 2nd degree zonal Harmonic coefficient of the gravitational potential | $C_{2,0}$ | $-484.16685 \times 10^{-6}$ |

3.2 Realization of the WGS 84 coordinate system

3.2.1 The origin and the orientation of coordinate axes in WGS 84 are defined by the X, Y, Z coordinates of the five GPS monitoring stations (see Fig.II- 3-1).

3.2.2 Historically the coordinates of the GPS tracking sites have been determined by the use of Doppler measurements to the TRANSIT satellite navigation system. Long observation periods of data have been processed in order to derive precise station coordinates. The use of TRANSIT Doppler measurements in WGS 84 is a good example of the practical realization of a reference system. It should be pointed out once again that errors can propagate in the procedures used to realize reference frames.

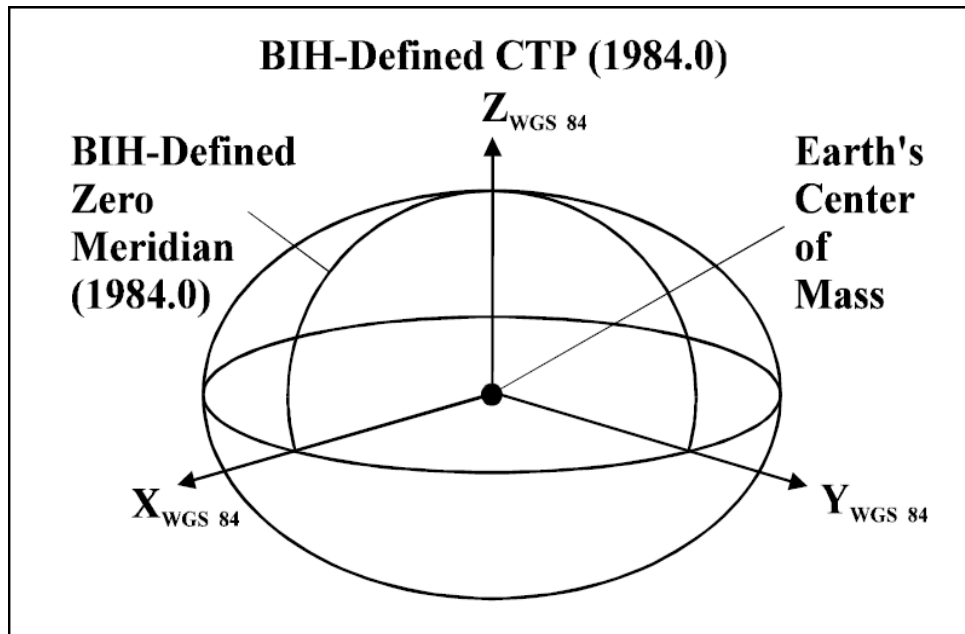


Figure II-3-1 The WGS-84 coordinate system definition

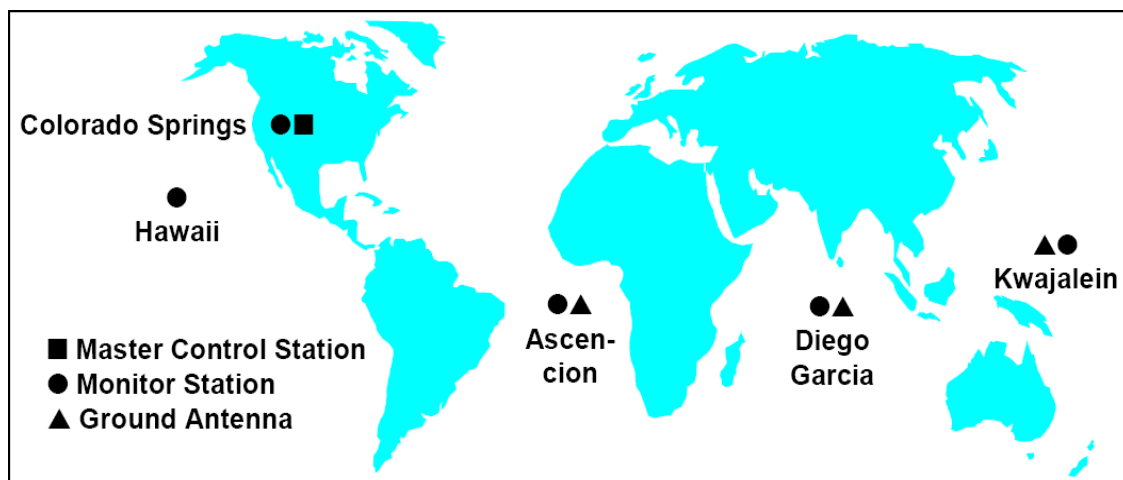


Figure II-3-2 Realization of origin and orientation of WGS -84

3.3 Accuracy of WGS 84 coordinates

3.3.1 The accuracy (one sigma) of WGS 84 coordinates directly determined in WGS 84 by GPS Satellite Point Positioning, their respective precise ephemerides and ground-based satellite tracking data acquired in static mode, in terms of geodetic latitude Φ geodetic longitude λ , and geodetic height h are:

Horizontal -- $s_{\Phi} = s_{\lambda} = < \pm 1\text{m} (1\text{s})$

Vertical -- $s_h = \pm 1 \dots 2 \text{ m} (1\text{s})$

3.3.2 These errors incorporate not only the observational error but the errors associated with placing the origin of the WGS 84 coordinate system at the earth's centre of mass and determining the correct scale. These absolute values should not be confused with the centimetre-precision of GPS differential positioning. Historically, at the time of establishing WGS-84, only Satellite Doppler measurements with corresponding accuracy were available to determine the ground control segment of WGS 84.

3.3.3 The WGS 84 coordinates of a non-satellite derived local geodetic network station will be less accurate than the WGS 84 coordinates of a GPS station. This is due to the distortions and surveying errors present in local geodetic datum networks, the lack (in general) of a sufficient number of properly placed GPS stations collocated with local geodetic networks for use in determining the transformation parameters, and the uncertainty introduced by the datum transformation.

3.3.4 The accuracy of +/- in the definition of WGS 84 is sufficient for nearly all air navigation applications. Additional considerations may be necessary, if for example, satellite based landing systems down to CAT III are to be used in future. Precision approach CAT III needs a vertical accuracy of 0.6 m (horizontal : 6.0 m), which cannot be supplied by WGS 84 according to its accuracy definition, but for instance by International Terrestrial reference Frame (ITRF).

Chapter 4 : A GUIDE TO OBTAIN WGS-84 COORDINATES

4.1 GENERAL

The following chapter is intended to be a guide with "recipes" for users to produce WGS 84 coordinates. It is written in such a way that the user of the manual is guided step by step to decide, dependent on the quality and/or existence of his data, what he shall do to get WGS 84 coordinates. So the first decision, which has to be made is to answer the following question:

Are (when) sufficiently accurate coordinates available?

Yes If these coordinates are available in a local reference frame, then proceed to *Case 1 (para 4.2)* of this chapter. If the available coordinates have been digitized from maps, then proceed to *Case 3 (para 4.3)* of this chapter. When considering the use of existing data it is important to check and control the coordinates of navigation facilities with respect to accuracy and integrity before transforming them to WGS 84 by mathematical means. One has to keep in mind that coordinates in air navigation could be safety critical and that high integrity requirements have to be fulfilled. In order to fulfil the minimum requirements for coordinates the surveyor must ensure that:

- a) point labels have not been interchanged or misidentified,
- b) that the coordinates can be verified by aid of redundant measurements,
- c) that the accuracy is predictable and sufficient.

No If no accurate coordinates are available or if, for example, the integrity requirements can not be fulfilled, a re-survey with related field work must be performed. The different methods of performing this re-survey to provide accurate WGS 84 coordinates are explained under *Case 2 (para 4.2)*

4.2 CASE 1: COORDINATES IN A LOCAL REFERENCE FRAME ARE AVAILABLE

Two approaches exist to transform coordinates given in national coordinates to WGS 84 coordinates. They are dependent on the knowledge of the transformation parameters, the type of coordinate system, and can be used as stand-alone or combined methods

4.2.1 Checking the type of coordinate system

4.2.1.1 Before carrying out a datum transformation, it should be checked if all the transformation parameters from the local reference frame to WGS 84 are known. If

Yes, then perform a computational datum transformation by using the datum transformation formulae of para 4.1.2 to determine the WGS 84 coordinates. Several software programs exist to support this procedure, e.g. the DATUM programme.

No, Use the GPS surveying technique to survey at known control stations (covering the area under consideration) to obtain WGS 84 coordinates. Since these control stations are known in the local reference frame and in WGS 84, two sets of coordinates for identical stations exist. These can then be used to determine the datum parameters in the Helmert formula. At least three known control stations have to be surveyed by GPS to get additional WGS84 coordinates for determining all seven Helmert transformation parameters (using the Inverse Helmert transformation). However, in practice it is usual to use as many common points as possible to obtain the best estimate of the parameters by least squares.

4.2.1.2 For the following example it is assumed that only the shifts of origin between the local reference frame and WGS 84 have to be determined and that therefore only one known control station was GPS surveyed. The inverse Helmert formula for solving for the three shift of origin parameters reads:

$$\underbrace{\begin{bmatrix} \Delta X \\ \Delta Y \\ \Delta Z \end{bmatrix}}_{\text{Shift of Origin}} = \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{\text{WGS84}} - \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}_{\text{Local}}$$

Assumption: No change in orientation ($\varepsilon_X = \varepsilon_Y = \varepsilon_Z = 0$) and scale ($\mu = 1$) between the local reference frame and WGS – 84.

4.2.1.3 After determining all necessary transformation parameters, proceed as explained at the beginning at para 4.2.1.1. The way of referencing a local (e.g. relative) and sufficiently accurate GPS aerodrome survey to WGS 84 by simply measuring the coordinate differences between one aerodrome reference point to a known and monumented WGS 84 station is called **direct geodetic connection**. On applying this procedure all the airport coordinates can be directly transformed to WGS 84. However the problem is that not many geodetic stations exist for which accurate WGS 84 coordinates are known. Therefore it is recommended to use, if available, ITRF stations for this purpose. The INRES stations established by AAI may be used as the

4.2.2 Horizontal datum transformations

4.2.2.1 There are three different approaches for transforming coordinates from a local datum to WGS 84. Use the :

a) Helmert's formula to carry out the transformation in rectangular Cartesian coordinates X,Y,Z using three-, four-, or seven parameter transformations depending

on the availability

(and/or reliability) of the transformation parameters. *Helmert's formula* can also be applied for spatial ellipsoidal coordinates f, l, h by transforming from ellipsoidal coordinates to rectangular coordinates and vice versa.

b) Standard Molodensky Formula to solve the transformation in curvilinear coordinates f, l, h .

c) Multiple Regression Equation approach to account for the non-linear distortion in the local geodetic datum.

4.2.2.2 Accuracy considerations

4.2.2.2.1 Because of error propagation a datum transformation will never improve the survey accuracy. In most cases the accuracy of the transformed coordinates in the absolute sense is worse than the accuracy of the original coordinates. It has to be checked by the user, in particular, whether the resulting coordinate accuracy still meets the requirements. Furthermore, this quality control may be difficult to perform.

4.2.2.2.2 Two of the several reasons known for this loss of accuracy are :

- a) Because the datum or transformation parameters are, in many cases, only weakly determined, substantial discrepancies of up to 50 m in datum parameters can occur between published values from different reference sources. Furthermore, the accuracy of a NavAid's original coordinates may not be sufficient, and in many cases the accuracy of the datum parameters is undefined; and
- b) there may be a slight distortion in the national network in the area under consideration.

4.2.2.3 Limitations of transformations

4.2.2.3.1 It should be noted that random and systematic errors in local survey data transform directly to WGS 84. Because of geodetic network geometry and error propagation in these networks the local datum parameters for a country are, in practice, not constant but vary with location in the geodetic network.

4.2.2.3.2 The signal-to-noise ratio for the datum parameters is in many cases close to one, i.e. the noise level is very high relative to the magnitude of the datum parameter itself. E.g. the orientation angles of a datum could be published typically as, say, $0.5^\circ \pm 0.3^\circ$.

4.2.2.3.3 The predicted error, or uncertainty, is often larger than the value itself. Fig.II- 4-1 shows in a qualitative manner how the errors in transformation procedures propagate into transformed coordinates.

4.2.2.3.4 The error sources in a datum transformation are errors in the shift parameters, in the orientation parameters and in the scale factor. The scale factor error is incorporated in

the above in that it is treated like an orientation error, in radians, applied to the coordinate value to be transformed by multiplication. Even an accurate survey with an internal accuracy of say 0.1 m may show, after the transformation parameters have been applied, only meter level accuracy in WGS- 84. Here the difference between absolute and relative point accuracy has to be considered.

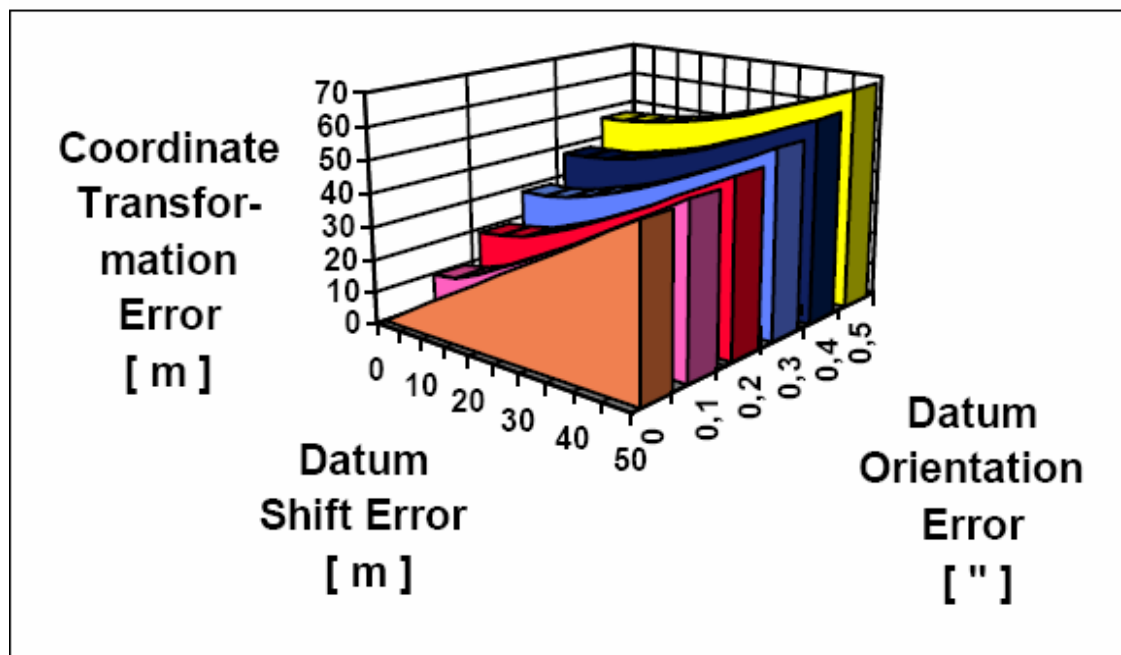


Figure II-4-1 Error propagation in datum transformation

4.3 Case 2: WHEN SUFFICIENTLY ACCURATE COORDINATES ARE NOT AVAILABLE

4.3.1 New field survey techniques

4.3.1.1 If there are no (adequately) precise coordinates available, a new field survey must be performed using one of the following techniques:

- Conventional surveying
- GPS surveying
- Photogrammetric surveying

4.3.2 Best technique(s) for new field survey

4.3.2.1 In deciding, which of the above techniques is the most efficient one for the new field survey, the following may be used as guidance:-

- Use the GPS technique for surveying limited and relatively small areas in a very economical way.
- Use the photogrammetric technique, if the area to be surveyed is very large
- Use conventional surveying, if the area to be surveyed contains a lot of obstructions, which would lead to GPS signal losses or multipath.

Note : There is no doubt that a complete resurvey of the point using differential GPS satellite surveying techniques (relative to a known station with WGS 84 coordinates) is the most accurate approach for determining precise WGS 84 coordinates.

4.3.3 Determination by conventional terrestrial surveying

4.3.3.1 Fig.II- 4-2 shows, how WGS 84 coordinates can be obtained by terrestrial surveying.

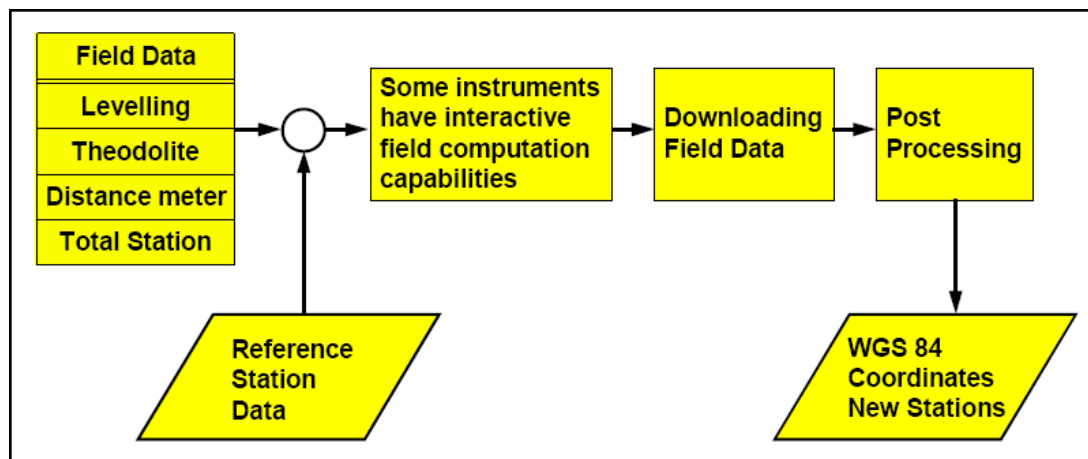


Figure II-4-2 From terrestrial surveying data to WGS -84 coordinates

4.3.3.2 Some of the conventional surveying instruments of modern type (levelling instrument, theodolite, distance meter, total station) have interactive field computational capabilities. After downloading the data via an interface into an office computer, final post processing is carried out. Before the derived coordinates may enter the survey data base they have to be quality controlled and integrity checks have to be performed. Various graphic visualizations of data and results can be done.

Note : Refer Appendix C for more conventional surveying

4.3.4 Determination by GPS surveying

4.3.4.1 As already outlined in the beginning of this section most of the field surveying which is necessary for the positioning of navigation aids, radars, runways, etc., is best carried out

by differential GPS satellite surveying. The method has the advantages of 24-hour all- weather operations, ease of use, speed, very economical, high accuracy and, most importantly, direct compatibility with the WGS 84 datum.

4.3.4.2 GPS receivers store the field data. After finishing the survey the data have to be downloaded to a computer where they are post processed using software packages provided by GPS hardware manufacturers and/or universities. The processing can be done either by individual baseline or in a multi-session multi-station network approach. Again, before the derived coordinates may enter the survey data base they have to be quality controlled and integrity checks have to be performed. Various graphic visualizations of data and results can be performed.

4.3.5 Determination by aero-photogrammetry

4.3.5.1 Fig.II-4-3 shows the determination of WGS 84 coordinates by using photogrammetric flights. The parameters of the photogrammetric flight have to be determined as a function of anticipated coordinate accuracy of the ground stations. If no WGS 84 coordinates at ground stations are available, they have to be established using GPS differential surveying techniques. So a network of ground control points whose coordinates and heights are known in advance is an essential requirement for referencing the newly derived coordinates to a national datum. The points to be coordinated have to be marked so that a unique identification in the aerial photos is possible

4.3.5.2 After obtaining permission to release photo data (if necessary), they are developed and the stereo model construction is carried out in a photogrammetric instrument in the office. After inputting the ground control coordinates and, if available, GPS-derived camera positions, the data are processed by a bundle block adjustment.

4.3.5.3 Again, before the derived coordinates may enter the survey data base they have to be quality controlled and integrity checks have to be performed. Various graphic visualization of data and results can then be done.

4.4 Case 3: DIGITIZED COORDINATES FROM MAPS ARE AVAILABLE

This section helps the user to transform coordinates to WGS 84, if the coordinates are available from digitized maps. After some remarks on the restrictions of digitized maps the user is guided through the transformation process in Chapter 4.3.2.

4.4.1 Restrictions

4.4.1.1 While digitized data has no inherent scale information, the accuracy of the data is clearly limited by the corresponding accuracy of the analogue map from which it was originally extracted, and of the digitising process involved. A new analogue map may be printed at a larger scale than that of the original map, but in doing so one does not increase the accuracy to that normally associated with the larger scale. The problem is further

compounded by the frequent revision and updating of the data base with newly surveyed field data. Furthermore, the digitizing process involves the *straightening* and *squaring* of regular objects, leading to apparently "well drawn" maps even after the enlargement process.

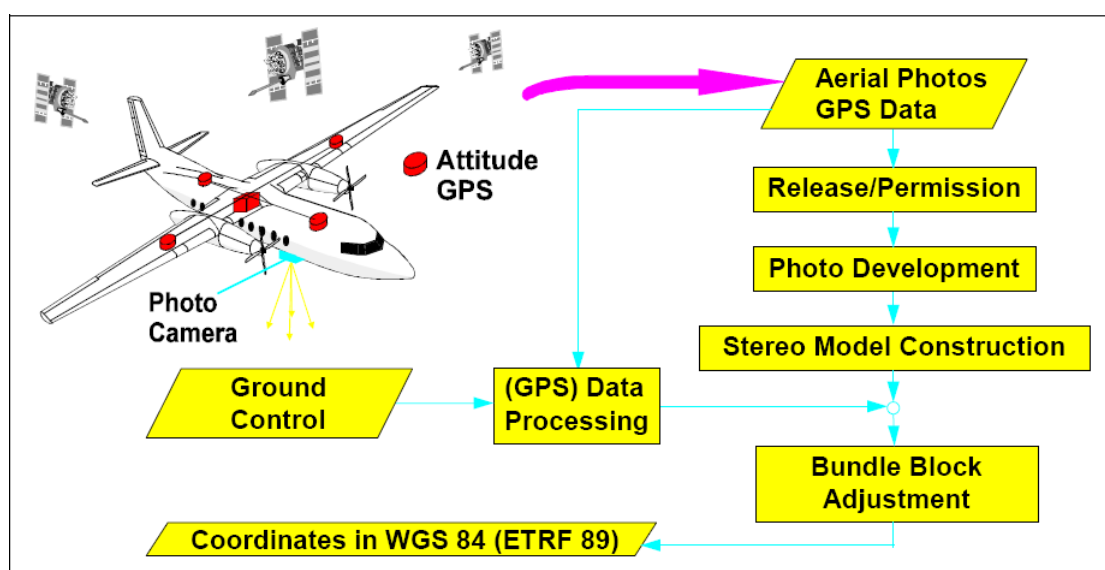


Figure II-4-3 From photogrammetric flights to WGS -84 coordinates

4.4.1.2 The most important drawback of digitized maps, however, is the very nature of an analogue data base. High precision mapping coordinates are generally given in National Grid Northings and Eastings, which have been obtained by converting geodetic (ellipsoidal) coordinates into a map projection. In addition to these, one must consider the more significant projection scale and orientation errors inherent to all map projections. While these can be reduced by the judicious use of an orthomorphic projection (e.g. Transverse Mercator), they are still substantial, rendering the process of extracting coordinate information from a map

precarious. For example, if the grid coordinates of two points are extracted from the map and the grid distance computed, the distance would be up to 30 cm per kilometre shorter than the value measured on the ground. This is significant and may have serious implications.

4.4.1.3 So when digitizing coordinates from maps, the following points should be considered:

- a) Check how the map was established, by which technique (from analogue data/digitizing of other maps, from digital data, etc.)
- b) In order to convert the Northings and Eastings to geographical coordinates, it is necessary to know the exact formulas of the map projection.
- c) Furthermore, it is necessary to know the original datum of the projected coordinates as well as the new one, when transforming.
- d) Datum coordinate transformation can only be applied after converting map projection coordinates to geodetic coordinates.
- e) The resulting accuracy of such coordinates should be checked and verified in order to decide whether the anticipated accuracy needs have been met.

4.4.1.4 WGS 84 is the definition of the centre of mass of the Earth as determined in 1984 and all charts produced prior to that date using a different geodetic reference will not correspond exactly to new charts based on WGS 84. Finally, one has to bear in mind that maps never contain ellipsoidal heights! For example, heights in different maps may refer to :

- a) different zero points (tide gauges); or
- b) different type of height systems. (There are not only orthometric heights, but also orthometric heights, for example, in Eastern Europe)

4.4.2 Transformations

4.4.2.1 To transform digitized coordinates from maps to WGS 84, it is essential to answer the following question:

Is the kind of map projection known, which was used in the local survey for mapping the reference ellipsoid to the plane and for computing the plane metric coordinates?

No If this question cannot be answered, then one has to proceed to Chapter 4.2 and to perform a re-survey.

Yes If the type of map projection is known, the inverse map projection has to be calculated to compute latitude and longitude of the digitized metric coordinates on the reference ellipsoid.

4.4.2.2 All datum transformations require the use of the **ellipsoidal height h** in the local system which is

$$h = H + N$$

where **H** is the **orthometric height** (elevation) and **N** is the **geoid height**. In general, only the orthometric height is known (and found also on maps). The geoid height has to be taken from

a digital model (if available). However, an investigation was made checking the effect of an unknown (orthometric) height on the transformed latitude and longitude of a point using the Helmert transformation formulas. By assigning heights ranging from zero metre to 8000m, it was concluded that the effect on both latitude and longitude was negligible (less than 15cm at 8000 m). Consequently, for a point of known latitude and longitude, but unknown (orthometric) height, an arbitrary height of zero could be assigned without significantly affecting the transformation.

4.4.2.3 Because national surveying agencies are using different kind of reference ellipsoids, the next step is to determine this reference ellipsoid in order to be able to perform the datum transformation from the local datum to the global datum. Sometimes it may be possible to transform directly from the local datum to WGS 84. If not, then a further transformation from the global datum to WGS 84 has to be undertaken

Chapter 5: SURVEYING GUIDANCE

5.1 INTRODUCTION

This chapter sets out guidance for surveying the geographical positions of navigation aids and navigation points brought about by the adoption of WGS-84 as a common geodetic reference frame for international civil aviation. The particular accuracy of the field work values has been based on operational requirements and is in accordance with the provisions set forth in Annex 14 and Annex 11 while resolution requirements are set forth in Annexes 4 and 15.

5.1.1 Application of requirements

5.1.1.1 The requirement contained in this chapter apply to all aerodromes / heliports for international as well as domestic use and they relate to the surveying, with respect to WGS-84, of the geographical coordinates of navigational elements. (Navigation aids and points whose coordinates contribute directly to air navigation). Surveying guidance covers surveying of WGS-84 related geographical positions of navigation determination of coordinates, i.e. latitude and longitude of certain navigation positions.

5.1.1.2 The result of the surveying of WGS – 84 coordinates of navigation elements must be reported to the aeronautical information service (AIS) in accordance with the provisions of Annex 11 & Annex 14.

5.1.1.3 The list of navigation element to be surveyed is given at table II-5-1. Coordinates of these elements may be used for the purpose of checking, calibrating or initialisation navigation equipment.

Table II-5-1 : Minimum Survey accuracy & integrity requirement for navigation elements

| Latitude and longitude | Accuracy Data type | Integrity Classification |
|---|--|--------------------------------|
| ARP | 30 m surveyed / Calculated for Navigational | 1 x 10 ⁻³ routine |
| En- route NAVAIDS and fixes, Holding, STAR/SID point | 100 m surveyed / calculated | 1 x 10 ⁻⁵ essential |
| NAV AIDS located at the aerodrome/heliport | 3 M surveyed | 1 x 10 ⁻⁵ essential |
| Aerodrome/heliport survey Control network(datum transfer) | 1 m* surveyed | 1 x 10 ⁻⁸ critical |
| Significant obstacles in approach and takeoff area | 3 m surveyed | 1 x 10 ⁻⁵ essential |
| Final approach fix and other essential fixes and points used in instrument approach procedure | 3 m calculated | 1 x 10 ⁻⁵ essential |
| Rwy Threshold | 1 m surveyed | 1 x 10 ⁻⁸ critical |
| Rwy End(flight path alignment point) | 1 m surveyed | 1 x 10 ⁻⁸ critical |
| Rwy centreline points | 1 m surveyed | 1 x 10 ⁻⁸ critical |
| Taxiway centreline points | 0.5m surveyed | 1 x 10 ⁻⁸ critical |
| WGS -84 geoid undulation at aerodrome elevation position | 0.5 m surveyed | 1 x 10 ⁻⁵ essential |
| WGS- 84 geoid undulation at threshold | 0.5 m surveyed | 1 x 10 ⁻⁵ essential |
| Obstacle within the circling area and at the airport/heliport | 3 M surveyed | 1 x 10 ⁻⁵ essential |
| Aircraft standpoints/INS Check points | 0.5 m surveyed | 1 x 10 ⁻³ routine |
| En-route NAVAIDS and fixes, Holding, SID/STAR points | 100 m surveyed/calculated | 1 x 10 ⁻⁵ essential |

Note: Accuracies are those relative to the established aerodrome/heliport survey control network except where marked by an asterisk(*) when they relate to absolute coordinates with respect to the datum.

5.2 GENERAL SPECIFICATIONS

5.2.1 The coordinates of navigation elements must be referenced to WGS-84 geodetic datum.

5.2.2 All the aeronautical data determined as per the specifications should be such that its quality must be demonstrated. The accuracy of field work, with respect to determination of the geographical coordinates of the various elements, has been set in accordance with both current and anticipated operational requirements.

5.2.3 All position accuracies must relate to the probability of 95% (2 sigma) containment. All published geographical position and dimensions must be in accordance with the requirement of ICAO Annex 15, Appendix 7 and for geographical positions and publication resolution and Annex 4 for the charting resolution.

5.2.4 Dimensions and distances must be quoted in one of the following units :

- a) (m);
- b) Feet(1 ft = 0.3048 m); or
- c) Nautical miles (1NM= 1852 m)

5.2.5 Aerodrome /heliport survey control network

In order to determine the position of navigation elements at, and in the vicinity of, aerodromes/heliports, a network of survey control stations must be established at each such aerodrome/heliport. The network must consist of a minimum of two inter-visible survey stations separated laterally by at least 500 m. The airport/heliport survey control station may consist of a minimum of four stations so as to provide sufficient redundancy to be able to sustain the loss of one survey station and still enable the orientation to be checked. Survey stations must be strategically located so that it may be utilised in the subsequent surveys. The monuments of existing aerodromes/heliport survey control network and the specially prepared for GAGAN (INRES) may be used for the purpose.

5.2.6 Accuracy requirement of control network

5.2.6.1 The position of each survey station must be determined to an accuracy of 1m with respect to an appropriate geodetic reference frame. The control network must have a better internal accuracy consistent with the need to provide control for the survey of navigation elements to the specified accuracies. The survey control network may have an internal consistency better than 10 cm.

5.2.6.2 Mathematical transformation methods based on a single set of average transformation parameters, which relate known(existing) datum to WGS-84, must not be used for the purpose of determining the coordinates of the aerodrome/ heliport survey control network.

5.2.7 Monumentation of Survey Control Stations

The survey control stations consist of standard types of survey monuments. Different types of monument will be appropriate for different locations and ground conditions; it is the surveyor's responsibility to decide the most appropriate monument. Prior to the installations of monument, it must be ensured that underground cables and services are not affected by the installation. If no of stations consists of fewer than recommended four stations, monuments of a larger size must be used.

5.2.8 Station Numbering

Each survey station must carry an individual number. This will ensure that, where a station has been destroyed and subsequently replaced by a new station in approximately the same location, misidentification does not occur.

Station labelling and numbering must be such that there is no doubt as to the provenance or identity of the survey station. Uniform labels may be used at individual aerodrome/heliports for all survey stations. An unambiguous numbering system identifying the aerodrome, year and station number may be used. Station labelling and numbering should be such that there is no doubt to the identity of the survey station. Where an existing substantial topographic surface is used as a survey station, it must be clearly marked with the durable paint.

5.2.9 Station location plan

An aerodrome/heliport survey network plan, at a scale of 1: 2000 or other appropriate standard cartographic scale, indicating the location of all survey stations and principal topographic features must be prepared. The plan may be oriented to the true north or alternately, have the direction of true north indicated on the plan.

5.2.10 Station Descriptions

A comprehensive aerodrome/heliport survey network station description must be prepared. There must be a written description and a clear diagram indicating the dimensions and direction to other visible points on the aerodrome/heliport network.

A photograph of the station showing background detail should be included in the description. General condition of the survey network should be inspected and any disturbance or damage recorded.

5.2.11 Determination of control coordinates

The coordinates of the survey network stations will be fixed by one of the following methods:

- a) **Direct Geodetic Connection** : Survey measurements must be taken to connect the aerodrome/heliport survey control network to a national or international (e.g. ITRF) geodetic frame in such a way that the survey error in the connection does not contribute significantly to the coordinate error of the aerodrome/heliport survey control network. This is the preferred option, in that it consists of the most accurate method of observation and incorporates a directly observed connection to the approved geodetic reference frame. Static differential GPS connections may be made to, preferably, three points on an appropriate geodetic network but, in all cases, must be made to a minimum of two.
- b) **Derived Geodetic Connection** : Where the local relationship between the existing geodetic control network and WGS 84 is known to an accuracy commensurate with the requirements, then standard, nationally or regionally approved transformation methods may be used to determine the coordinates of an existing aerodrome/heliport survey control network. Where this method is adopted a full description of transformation method and the value of transformation parameters must be included in the report. Full details of the connection of the existing aerodrome/heliport survey control network to the existing geodetic network must be included in the survey report (an existing network means one that existed at the aerodrome/heliport prior to the implementation of WGS-84 at that aerodrome/ heliport).
- c) **Direct observation of WGS- 84:** For those regions where national or international coordinates are not available the coordinates of the aerodrome/heliport survey control network must be determined by direct observation of WGS-84 by using an appropriate type of geodetic GPS receiver. All such observations must be controlled by simultaneous observations made at points of known absolute WGS-84 coordinates. The observation and computation method must be such that the absolute coordinates of the aerodrome/heliport survey control network are determined to the accuracy already specified in this chapter.

5.2.12 Determination of local relationship between the known existing datum & WGS-84

5.2.12.1 Where existing relative surveys need to be related to WGS-84, observations must be taken to determine the local relationship (latitude, longitude, orientation and scale) between the known existing datum and WGS-84, except where the required information is provided by a derived geodetic connection.

5.2.12.2 Wherever used, the local relationship between the known existing geodetic datum and WGS-84 must be determined to an accuracy commensurate with the relative accuracy of the data to be transformed. The values and accuracies of the local relationship must be declared in the survey report.

5.2.13 Report requirements

5.2.13.1 All survey work undertaken to determine the coordinates of navigation facilities aerodromes / heliports must be in the format specified at Attachment - C of this chapter.

5.2.13.2 During the survey, minimum specified accuracies must be achieved and it is quite feasible even to exceed the same with the help of modern survey instruments. All survey observations may be made and recorded to the resolution and accuracy of the equipment used so that future requirements for survey of higher precision may be met. Where surveys are undertaken using equipment or technique that yield height data as well as horizontal position, these must be comprehensively recorded and included in the survey report.

5.3 SURVEY REQUIREMENTS FOR AERODROME/ HELIPORT NAVIGATION ELEMENTS

5.3.1 Runway centreline and Thresholds

5.3.1.1 For surveying purposes the centre line of a runway must be taken as being the geometric centre of the width of the bearing surface and this definition takes precedence over any existing runway centre line markings or lighting. Where the edge of the runway is irregular or connected to a taxiway, an appropriate theoretical line must be selected which best identifies the probable edge of the runway.

5.3.1.2 For surveying purposes, threshold positions must be taken as being at the geometric centre of the runway and at the beginning of the paved surface i. e. the beginning of the portion of runway usable for landing. Where thresholds are marked by appropriate threshold markings (e. g. displaced THR) these must be taken as the threshold points. Where threshold lighting is surveyed, the location must be described on the diagram accompanying the report. Where there is no threshold lighting, the surveyor must select an appropriate point for survey in accordance with the diagrams shown in the Attachment B of this chapter.

5.3.1.3 If the runway has only one threshold certified for landing, the runway end position must be surveyed. For surveying purposes, the runway end position must be taken as being at the geometric centre of the runway and at the end of the paved surface i.e. end of that portion of the runway usable for landing.

5.3.1.4 Survey witness marks must be installed to enable the threshold survey point to be re established in the event of resurfacing, repainting or verification. In addition, two associated runway centre line points, at a separation not less than 10% of the runway length, must be surveyed. The surveyor must in processing the surveying data, determine and report on the co-linearity of the three points. Where a runway has a threshold at each end, then the two thresholds and the two additional runway centre line points may be surveyed and determine the co-linearity of four points.

5.3.2 Taxiways and stand/checkpoints

5.3.2.1 General Guidelines

5.3.2.1.1 In accordance with the operational requirements for the advanced surface movement guidance control system (ASMGs), pilot should be provided with continuous guidance and control during the landing roll- out, taxiing to the parking position and from the parking position to the runway holding point to line up for take- off position and during the take-off roll.

5.3.2.1.2 Diagrams depicting appropriate points on aerodrome/heliport movement areas are shown in the Attachment B to this chapter.

5.3.2.1.3 For surveying purposes the centre (mid width) of the taxiway center line marking , apron taxi lane marking or the aircraft stand guide line marking must be taken as the reference datum. Survey witness marks must be installed to enable the taxiway centre line, apron taxi lane and aircraft stand guide line marking to be re – established in the event of resurfacing or repainting and for verification purposes.

5.3.2.1.4 The points of commencement and ends of straight section of taxiways, apron taxi lanes and aircraft stand point guidance line marking must be surveyed to maintain required accuracy along the lines.

5.3.2.1.5 For the curved section of taxiways, apron taxi lanes, and aircraft stand guide line markings, the commencement and end of the curved section centre line must be surveyed together with the position of centre position of arc and its radius. In the case of compound curve, the centre and radius of each arc and commencement and end must be surveyed. Where this is impracticable, a series of sequential points must be surveyed along the curved section of the centre line with a maximum arc to chord distance not exceeding 0.25 m for taxiways and 0.10 m for apron taxi lanes and aircraft stand guideline markings. Sufficient no of points must be surveyed to maintain the required accuracy along the lines and graphical inspection of surveyed points must be conducted to ensure the co-linearity.

5.3.2.2 Taxiways

5.3.2.2.1 As per recommendation of Annex 14, taxiway marking on the runway are offset by 0.90mtr parallel to runway centre and associated runway centre line marking to enable pilots to visually distinguish between the runway centre line and taxiway centre line marking for exits from the runway. However, to permit uninterrupted transition from actual runway centre line to the taxiway centre line and to provide the required continuity of guidance for the aircraft navigation data base, differentiation must be made between the surface markings and the actual path the aircraft must follow. For the guidance of aircraft entering or exiting the runway for landing or take- off, the following must be surveyed:

- a) The point at which the radius of turn, prescribed for each taxiway, is tangential to the runway centre line and the point at which that radius of turn joins the taxiway joins the taxiway centre line marking at a tangent.
- b) The point that prescribes the centre of the arc; and
- c) The radius of the arc,

Where this is impracticable, series of sequential points must be surveyed along the curved section of the centre line of the taxiways.

5.3.2.2.2 Where taxiway centre line marking is provided on a runway that is part of a standard taxi route, or a taxiway centreline is not coincident with runway centre line, the following must be surveyed:

- a) The point on the taxiway marking at which the taxiway enters the runway
- b) The points at which the taxiway deviates from a straight line
- c) The intersection of the taxiway centre line marking and boundary of each block that has been published as part of the airport movement and guidance control system ;
- d) The point on the taxiway marking at which the taxiway exits the runway.

5.3.2.2.3 In defining taxiways, the following points must be surveyed at the centre of the centre line marking of each taxiway, as appropriate

- a) Intermediate holding positions (if available) and runway holding positions and for points established for the protection of sensitive areas of the radio navigation aids;
- b) Taxiway intersection markings;
- c) Intersection of other taxiways
- d) Intersection of blocks defined for the surface movement guidance and control system
- e) Commencement and end of selectable taxiway lighting system provided as part of the surface movement, guidance and control system, where different from sub paragraph (d) above and
- f) At stop bars

5.3.2.2.4 In defining the helicopter air taxiway, the centre of each air taxiway marker must be surveyed, as surveyed.

5.3.2.3 Aircraft standpoints

5.3.2.3.1 In defining the aircraft stands, the following points must be surveyed at the centre of the guide line marking of the aircraft stands, as appropriate:

- a) Taxiway centre line
- b) Lead in lines
- c) Turning line
- d) Straight section of the turning line
- e) Nose wheel stopping position
- f) True heading of the alignment bar
- g) Lead out lines

5.3.2.3.2 Where aircraft stands are utilized by more than one aircraft type and different guide line markings exist, a diagram must be prepared by the surveyor showing the arrangement of the marking in use, together with an indication of the points surveyed.

5.3.3 Navigation Checkpoints

Where navigation checkpoints used for the validation of navigation system are surveyed, their coordinates must be determined to the accuracy specified at table II- 5-1. Where these checkpoints coincide with the aircraft stands, the nose wheel stopping position must be surveyed in accordance with the previous para.

5.3.4 Road holding positions

In accordance with the local requirements, significant points shall be surveyed to meet the requirement of surface movement guidance and control system for vehicular traffic on the movement area of the aerodrome.

5.3.5 All other aerodrome/heliport navigation elements

For all other aerodrome/heliport navigation elements that require surveying, the geometric centre of the element must be surveyed except where a different specific survey point is standardised for the element as indicated in Attachment B to this chapter.

5.4 AERODROME / HELIPORT SURVEY REPORT REQUIREMENTS

All the survey work undertaken to determine the coordinates of navigation elements at aerodromes/heliports must be reported in format provided in the Attachment C to this chapter.

5.5 SURVEY REQUIREMENT FOR NAVIGATIONAL AIDS

5.5.1 En- route and aerodrome/heliport navigation aids

5.5.1.1 The coordinates of en-route and aerodrome/heliport navigation aids must meet the specified accuracy requirement (Table II- 5-1). Where existing coordinates of navigation aids meet the accuracy and integrity requirement, are converted to WGS-84 mathematically, the conversion process must be shown to be such that the required coordinate accuracies are maintained.

5.5.1.2 Where the quality (accuracy and integrity) of the existing coordinates cannot be determined, they must be surveyed to the specified accuracy. In all the cases, surveyed coordinates may be published in preference to coordinates determined by graphical methods.

5.5.2 Description of En route and aerodrome/heliport navigation aids

The diagram of the most common en-route and aerodrome/heliport navigation aids are shown in the attachment B to this chapter. For the purpose of survey the position of the geometric centre of the antenna must be surveyed. Where collocated VOR/DME are surveyed, the position of the DME element must be taken as the position for both system

5.6 EN-ROUTE SURVEY REPORT REQUIREMENT

All survey work undertaken to determine the coordinates of en-route navigation elements must be reported in the format specified in Attachment C to this chapter.

5.7 USE OF SOFTWARE

Where software is used for any of the survey processing, it must be demonstrated that it functions correctly. This demonstration must take the form of a written report showing that the software produces the same results as standard computation.

5.8 DIGITAL FORMAT FOR DELIVERY OF SURVEY DATA

Digital format for delivery of survey data is provided at Chapter 7, which may be used for the delivery in digital format of the surveyed data.

Attachments to Chapter 5

Attachment A: MONUMENTATION

1. GENERAL

Where survey markers are installed, they must be of a type appropriate for the task and for the surface and ground type in which they are installed. Designs of suggested survey markers are shown in the figures.

2. Numbering system for Survey markers

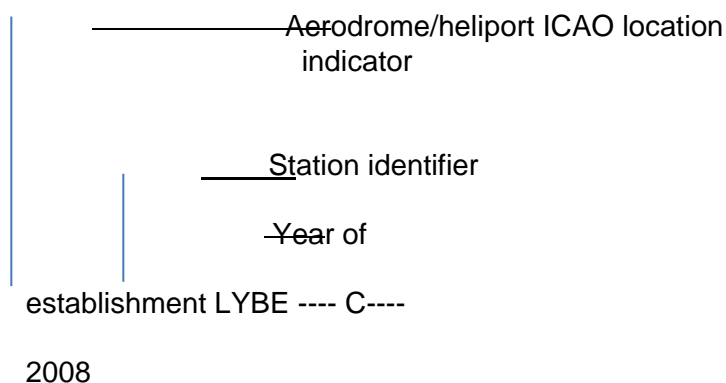
2.1 Each survey control point forming part of aerodrome/ airport control network shall be marked with a unique identification number.

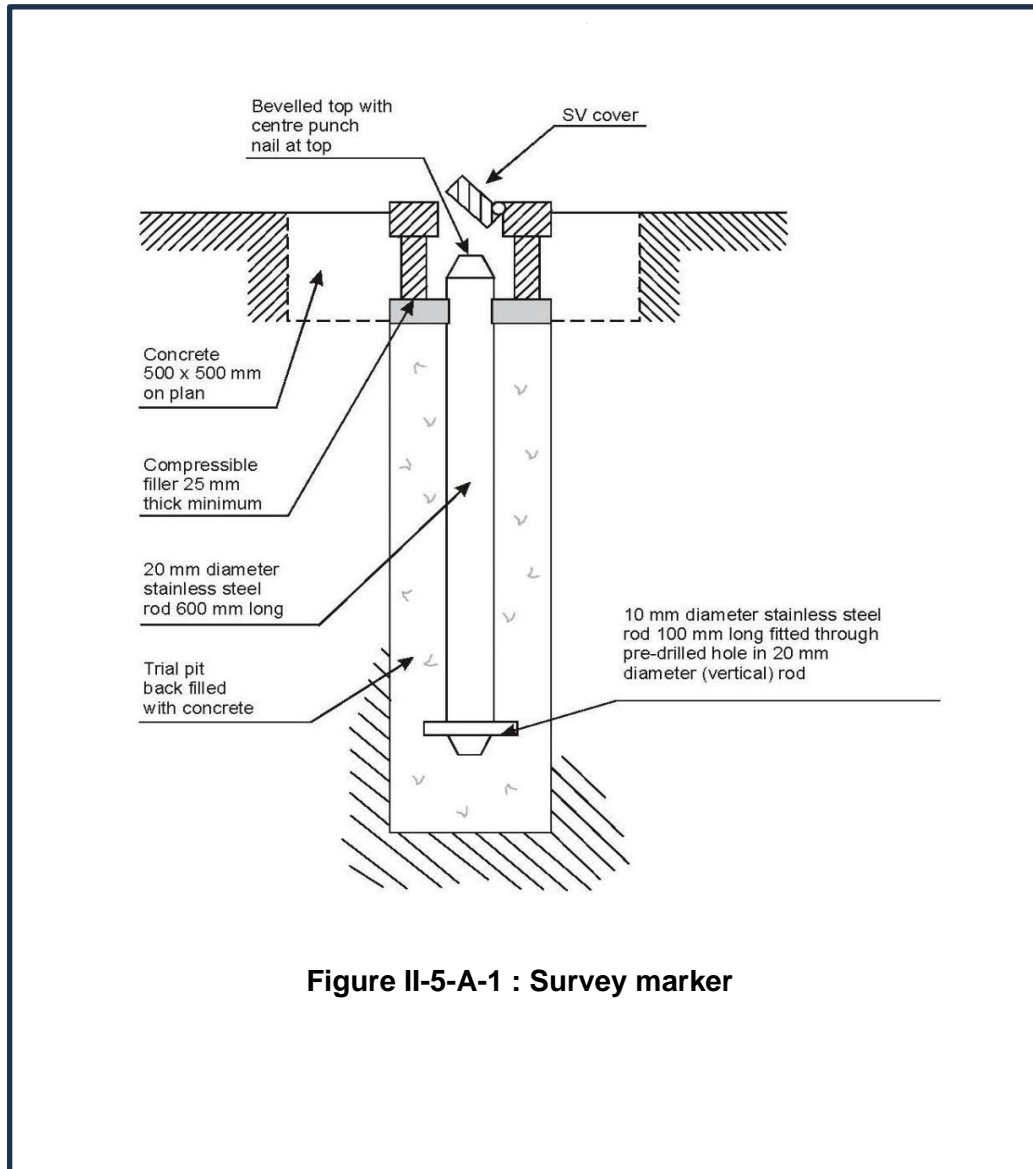
2.2 The system of numbering may include the aerodrome/heliport identifier, the station identifier, and the year of establishment. Inclusion of identifier is important for identification purposes in digital databases.

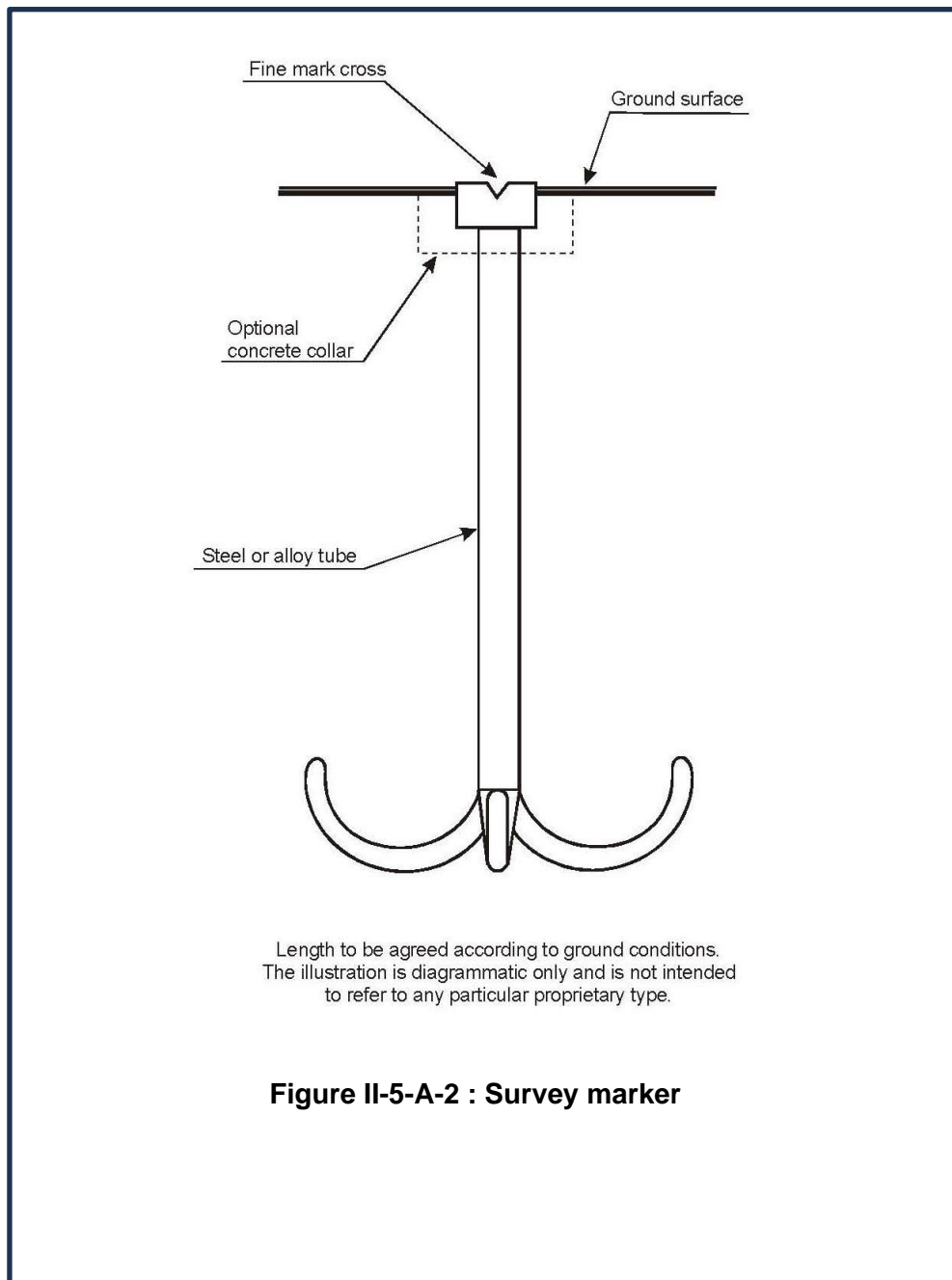
2.3 Station identifier whether alphabetic or numeric may be assigned chronologically with the construction of the station. The inclusion of the year allows the time of establishment to be referenced and lessens confusion where replacement stations have been established.

2.4 While numbering system may vary from state to state, it is important that each system include a means whereby the stations are not confused with other survey markers being established at the same aerodrome/heliport. A simple consecutive numbering system alone, without other identifiers, would not be suitable.

Example :







Attachment B : DESCRIPTION OF GEOGRAPHICAL POSITIONS

In order to standardise the determination of threshold positions for survey purposes, the following guidance is provided:

- Diagrams most closely representing the runway marking may be selected and used as the basis for a description of the location of the markings (lights) and the positions selected for the survey.
- Where none of the diagrams in this attachment are appropriate, a new diagram must be prepared, showing the actual arrangement of the markings and the positions selected for survey.

Note: Wing –bar threshold lights and lights installed ahead of the runway hard surface have no direct survey status with respect to thresholds.

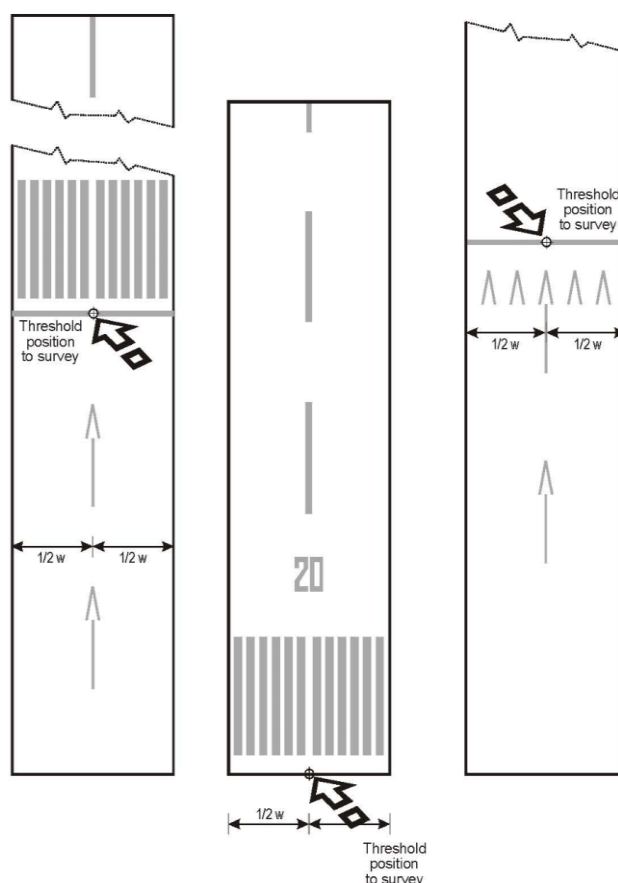
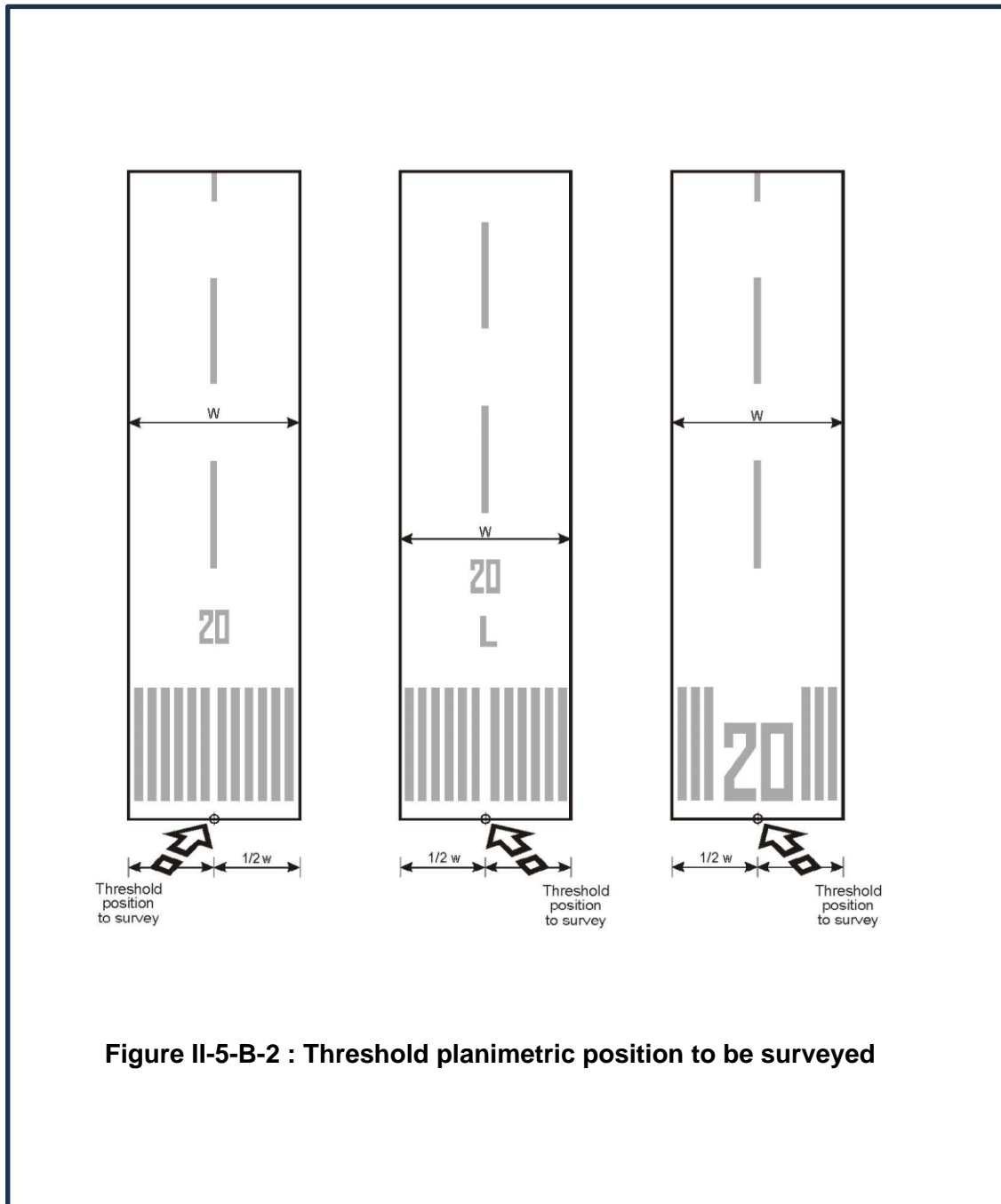


Figure II-5-B-1 : Threshold planimetric position to be surveyed



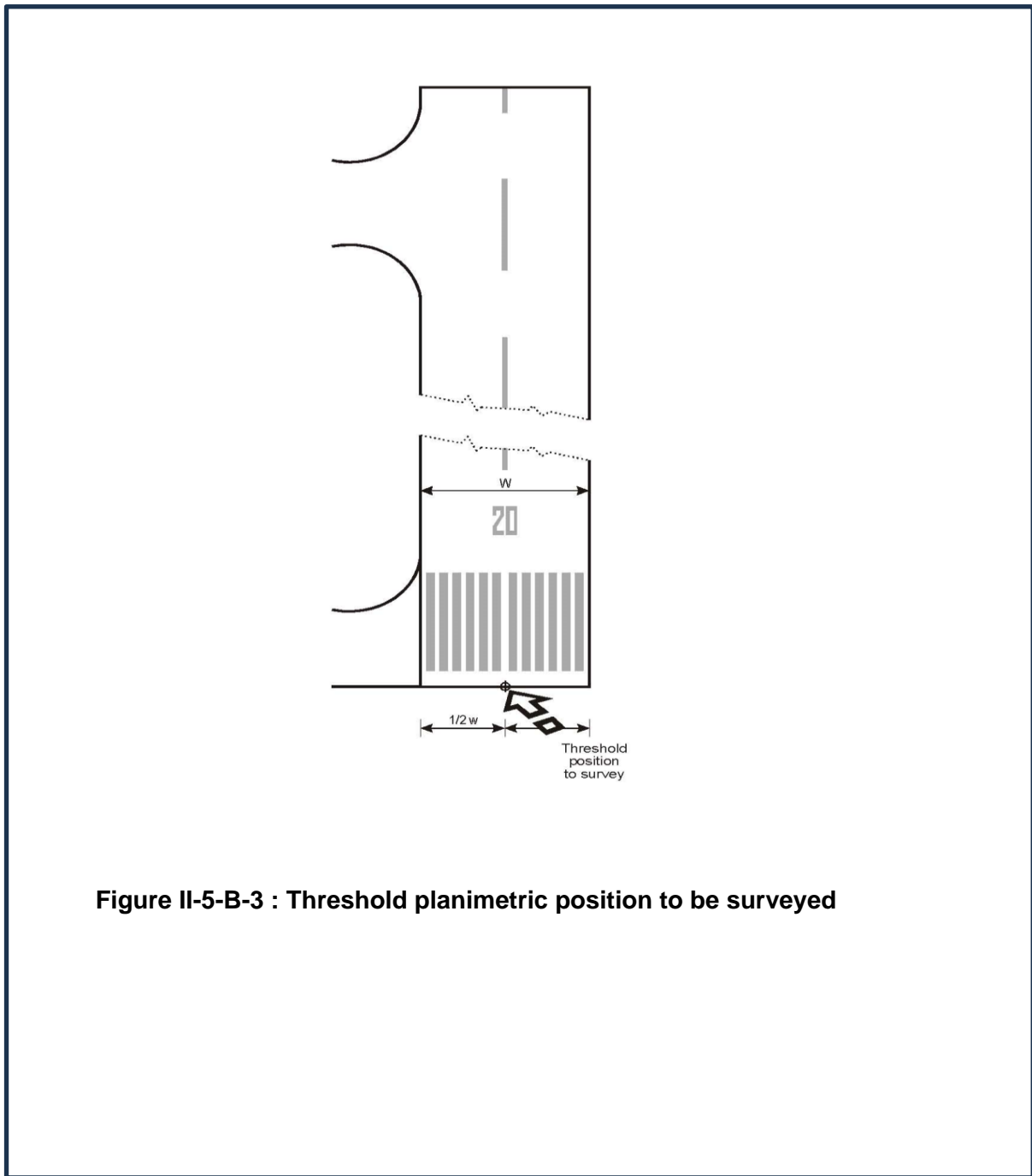


Figure II-5-B-3 : Threshold planimetric position to be surveyed

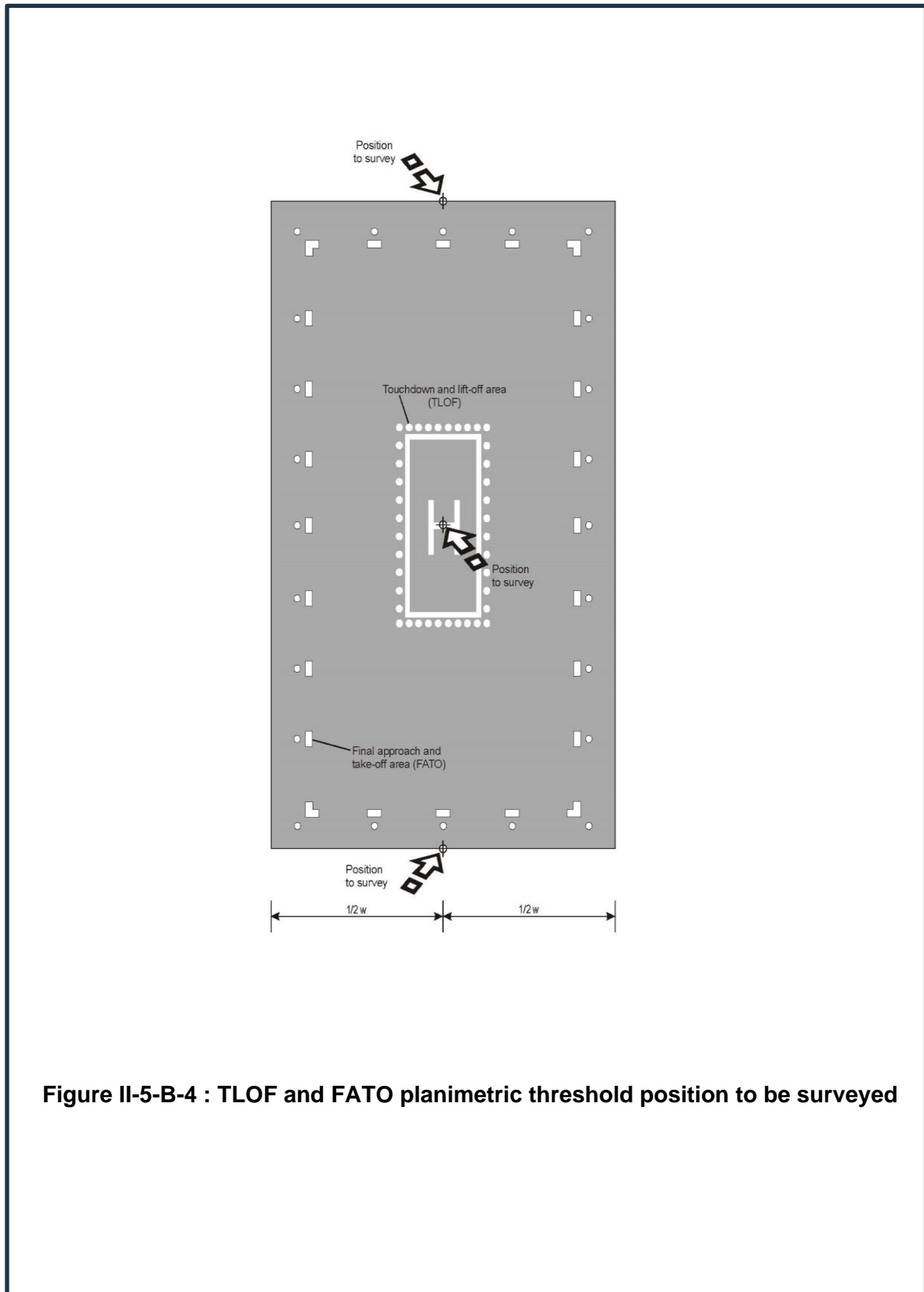


Figure II-5-B-4 : TLOF and FATO planimetric threshold position to be surveyed

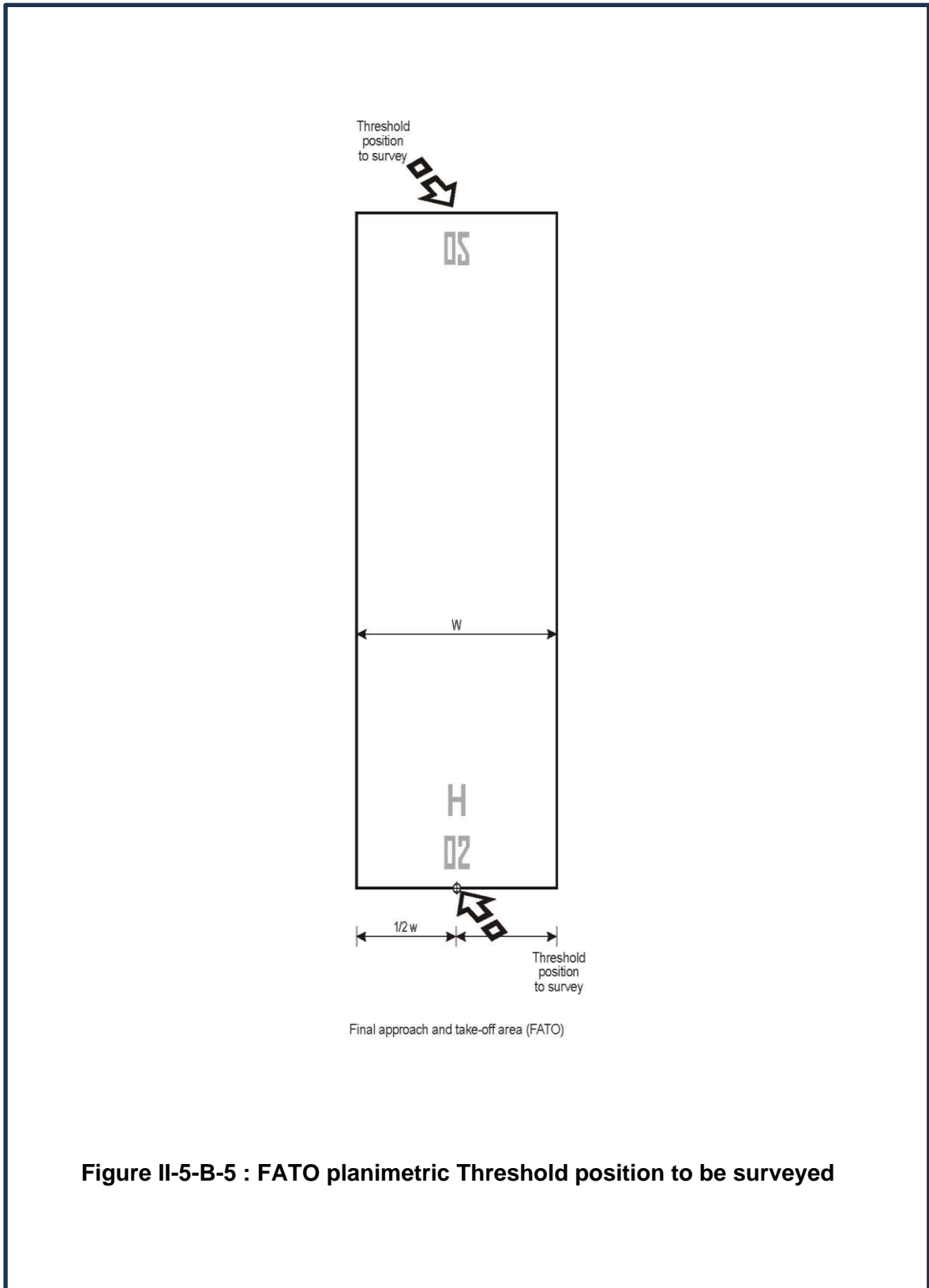


Figure II-5-B-5 : FATO planimetric Threshold position to be surveyed



Figure II-5-B-6 : ILS Localiser



Figure II-5-B-7: DVOR/DME



Figure II-5-B-8: NDB



Figure II-5-B-9: Runway and taxiway intersection to be surveyed

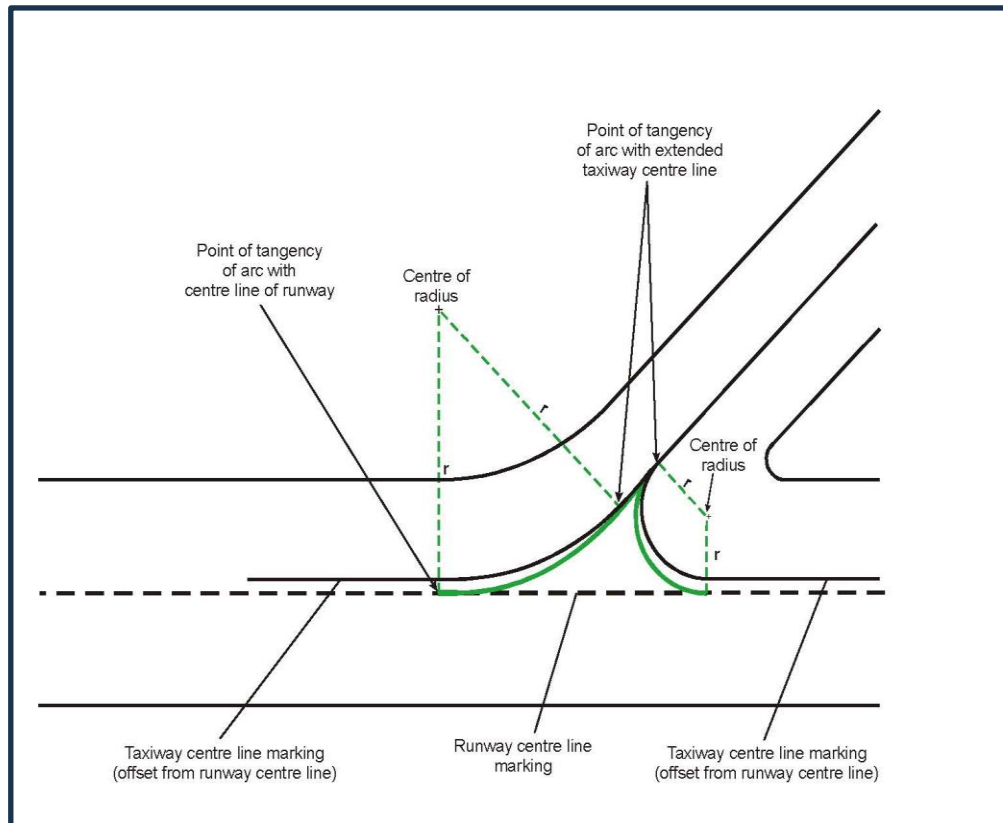
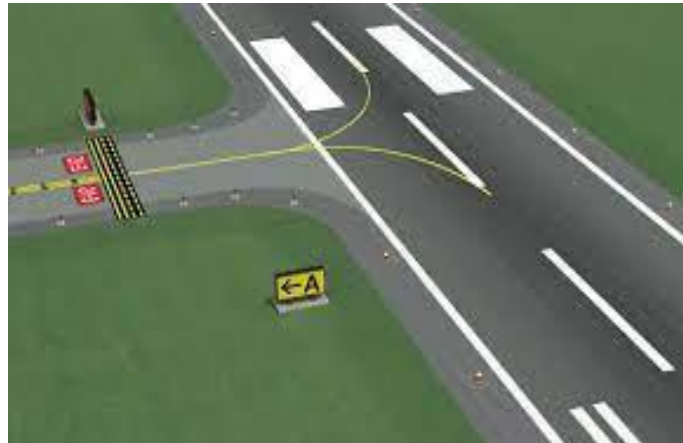
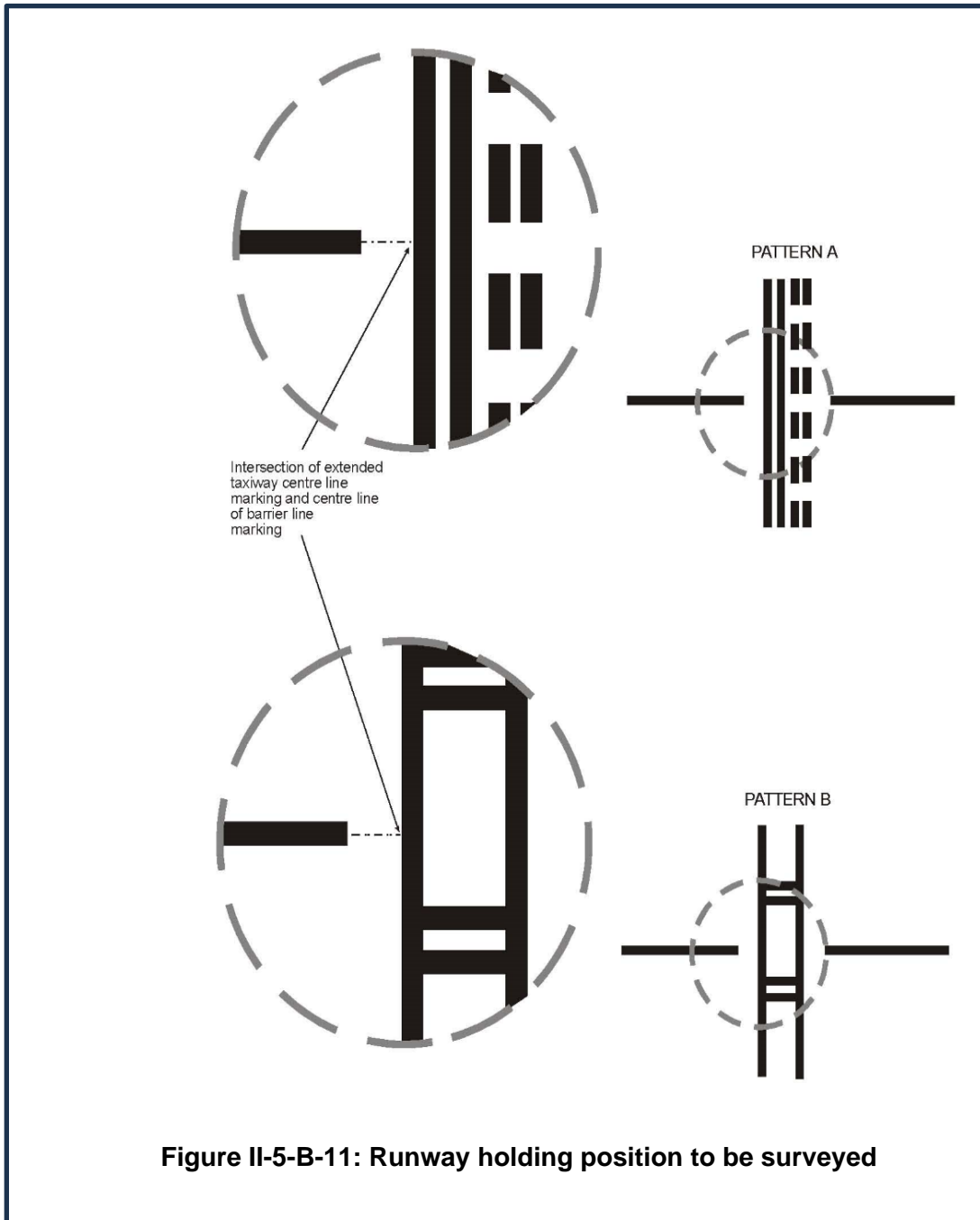
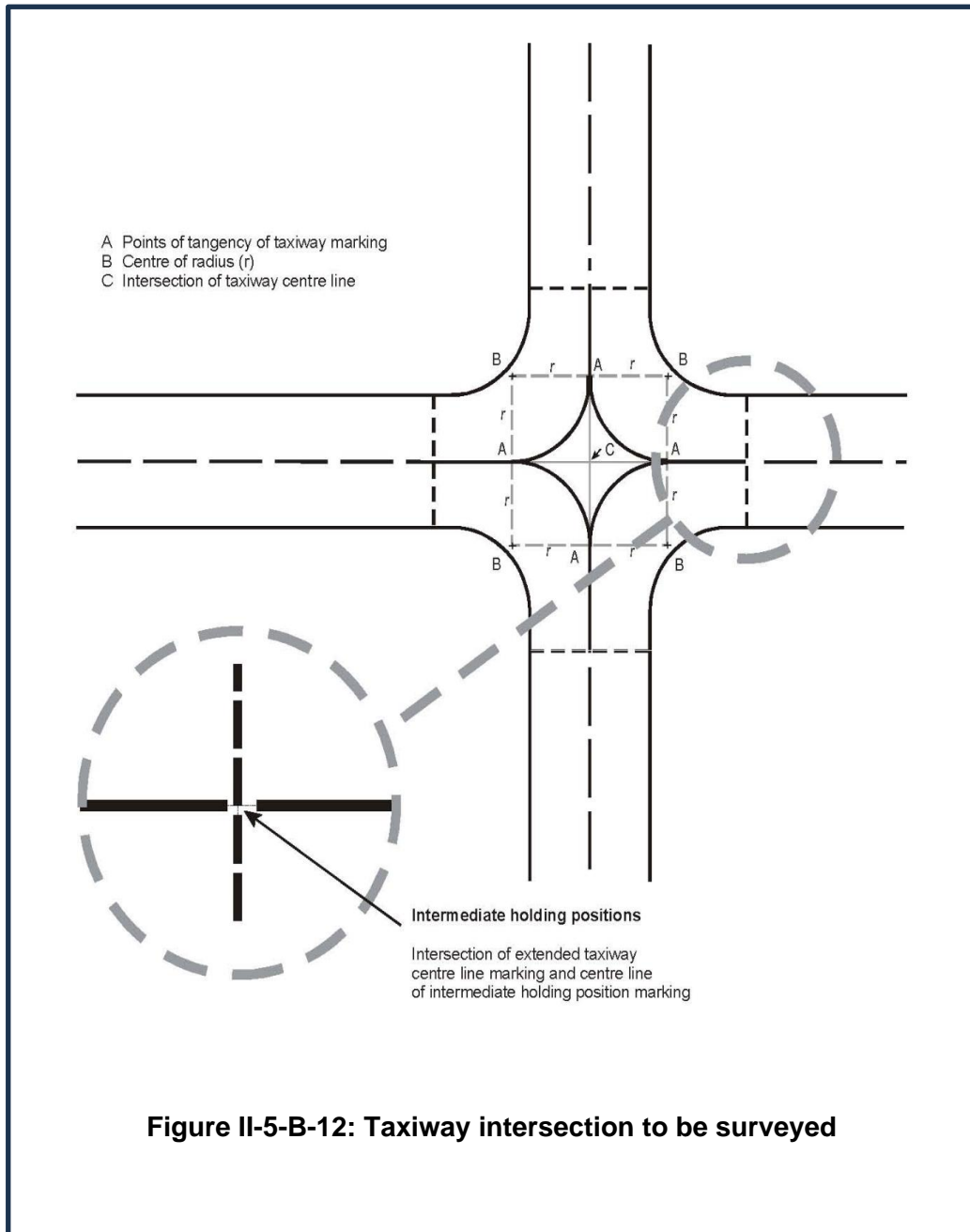


Figure II-5-B-10: Runway and taxiway intersection to be surveyed





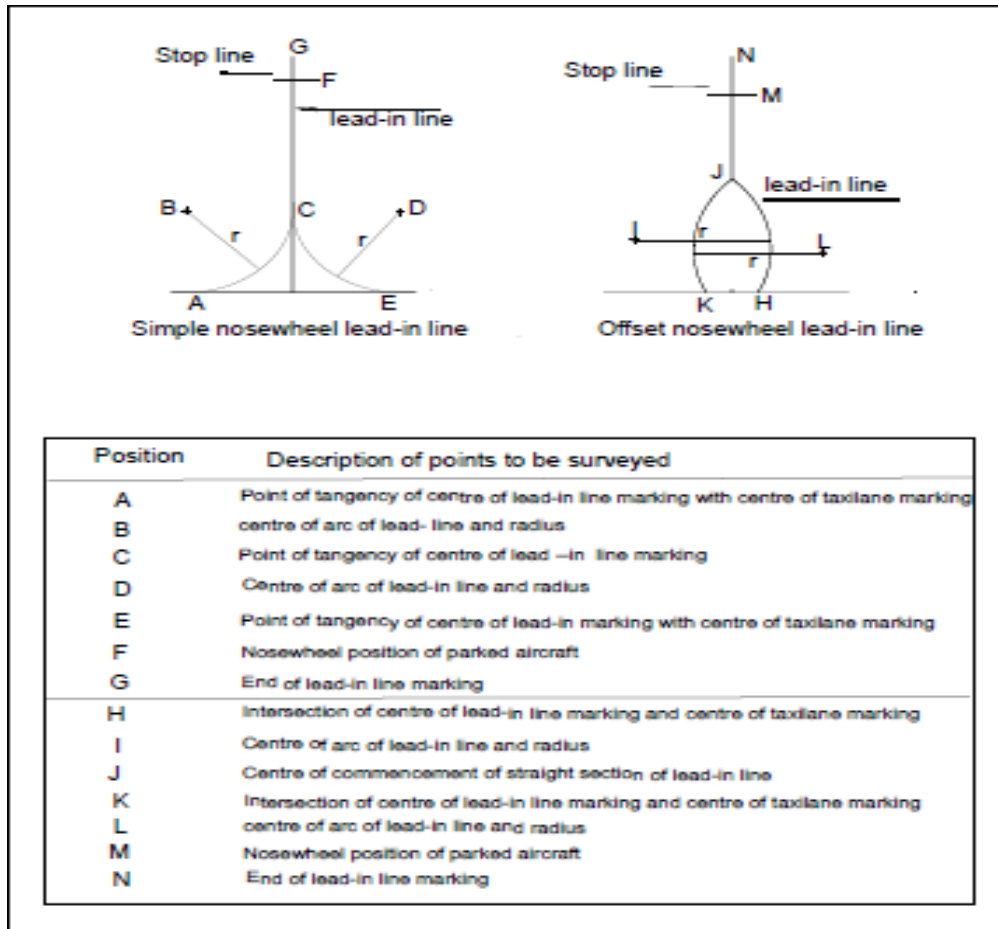


Figure II-5-B-13: Simple nose wheel lead-in line

Figure II-5-B-14: Offset nose wheel lead-in line

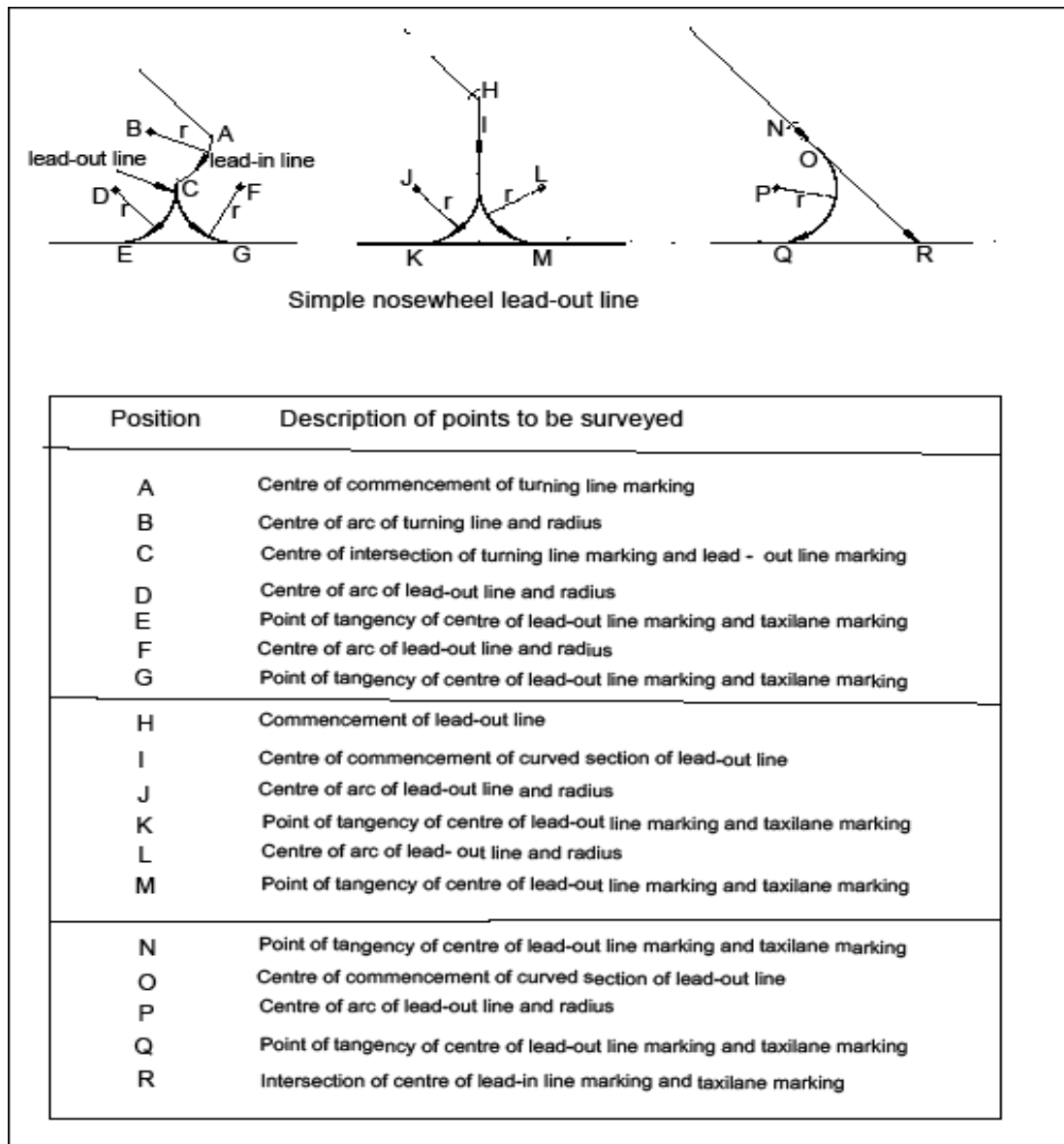


Figure II-5-B-15/16/17: Simple nose wheel lead-out line

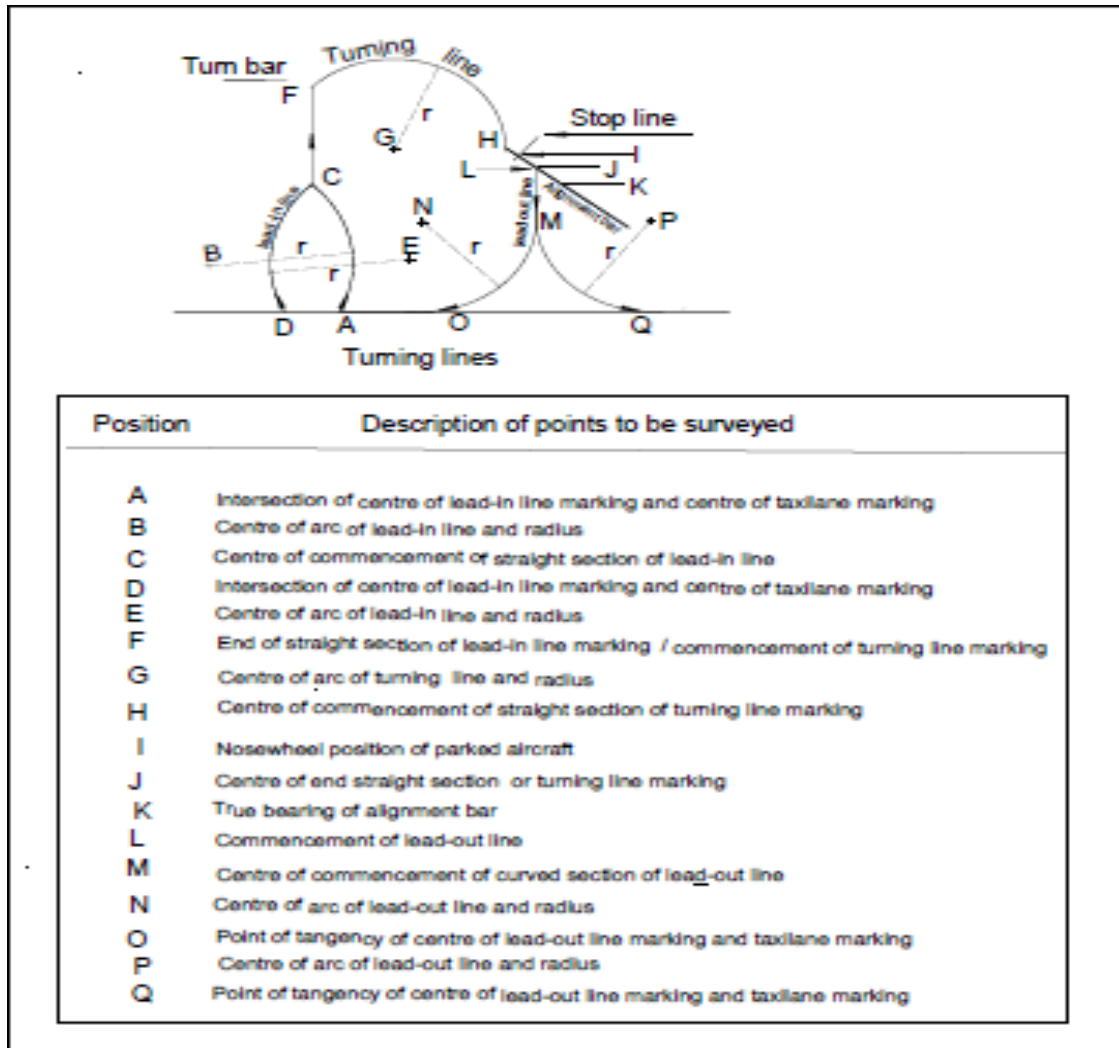


Figure II-5-B-18: Turning lines

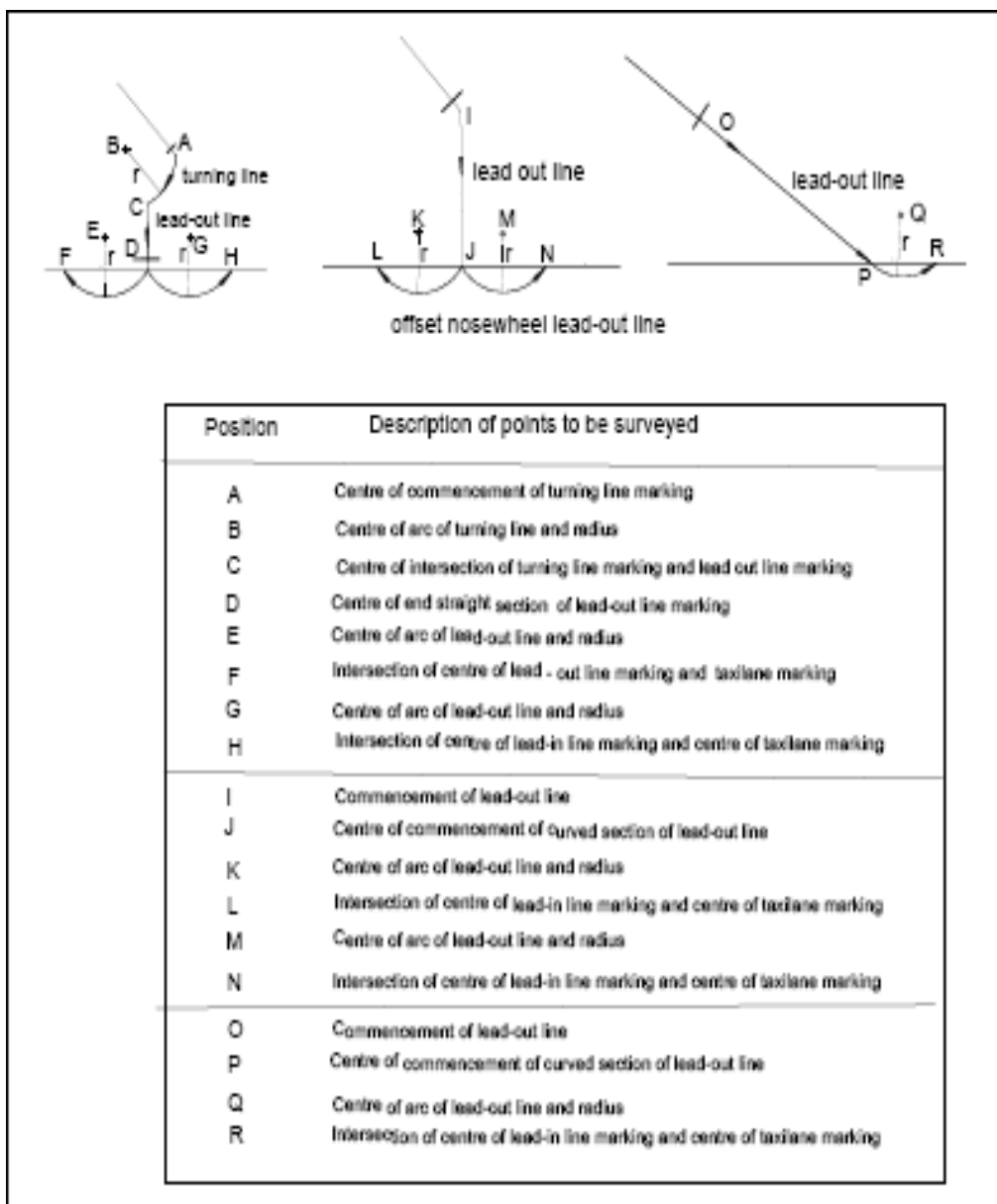


Figure II-5-B-19/20/21: Offset nose wheel lead-out line

Attachment C: SURVEY REPORTS

1. GEODETIC CONNECTION

1.1 A survey report conforming to the following general format must be provided:

Content list - Geodetic connection

1. Receipt note signed on behalf of the commissioning organization indicating the date of the receipt of the survey report, confirming its completeness and listing the distribution copies of the report
2. Historical data (date and general purpose of survey, name of the surveyor and surveying organization)
3. Description of the method of survey
4. Details of the datum connection and the source of control coordinates (i.e. original description and coordinate list from the national geodetic organization or list cross referenced to previous surveys)
5. Control network diagram
6. Survey stations description
7. Schedule of points surveyed showing date of monument, description and survey.
8. Quality control report indicating equipment calibration information and the method of checking of the survey. Demonstrate evidence that the accuracy requirements have been met

1.2 Records of actual observations must be provided in a separate indexed volume. Cross references to observations must be made in the report.

2. AERODROME / HELIPORT SURVEY

2.1 A survey report conforming to the following general format must be provided:

Contents list - Aerodrome/heliport survey

1. Receipt note signed on behalf of the commissioning organization indicating the date of the receipt of the survey report, confirming its completeness and listing the distribution copies of the report
2. Historical data (date and general purpose of survey, name of the surveyor and surveying organization)
3. Description of the method of survey
4. Details of the observations made, cross referenced to the control survey
5. Navigation elements survey plan and cross- referenced witness diagrams (where necessary)
6. Schedule of points surveyed showing coordinates and the date of

survey, including the diagrams as required

7. Quality control report indicating equipment calibration information and the method of checking of the survey. Demonstrate evidence that the accuracy requirements have been met

2.2 Records of actual observations must be provided in a separate indexed volume. Cross references to observations must be made in the survey report.

3. EN-ROUTE SURVEY

3.1 A survey report conforming to the following general format must be provided:

Content list - En-route Survey

1. Receipt note signed on behalf of the commissioning organization indicating the date of the receipt of the survey report, confirming its completeness and listing the distribution copies of the report
2. Historical data (date and general purpose of survey, name of the surveyor and surveying organization.
3. Description of the method of survey
4. Details of the coordination of individual navigation aids
5. Survey diagram showing the local connection by which the coordination of the centre of the aid were obtained
6. Schedule of points surveyed showing coordinates and date of survey
7. Quality control report indicating equipment calibration information and the method of checking of the survey. Demonstrate evidence that the accuracy requirements have been met

3.2 Records of actual observations must be provided in a separate indexed volume. Cross references to observations must be made in the report.

Chapter 6 : QUALITY ASSURANCE AND INTEGRITY

6.1 QUALITY DEFINITIONS

6.1.1 It is essential to have a common understanding of the terminology used in discussing quality issues. In order to avoid the different interpretations of the meaning of 'quality' based on their personal experience, the following definitions and descriptions are included to establish consistency.

Procedures: These describe the method used:-

- how the responsibilities for the task should be assigned.
- what should be achieved in the tasks.
- what should be recorded as the associated quality record.

6.1.2 A procedure is not equipment specific. It deals with what should be achieved having satisfied the steps of the procedure. Work instructions are the detailed "how to" descriptions. For example, how to operate a particular instrument or piece of equipment.

Quality

Totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs (ISO 8402).

Note: An **entity** is an item which can be individually described and considered (ISO 8402).

6.1.3 Quality can be described as the ability of a product to consistently meet its stated requirements, that the product is fit for its specified purpose. There is no single or absolute measure of quality although statements about the quality of a process or item may be based upon physical measurements and observations, for example 'quality level' defined below

Quality Assurance (QA)

All the planned and systematic activities implemented within the quality system, and demonstrated as needed to provide adequate confidence that an entity will fulfil requirements for quality (ISO 8402).

6.1.4 Once a method has been proven to produce the required product successfully, a system is required that can assure the method or methods are followed correctly each time the process is repeated. This is quality assurance and is achieved through the use of a Quality System.

All activities and functions which affect the level of quality of a product are of concern to Quality Assurance.

Quality Level

The extent to which the customers needs have been met.

A quality level of 100% means that there has been a complete conformance to specification every time.

Quality Management

All activities of the overall management function that determine the quality policy, objective and responsibilities, and implementing them by means such as quality planning, quality control, quality assurance and quality improvement within the quality system (ISO 8402*).

*This could be interpreted as the implementation of Quality Assurance (QA).

Quality Record

Documented evidence of tasks carried out which demonstrate that the required results have been achieved and providing sufficient links to other quality records to ensure traceability.

Quality System

The organizational structure, procedures, processes and resources needed to implement quality management. (ISO 8402)

Standard

The minimum specifications that must be met to fulfil the stated requirements. A quality system provides the management control to assure the required quality thresholds are achieved. These quality thresholds or specifications must be pre-defined. Hence the need for a 'standard document'.

Traceability

Ability to trace the history, application or location of an entity by means of recorded identifications. (ISO 8402)

Validation

Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. (ISO 8402)

Note: **Objective evidence** is information which can be proved true, based on facts obtained through observation, measurement, test or other means (ISO 8402)

Verification

Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. (ISO 8402)

Work instructions

Actual steps to carry out a procedure. These are the details which are specific, for example, to a particular piece of equipment used in the production process.

6.2 QA IMPLEMENTATION

6.2.1 Need for a Quality Assurance system

The objective of the WGS 84 Implementation Programme is to produce coordinate data referenced to a common datum in which a high degree of confidence can be placed on the accuracy and integrity of the data. The method used to acquire all the positional data to the required standard has to address the problems of the size of the task. All the coordinates produced should be traceable back to their origin along an unbroken trail. Each point is unique so that quality control checks on a sample would not be suitable. Considering the large number of points and the geographical spread it would be impractical to independently check every single point. However, it is possible to check the method by which the data is acquired. This can be achieved by quality assurance.

6.2.2 QA and WGS 84 Implementation

6.2.2.1 QA is about preventing errors occurring rather than fixing them. A method has to be designed that will give the required end product when followed correctly. To do this it is essential to understand the requirement. The various tasks involved need to be identified and managed efficiently. This is done by using a Quality System (QS) or Quality Management System(QMS). An example of the basic elements of such a system follows(Figure II-6-1):-

- a) **Organization** : The management structure. It is very important that responsibilities for the operation are stated and understood by all concerned i.e. everyone knows who does what
- b) **Planning / Procedures** : Identifying the tasks to be done and developing procedures necessary for the production process.
- c) **Documentation** : Procedures should be written down to enable consistency of application by different personnel. Documents can be updated, but under an authorized control procedure. Written quality records are needed to provide traceability if there is a cause of a problem to be located.

- d) **Assessment:** A most important part of any quality system is the method of assessment used, the audit process. This is what provides the checks that show whether the procedures are being used correctly, that they are achieving the required results. It initiates the loop back to make improvements where necessary. The aim of an assessment is to provide constructive recommendations for improvement where there are non-conformances, establishes confidence in the methods where there is a conformance.
- e) **Review:** The process of considering the assessment result and implementing any necessary changes through a corrective action procedure.

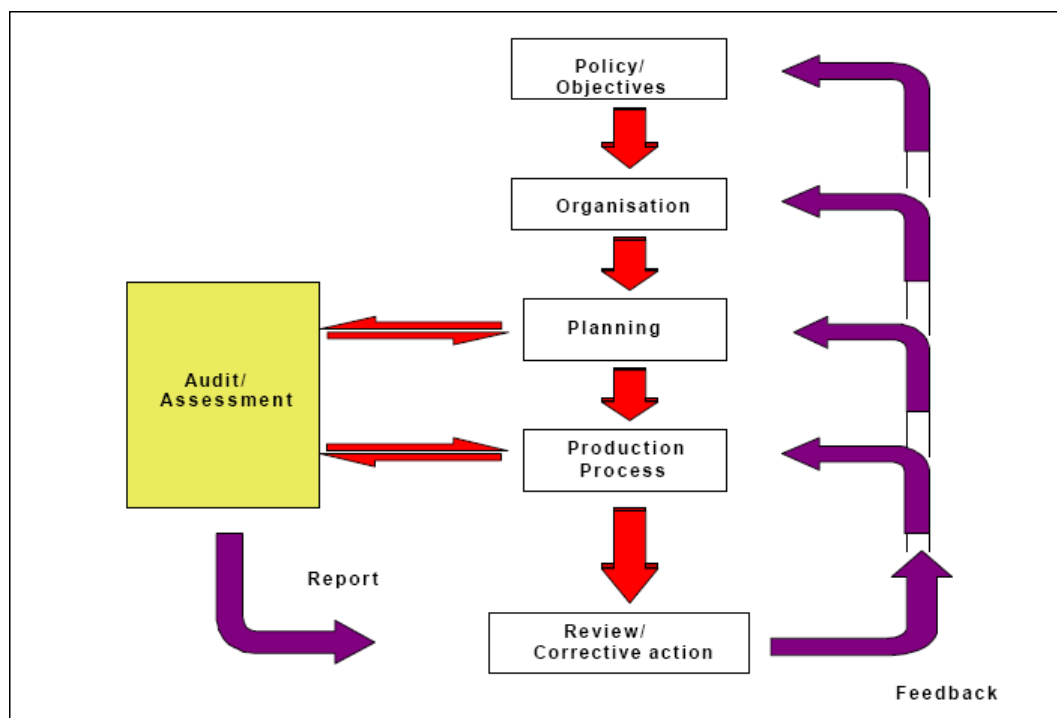


Fig. II-6-1 shows a basic structure of a quality system

This is expanded further in the Fig.II-6-1

6.2.2.2 Fig. II- 6-2 is an example of QMS structure applicable to the QA of the acquisition of new data described as follows:-

- a) The objective and the responsibilities as set up within the National Administration.
- b) The various planning tasks that are needed, including: -
- i) the decision as to whether to use existing data or to resurvey.

- ii) the type of survey, geodetic, aerodrome or en route.
 - iii) the accuracy requirement
 - iv) the briefing of survey contractors on these requirements, safety issues and evaluating their suitability before awarding contracts.
- c) Having received a completed survey, the assessment process (or audit).
There are two outcomes from the assessment :
- i) conformance in which case, data can then processed; and
 - ii) nonconformance, where the process flow then should loop back to the planning via a corrective (or remedial) action procedure.

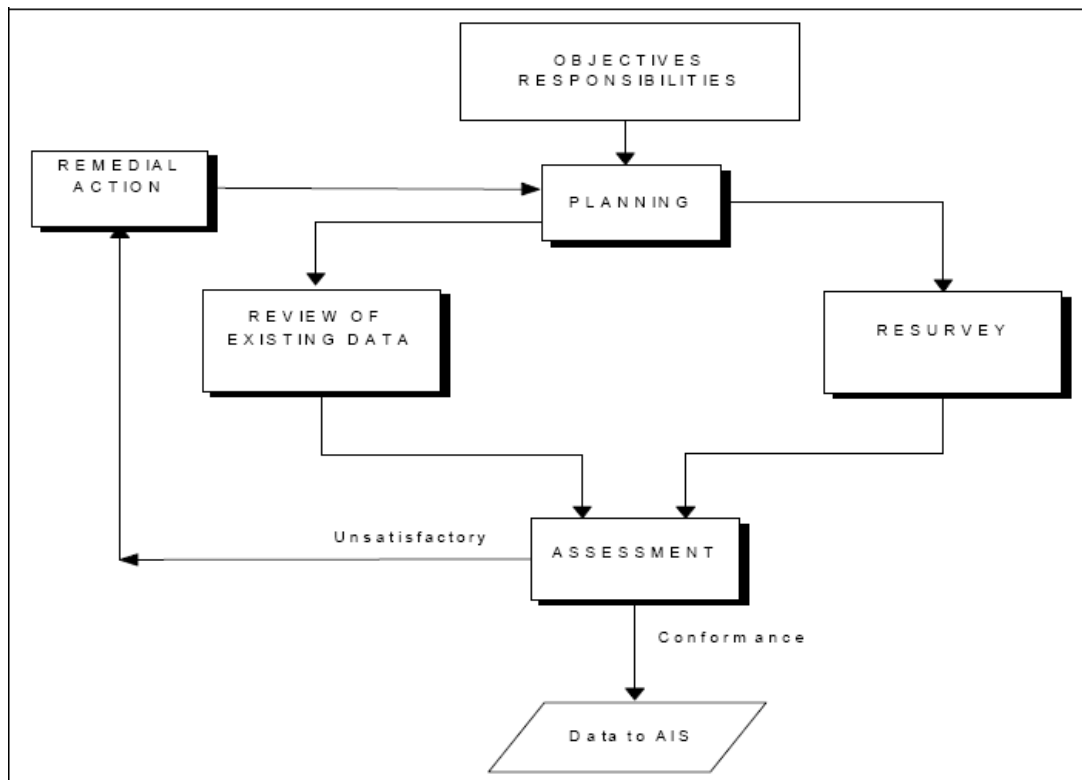


Fig. II-6-2 Model of a state quality plan

6.2.3 Safety

6.2.3.1 A Quality System must take account of safety issues. Involvement in safety has various legal positions to be considered, and will vary within each Administration. However, any Quality System needs to encourage safe working practices as any accident is a

reflection on the quality of the service. For example, making sure that the survey teams are well briefed on the type of survey they are to do, and on any local procedures that they should be aware of. This is particularly important where work about airfields is concerned.

6.2.3.2 Prior to awarding any contracts evaluation of the survey company's experience should be considered. Such as, have they conducted any airfield programmes before. To follow the requirements of a Quality Management System quality records should be kept, such as a checklist of the briefing of the survey team. For example, if there is no acknowledgement that the surveyors have been briefed on the airport safety requirements then they should not proceed

6.2.4 Quality plans

The QMS described above has been designed purely for the QA of the origin of WGS 84 data, largely relying on the acquisition by survey crews. The scope of this system does not extend to include the management of all the navigation data processes that may be the responsibility of an AIS department. However it is possible for this QMS to function as a subsidiary element within total QS having a wider scope. The demoted QMS is referred to as a Quality Plan. For example the QMS described in Fig.II-6-2 has been labelled the State Quality Plan. This plan can be incorporated within an existing Administration's quality system or as part of a new one along with other QP's such as for managing the onward flow of data via data base storage and publication. Fig.II-6-3 gives an example relationship of such a total data management system.

6.2.5 Data quality

If integrity is to be assured and demonstrable, all coordinates must be traceable to their source by an unbroken trail. Whilst the CRC will be used by receivers of data to confirm correct receipt, it is not sufficient to define quality of data. A record must, therefore, be kept of all changes. A sample set of data required could be elements of the following :

- i. Data accuracy
- ii. Origin
- iii. Details of changes made to the data
- iv. The reason for the change
- v. References associated with the change
- vi. The source of the change
- vii. The identity of the person making the change
- viii. Date of the change

6.2.6 Procedures to ensure traceability

6.2.6.1 The quality records will need to be kept by the organization carrying out the modification. Whilst an indicator allowing the retrieval of this information will need to be

associated to data transferred to the user organization together with the CRC, the quality record itself does not need to be sent.

6.2.6.2 Such records may be electronic or paper-based, although certain change information must remain with the data item throughout the navigation data cycle, to provide the unbroken trail and must, wherever possible, be stored in an associated field or record.

6.2.7 Procedures to ensure integrity

6.2.7.1 The accuracy of data is determined at the point where the data originates. In the case of surveyed data, the Procedures necessary to ensure accuracy are being addressed in the WGS 84 Implementation Programme. Declared points must be declared to the accuracy required by the data model. Procedures for calculating points must not only be detailed in the Quality Framework and take account of the accuracy of the source data but must also ensure that subsequent mathematical manipulation maintains the accuracy set by the data model requirements.

6.2.7.2 If data integrity is to be assured, there must be clearly defined Procedures for all stages of the navigation data process, from the point where the data are originated to the point where the data are used. Apart from rigorous manual independent verification, there is little that can be done to ensure the integrity of data held in a manual system. However, once the data are held on electronic media, there are a number of options available. When choosing appropriate methods to protect the integrity of electronically stored data, consideration must be given to the integrity requirements for the data and the risk posed to that data.

6.2.8 Manual data entry

The transfer of data from written or printed form into the format the data is stored in computer, is the *greatest potential source of error in the entire process*. If end to end integrity, at the required levels, is to be achieved careful consideration must be given to the means by which this transfer is to be performed and verified.

6.2.9 Validation checks

Validation checks, which can be performed once the data item is held in an electronic format, will detect many of the errors induced by manual data entry. It is doubtful though whether integrity can be improved even by one order of magnitude on the basis of validation checks alone.

6.2.10 Software aspects

6.2.10.1 Whenever data are manipulated by a computer program, even if it is simply to extract an item from a data base and output it onto magnetic media, there is a risk that (as a result of software error) the resultant data item will not be a true copy of the original. Accordingly, all software used to manipulate data must be subject to rigorous testing, verification and validation.

6.2.10.2 In addition to the threat to integrity posed by a software fault, there is a threat from computer viruses, which may be introduced via executable code in applications software and utilities. This must also be addressed by configuration management system.

6.2.11 Data retention aspects

Although hardware reliability has improved markedly over the years, there is still a risk of corruption from component failure or power surge/spike. Detection of corruption caused by hardware faults can be improved by the use of validation and verification checks at regular intervals.

6.2.12 Data transfer aspects

The risk to data, while being written to or read from magnetic/optical storage media, depends upon the devices used and the methods employed in the packing and handling of the media. Protection is provided by the software controlling the reading from/writing to operation. To achieve the protection of data while stored or being transferred CRC must be used.

6.2.13 Data use aspects

Consideration must be given as to whether the Procedures for the production and delivery of data to the airborne Flight Management System (FMS) have provided the necessary level of integrity when the data are eventually extracted from the FMS data base for final use. The probability of corruption after delivery into the FMS will depend upon the design of the FMS itself

Chapter 7: DELIVERABLES AND PRESENTATIONS

7.1 SURVEY REPORTING REQUIREMENTS

7.1.1 It is important to know what type of data has been surveyed and to what level of accuracy and resolution this was done. The classification of data types, accuracy and resolution was described in chapter 2. In addition to the production of accurate positional data, the other aim of the programme is to be able to recall the history of that data. It is the survey report that will provide the details of the acquisition method used. This is the quality record that will be used for assessment and future reference.

7.1.2 It is therefore essential that the surveyors record all the necessary information that will be required. To ensure this a minimum survey report specification should be given in the Surveying Standard. This way all survey work undertaken to determine the coordinates of navigation facilities can be reported in a predefined format.

7.1.3 An advantage in having consistency of report formats will be seen in the assessment phase. Checklists drawn up based on the Standard format and cross referenced to the mandatory points would facilitate an efficient audit process particularly where large numbers of surveys are involved. A further advantage can also be seen in providing the surveyors with the checklists prior to operations as a guidance document for the reporting requirement

7.2 BASIC REPORTING STRUCTURE

The following description is an example of the basic reporting format structure;

7.2.1 Types of survey

a) *Three types of reporting formats.*

- i. Geodetic survey
- ii. En Route survey
- iii. Aerodrome/heliport survey

There is also the case of coordinate data that has been produced by conversion from an existing data set, which itself should have originated from one of the above survey types.

b) *Common reporting elements:* A number of topics are common to each of the report formats:

- i) Historical data should describe the general survey information
- its purpose,
 - the date,
 - the surveyors names and the company.
- ii) Survey method used
This is the actual way the survey was carried out not just a description of the theory behind the technique used.
- iii) Diagrams
Where relevant, diagrams should be included such as for station descriptions, control networks, threshold descriptions.
- iv) QC report.
The Quality Control (QC) report should provide information of the equipment calibrations carried out. It should also describe the methods used to check the survey and in particular show evidence that the required accuracy for the particular data type has been achieved.
- v) Observations:
Records of the actual observations should be provided in a separate volume. Cross references should be made to the survey report.

c) Aerodrome/heliport survey report format example.

The following list shows a complete reporting format specified for an aerodrome/heliport survey.

1. A receipt note signed on behalf of the commissioning authority indicating the date of receipt of the survey and the number of copies of the report
2. Historical data giving the dates and purpose of the survey, the survey company names and personnel.
3. Description of the method of the survey
4. Details of the observations made with cross references to the control survey.
5. A facility survey plan with cross referenced witness diagrams (where necessary).
6. Schedule of the points surveyed giving the coordinates and the date when surveyed.
7. QC report which gives equipment calibration detail, and describes the methods used to check the survey. In addition evidence should be provided to show that the accuracy requirements have been met.
8. The actual observations should be provided in a separate volume indexed

so that cross references can be included in the report.

7.3 FORMATS, STANDARD ALGORITHMS AND WORKING PRACTICES

The following data format, standard algorithms and working practices are suggested for common use.

7.3.1 Universal data delivery format (UDDF)

7.3.1.1 The UDDF submitted by United States (FAA document 405) details a digital format that can be used when delivering surveyed data. It accommodates fields for various aeronautical data including aerodrome/heliport runway, navigation aid and obstacle, in a standard ASCII format. This information can be easily read into the user data file and databases. It details the format to be used when reporting surveyed data to the AIS. Annex 15 to the Convention on International Civil Aviation details the format to be used when reporting AIS data in printed form. Standardization of a transfer format for an Electronic AIP (E-AIP) is currently under consideration. ARINC 424 details the format to be used when preparing navigation reference data tapes/disks for merging with operational FMS software, flight planning system software and simulator software and can be considered to be the standard format for electronic transfer of navigation data.

7.3.1.2 FAA document No. 405 is organized as follows:

- 1) *Structure overview* describes the general structure of the UDDF format.
- 2) *Conventions* describes UDDF conventions, such as the use of record type separators and field delimiters.
- 3) *Annotated file listing* presents annotated UDDF files which include code numbers at the beginning of each field. The code numbers have been decoded indicating data description, field type and field columns.

7.3.1.2.1 *Structure overview*: The UDDF is implemented in 7 files, each file providing data for one of seven survey types, as follows;

- a) airport obstruction chart (AOC);
- b) area navigation approach precision conventional landing (APC);
- c) area navigation approach non-precision conventional landing (ANC);
- d) area navigation approach precision vertical landing (APV);

- e) area navigation approach non-precision vertical landing (ANV);
- f) engine out departure (EOD)
- g) special purpose (SPL)

Each of these files is organized into the following data sections.

- a) Airport data furnishes airport name, ICAO location indicator, FAA site number, survey date, survey edition, magnetic declination and other airport and survey information.
- b) Runway data furnishes thresholds and displaced thresholds, stopway, blast pad and other runway related information.
- c) Navigation aid data furnishes navigation aid information including computed distances between navaids and selected runway points.
- d) Obstacle data furnishes information on obstacles, including computed distances from and heights above selected runway points.
- e) Special notices lists miscellaneous information that cannot be logically
- f) included with the other data, such as advisories of possible surface penetrations by vessels.

7.3.1.2.2 *Conventions:* UDDF information is furnished as ASCII files. The file name identifies the airport, approximately survey date and survey type. Each field is delimited by the vertical broken line symbol and data sections are separated within the file by the “@” symbol. Data section within a section, such as data for individual runway within the runway section, are separated by the “#” symbol. The end of the file is indicated by “EOF”.

7.3.1.2.3 *Annotated file listing:* An annotated file with field descriptions is required (Figure II-7-1).

7.3.1.2.4 When entering data into the database, it will be necessary to :

- a) confirm the data against the original survey data;
- b) enter the data under strict quality control procedures; and
- c) verify the entered data.

7.3.2 Cyclic redundancy check (CRC) algorithm

7.3.2.1 For the preparation of electronic aeronautical database, it is specified that the transfer of data, whether personal computer to personal computer, within a database, or digitally over communication network, be monitored by CRC determined for the batch of data to be transported. A CRC can also be used to monitor the integrity of specific records within the database.

7.3.2.2 CRC is an error detection algorithm capable of detecting small changes in block of data. When development and transfer of data takes place by manual means, CRC value could be attached to the data set so that each user could compare the original CRC to a recalculated value. A hard copy AIP could be created using a desktop publishing system that would provide the aeronautical data in an electronic format. Individual data or all the data contained in one page could then be wrapped into the CRC to ensure the protection of data. The resulting calculated value of the CRC applied should be printed either together with the specific individual data or for the whole page. In this way, the CRC value attached to the original data values could be monitored from data creation through publication. Recipients of data such as the data preparation agencies and avionics manufacturer, would then be able to verify the integrity of the values received from the ANSP prior to inputting into the database by comparing the printed CRC value with the value obtained from their own, independent CRC check.

7.3.2.3 The CRC is a mathematical process whereby a sequence of N data bits is manipulated by an algorithm to produce a block of n bits, known as the CRC, where n is less than N . A check of the integrity of the data can be performed by comparing the result of the application of the algorithm with the declared expected result. A failure of the mathematical routine to regenerate the CRC value from the data indicates that either the data or the CRC has become corrupted and the data is therefore no longer reliable. By careful choice of the algorithm employed, in conjunction with the relative values of n and N , it can be guaranteed that more than a specified proportion of the original N bits must be corrupted before there is any possibility of the same resultant n bit code being produced. For a given CRC formula the ratio between n and N will determine the integrity level achieved for any data element. Typically, the highest level of integrity will be achieved for the latitude, longitude and identifier with a 32 bit CRC.

7.3.2.4 In summary, the characteristics of a CRC are:

- a) Better than check sums or parity bits for error detection
- b) Elements of generating a CRC:
 - data block divided by a generating polynomial
 - CRC is Resulting Remainder
 - CRC tagged onto the end of the data block
 - No errors: Remainder from division should be zero

- c) Assurance of error detection (see relationship integrity <> CRC length, (Tab.II-7-1)

7.3.2.5 Using a CRC for checking the correctness of data

7.3.2.5.1 Integrity cannot be added once it is lost. Thus the integrity assurance must be provided from origination to final application. It is therefore suggested that when a data item is entered into electronic format it will need to be provided with the CRC and thereby provide the capability for verification on its transfer to the AIS. Then, and at each subsequent step, the receiver must confirm the data validity to provide assurance that it has not been corrupted while stored or during transmission.

7.3.2.5.2 The insertion into the data base at the start of the process is therefore a critical point in the process. At this time it will be necessary to :

- confirm the correctness against the original survey data.
- enter data under strict quality control procedures
- execute checks to verify data following entry.

7.3.2.5.3 For the CRC to be used for checking the correctness of data, the chosen CRC must be agreed between the system which produces the CRC and all systems which wish to receive the data. Furthermore, it must meet the level of integrity required for the individual data items to be transferred. This CRC value will need to be associated with the smallest related set of data. Thus for much of the WGS 84 Implementation programme this smallest element will be a single point. However a suitable set of data for a CRC check could be a procedure and ultimately, as the delivered set of data derived for the FMS which will not be changed, it could be a whole navigation data base.

7.3.2.6 Relationship between security and integrity

It is important to note that the CRC process provides integrity, in that it allows a receiver of 'wrapped' data to determine whether there has been any corruption of the data, or the calculated CRCV, since the data was wrapped. The CRC process does not provide security for the aeronautical data, in that it does not prevent the 'wrapped' data from becoming corrupted. Within the context of quality assurance, the CRC process can only detect inadvertent corruption of aeronautical data. The CRC process is a tool and not a single quality solution. Safety is not compromised by a verification failure of a CRCV as procedures should be in place to ensure such data is removed from the distribution process.

7.3.2.7 Computer format differences

Ideally, once formed, the CRC would remain unchanged until its application in the FMS or RNAV system. However, data formats change during the process and a CRC is only valid for a particular format of data. For example data is held in a computer in a format dependent upon word length which is unlikely to be the same in the data base of the supplier and the RNAV/FMS. In addition one step of the processing is the conversion to ASCII to meet the ARINC 424 Format. Thus it will be necessary to recalculate the CRC at various steps in the management of data. This recalculation of CRC must be carried out under strict quality control if the CRC is to remain a valid indication of integrity.

7.3.2.8 Integrity and CRC length

7.3.2.8.1 CRC offers absolute assurance of error detection when there is only a single period of "burst error" within the stream of data which was subjected to the CRC, provided that the sub-string containing all affected bits is shorter than the length of the CRC employed. If the separation of corrupted bits is greater than the length of the CRC, the probability of an undetected error is the probability that the same CRC will be produced from both the original and the corrupted data. Assuming an "even" mapping of valid data strings to CRC, the probability of undetected error rises to a maximum of 2^{-n} when the number of bits protected by the CRC is several times the length of the CRC itself.

7.3.2.8.2 Tab.II-7-1 gives the length of CRC required to achieve different levels of assurance of detection of multiple bit error in the data, where there is no guarantee that the separation of the bits in error is less than the length of the CRC. In order to achieve an integrity assurance of 3×10^{-8} , it is therefore necessary to employ a 32 bit CRC.

Tab. II- 7-1 INTEGRITY AND LENGTHS OF CRC

| INTEGRITY | Lengths of CRC | |
|-----------------------|----------------|------------|
| | BITS | CHARACTERS |
| 3.9×10^{-3} | 8 | 1 |
| 1.5×10^{-5} | 16 | 2 |
| 6.0×10^{-8} | 24 | 3 |
| 2.3×10^{-10} | 32 | 4 |

Fig. II-7-1 shows a navigational aid data example for the UDDF format.



| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--|---|-----------------|----|---------------|----|------------------|-----------|
| 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 9 0 1... | | | | | | | |
| ASR (MFR) | | 422306.60 00 | | -1225146.7000 | | 1310.0 | |
| 60 | | 61 | 62 | 63 | 64 | 65 | 66 |
| DME (14) | | 422140.0470 | | -1225201.8010 | | 1334.0 | |
| GS (14) | | 422242.4910 | | -1225224.7530 | | 1297.1 | |
| GS (14) PP | | 422241.0590 | | -1225229.7230 | | 1299.7 | 400 108 1 |
| LOC (14) | | 422140.1380 | | -1225157.8070 | | 1318.9 | 998 |
| LMM (14) | | 422321.0000 | | - | | 1225250.600 0 | 3250 |
| LOM (14) | | 422703.2000 | | -1225448.2000 | | | 2742 0 |
| VORTAC (OED | | 422846.5000 | | -1225446.7000 | | 2080.0 | |

The items 1 to 6 are UDDF field descriptions with the following meaning:

1 AIRPORT IDENTIFIER/A6/2-7

2 AIRPORT SITE NUMBER/A10/9-18

3 FAA REGION/A4/20-23

4 SURVEY TYPE/A6/25-30

AOC - AIRPORT OBSTRUCTION CHART

SURVEY EOD - ENGINE OUT

DEPARTURE SURVEY

NPA - NONPRECISION AREA NAVIGATION

APPROACH SURVEY PAA - PRECISION AREA

NAVIGATION APPROACH SURVEY

SPL - SPECIAL SURVEY

(SPECIFIC SURVEY REQUIREMENTS FOR EACH SURVEY TYPE CAN BE FOUND IN "FAA No. 405 - STANDARDS FOR AERONAUTICAL SURVEYS AND

RELATED PRODUCTS.")

5. OC NUMBER/I5/32-36

6. OC EDITION/A3/38-40

7.4 Data Management

7.4.1 The acquisition of WGS 84 navigation data has involved resurveying of ground points and/or the conversion of existing data by mathematical transformation. It is essential that once this work is completed the data and associated computed/derived points be held in some form of data management system. Any entry process to such a system must be able to confirm to users that the data is correct when the entry process is completed and that it remains so. This means that two issues must be addressed before any integrity measures can be applied:-

- i. the data is accurate
- ii. data is referenced to the correct location i.e. associated identifier is present

7.4.2 Validation and Verification of WGS 84 Data

Of primary importance to the WGS-84 project is the point of origin of survey data. It has been recommended that source data be stored in some form of database. This can be a master database holding all the navigation coordinate data or even a source database with records that contain additional supporting information such as more detailed survey and geodetic information. How this data should be entered into such a system before integrity measures have been applied is considered here.

7.4.3 Manual Entry

The transfer of data from written or printed form onto electronic media. The procedures involved can vary but include one or more of the following:-

- i. multiple entry by different operator
- ii. repeated entries by the same operator
- iii. use of automatic (software) comparison methods to check entries against each other

Careful consideration must be given to the means by which the transfer from printed to electronic form is to be performed and verified, if end to end integrity is to be achieved

7.4.4 Validation

The activity whereby a data item is checked as having a value which is fully applicable to the identity ascribed to the data item. Validation checks provide some assurance that data have

been correctly entered, maintained or transferred and they can assist the checking of the integrity of the data to a limited degree. However, validation checks cannot be used to improve the reported data quality. Their primary use is to filter out gross errors. These checks include:-

- a) range limit - ensure that data fields which have been accorded specific ranges of values, do not hold data values outside that range
- b) related record / field - ensure that appropriate data are held in related fields or records.
e.g. every survey point needs to be supported by an identifier, description, latitude, longitude, and height data
- c) data item relationship - such as collinearity, elevation and geographical vicinity checks. Validation checks are often confused with verification, they are two different processes. Both are important as they can take place at different points of the data management operation. Normally, it is better to validate before verifying, as the latter can be a more time consuming process. It would therefore be more efficient to eliminate any gross errors prior to verification. Survey quality checks can be made by comparison with independent derivation, e.g. existing data may be used where parameters have been derived to transform existing data from the local datum to the WGS 84 reference system. Manual data entry methods can be made using software to check operator entries for correct field format, range limitations, expected geographical location.

7.4.5 Verification

The activity whereby the value accorded to a data item is checked against the source of that value. Here we have to achieve 100% comparison to the source data. Where manual data entry is used, software should be used to check consistency of multiple data entry methods. Verification is a process for checking the integrity of a data item. It can take place when data are input into a database, e.g. a visual check of the input data against the original source document by an independent checker, or an automatic check of the same data which is entered two or more times by one or more data entry operators (double, triple entry methods). Re-computation and confirmation of CRC values is also a form of verification check.

Note that the use of a CRC tool can only be effective in this instance if the CRCV's are applied at the point of origin by the data supplier i.e. verification has taken place at this point. Validating a CRCV only confirms that the data has not changed since the CRCV was derived and appended. Any procedure established to validate and verify must also ensure that where errors

are identified these are dealt with by corrective action i.e.

- a) ensure that the corrupt data is not stored or passed on.
- b) investigate the identified problem.

7.5 Presentations

(Refer Attachment C to Part II Chapter 4 for survey reports)

7.5.1 Plans

7.5.1.1 The format of the base mapping for the Aerodrome Layout / Grid map is at the discretion of the Aerodrome Operator. Listed below are the acceptable formats:

- Digital mapping (see Part I Chapter 1, paragraph 13)
- Hard copy mapping compilations
- Published mapping sheets

7.5.1.2 Surveyors shall ensure the following:

- The most recent mapping shall be used.
- National Grid reference system shall be shown with grid values along the plan edge at convenient intervals
- Data reference source and revision data shall be shown on the plan.
- Copyright licence requirements shall be met when required.

7.5.2 Plan Sheet Size

It is recommended that the sheet size should be limited to A0 size for easy storage and handling. Where this is not practical due to the extent of the survey area, out-size and adjoining sheets may be used. When using an adjoining sheet system, it should be capable of being abutted and orientated to give the most economical coverage.

7.5.3 Plan Sheet Layout

7.5.3.1 Where multi-sheets are used, full reference shall be given to the total number in the series

7.5.3.2 Each sheet shall have a title panel. The information shown should consist of the following:

- Aerodrome
- Drawing Title
- Drawing number or reference number including current amendment

- Date of survey
- Scale
- Survey company name and address including telephone number
- Surveyed by
- Checked by
- Sheet number
- Sheet lay-out and diagram, if applicable
- Abbreviations used
- A reference to the appropriate survey report
- Statement of vested copyright if required

7.5.4 Survey Reports

7.5.4.1 Geodetic Connection Report (if required) shall include the following:

- Quality Records as per Chapter 5 (Part II)
- Details of the connection of the aerodrome control network to the geodetic network
- Aerodrome control network plan
- Survey stations descriptions
- Transformation parameter

7.5.4.2 Full Survey Report Shall include the following:

- Quality Records as per Part II Chapter 6,
- Survey Declaration Form - as per Part III Annex A 7.5.4.3 Check Survey

Report shall include the following:

- Abbreviated Quality Records that refer back to the previous Full Survey with regard to surveying methodology
- Survey Declaration Form - Part III Annex A

- Schedules listing all obstacles that have been added or deleted since the last survey (see paragraph 7.5.4.4 below)

7.5.4.3 For traceability purposes the complete documentation shall be reissued on every occasion that a check survey amends the preceding full or check survey.

7.5.4.4 Format of the schedules listing changes shall be at the discretion of the surveyor as agreed with the Aerodrome Operator. It is recommended that schedules are prepared as digital spread sheets to enable users to track changes where an obstacle has been given a new feature number the old number shall be referenced against it.

7.5.4.5 Obstacles lists will also be provided as lateral, longitudinal distances with respect to associated runway centre line and threshold in a tabular form.

The permissible top elevation of the obstacles located in the approach, transitional, departure and missed approach areas would be calculated and penetration, if any, clearly mentioned along with the extent of penetration clearly depicted. If there are no obstacles penetrating the area the same would be clearly mentioned in the report.

7.5.5 Digital Data

7.5.5.1 The following master files of all surveyed obstacles and aerodrome facilities shall be created and supplied in Annex B format:

- a) Master obstacles file, named appropriately, e.g. egxx_obst00.crc ("egxx" is the ICAO indicator code for the surveyed aerodrome and "00" is the year of the survey). To include:
 - All features identified as obstacles.
- b) Aerodrome facilities file, named appropriately, e.g. egxx_ad00.crc ("egxx" is the ICAO indicator code for the surveyed aerodrome and "00" is the year of the survey). To include:
 - All facilities surveyed for the purposes of the Aerodrome Layout / Grid map survey area

7.5.5.2 The integrity of the survey information supplied in digital format (see Part III Annex B for illustration) shall be protected against third party corruption by wrapping with a Cyclic Redundancy Check (CRC) of at least 32 bit CRC-32Q algorithm value (CRCV format = Hexadecimal) should be provided as in case of Eurocontrol DQTS CRC Tool. CRC wrapping is mandatory for all survey data whenever it is submitted as per Part III Annex B format files.

7.5.5.3 The surveying company shall maintain an effective checking system to ensure that the data collected conforms to the accuracy standard and shall present proof of that conformity within the Survey Report.

AERONAUTICAL SURVEY MANUAL

PART III : APPENDICES

Appendix A : Survey Declaration Form

| | |
|--------------------------|--|
| Aerodrome | |
| Surveying Company | |

| | | | |
|---------------------------|--|-------------------------------|--|
| Aerodrome Classification | | Initial/Last Full Survey Date | |
| Geodetic Connection Date* | | Annual Check Survey Date* | |

(* If applicable)

| Survey Area Required | | No Change to Previous survey | Change to Previous survey |
|-----------------------------------|--------------------------|------------------------------|---------------------------|
| Aerodrome plan | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| AGA | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Non-Precision Instrument Approach | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Visual Manoeuvring (Circling) | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Departure | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Aerodrome Obstacle Chart - Type A | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Precision Approach Procedure | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Precision Approach Terrain Chart | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

(Check box as appropriate)

| | | | |
|--|--|------|--|
| Declaration by Aerodrome Operator's Representative | | | |
| I certify that information supplied meets the Aerodrome's operational requirements | | | |
| Name | | | |
| Position | | | |
| Signature | | Date | |

| | | | |
|--|--|------|--|
| Declaration by Surveyor | | | |
| I certify that information supplied is complete and conforms to Air Port Survey Manual | | | |
| Name | | | |
| Signature | | Date | |

Submit form together with all relevant survey information to:
Executive Director, Air Traffic Flow Management (ATFM), AAI, R.G.Bhawan, New Delhi.

Appendix B: Digital Data Specification

Master files of all surveyed facilities and obstacles shall be created and supplied.

Files of survey information shall be in the form of a comma delimited ASCII text file containing fourteen fields plus CRC field as listed below:

Aerodrome facilities file (named appropriately e.g. egxx_ad00.crc)

| | To be entered in field | Description |
|---------|------------------------------|-------------------------------------|
| Field 1 | SITE NAME | |
| | EGXX | ICAO Aerodrome Location Indicator |
| Field 2 | TYPE OF FEATURE | |
| | ABN | Aerodrome Beacon |
| | ATC | Air Traffic Control Location |
| | ASDA_END | End of ASDA |
| | CHECK_PT1 | Additional point along runway |
| | CHECK_PT2 | Additional point along runway |
| | DME | Distance Measuring Equipment |
| | FATO | Final Approach and Take-off Area |
| | GP | Instrument Landing System Glidepath |
| | IBN | Identification Beacon |
| | IRVR | Instrument Runway Visual Range |
| | L | Locator (NDB) |
| | LDA_END | End of LDA |
| | LLZ | Instrument Landing System Localizer |
| MM | Middle Marker | |
| NDB | Non-directional Radio Beacon | |
| OM | Outer Marker | |
| | RADAR | RADAR |

| | | |
|---------|-------------------------|--|
| | ROP | Runway Observing Position |
| | STAND | Stand |
| | THR | Runway Threshold |
| | TLOF | Touchdown and Lift-off Area |
| | TODA_END | End of TODA |
| | TORA_START | Start of TORA |
| | TORA_END | End of TORA |
| | VDF | Very High Frequency Direction-finding Station |
| | VOR | VHF Omni-directional Radio Range |
| | VOR/DME | VOR co-located with DME |
| Field 3 | IDENTIFICATION | |
| | ABC | Call sign of navigation aid |
| | 05L | Runway threshold, LLZ and GP designator |
| | 05/23 | Runway and DME designator |
| | 123 | Stand number |
| Field 4 | LATITUDE | |
| | 522704.83N | WGS-84 Latitude in DEG, MIN, SEC, 1/100's SEC |
| Field 5 | LONGITUDE | |
| | 0014431.27W | WGS-84 Longitude in DEG, MIN, SEC, 1/100's SEC |
| Field 6 | ELLIPSOIDAL HEIGHT (M) | |
| | 107.00 | Elevation in above WGS-84 ellipsoid to 2 decimal places |
| Field 7 | ELLIPSOIDAL HEIGHT (FT) | |
| | 351.05 | Elevation in feet above WGS-84 ellipsoid to 2 decimal places |
| Field 8 | LIT OR UNLIT | |

| | | |
|----------|-------------------------|--|
| | Y | To be entered if facility is lit |
| | N | To be entered if facility is unlit |
| Field 9 | EASTING | |
| | 312567.75 | Six figure easting grid reference to 2 decimal places |
| Field 10 | NORTHING | |
| | 435687.55 | Six figure northing grid reference to 2 decimal places |
| Field 11 | ORTHOMETRIC HEIGHT (M) | |
| | 113.76 | Elevation in EGM-08 to 2 decimal places |
| Field 12 | ORTHOMETRIC HEIGHT (FT) | |
| | 373.22 | Elevation in feet EGM-08 to 2 decimal places |
| Field 13 | RECORD IDENTIFIER | |
| | 1056 | Unique integer number |
| Field 14 | SURVEY DATA | |
| | 10/01/00 | Date of field survey of record (dd/mm/yy format) |
| Field 15 | CRC Value | 32 bit CRC-32Q algorithm Value (CRCV format = Hexadecimal) |
| | AB47A43 | (Created by Eurocontrol CRC tool) |

Example of CRC wrapped records in file:

```
EGXX,NDB,ABC,522732.45N,0014429.34W,119.74,393,Y,417662.27, 284592.4,70.35,231,1008,10/01/00,45F652A2
EGXX,LLZ,05L,522758.83N,0014539.27W,117.96,387,N,416246.56,285408.,103.63,340,1010,10/01/00,E74FA6A3
EGXX,STAND,5,522701.13N,0014399.21W,115.82,380,N,418234.34,283673.22,101.5,333,1013,12/01/00,219C3FE9
```

Master obstacles file (named appropriately e.g. egxx_obst00.crc)

| | To be entered in field | Description |
|---------|------------------------|-----------------------------------|
| Field 1 | SITE NAME | |
| | EGXX | ICAO Aerodrome Location Indicator |
| Field 2 | TYPE OF FEATURE | |

| | OBST | Obstacle |
|----------|-------------------------|--|
| Field 3 | IDENTIFICATION | |
| | BUILDING | Description of obstacle |
| Field 4 | LATITUDE | |
| | 522704.83N | WGS-84 Latitude in DEG, MIN, SEC, 1/100's SEC |
| Field 5 | LONGITUDE | |
| | 0014431.27W | WGS-84 Longitude in DEG, MIN, SEC, 1/100's SEC |
| Field 6 | ELLIPSOIDAL HEIGHT (M) | |
| | 107.00 | Elevation in above WGS-84 ellipsoid to 2 decimal places |
| Field 7 | ELLIPSOIDAL HEIGHT (FT) | |
| | 351.05 | Elevation in feet above WGS-84 ellipsoid to 2 decimal places |
| Field 8 | LIT OR UNLIT | |
| | Y | To be entered if obstacle is lit |
| | N | To be entered if obstacle is unlit |
| Field 9 | EASTING | |
| | 312567.75 | Six figure easting grid reference to 2 decimal places |
| Field 10 | NORTHING | |
| | 435687.55 | Six figure northing grid reference to 2 decimal places |
| Field 11 | ORTHOMETRIC HEIGHT (M) | |
| | 113.76 | Elevation in EGM-08 to 2 decimal places |
| Field 12 | ORTHOMETRIC HEIGHT (FT) | |
| | 373.22 | Elevation in feet EGM-08 to 2 decimal places |
| Field 13 | RECORD IDENTIFIER | |
| | 1056 | Unique integer number |

Field 14 SURVEY DATE

10/01/00

Date of field survey of record

(dd/mm/yy format) Field 15

AB47A43

CRC Value

32 bit CRC-32Q algorithm value (CRCV
format = Hexadecimal)

(Created by Eurocontrol CRC tool)

Example of CRC wrapped records in file:

EGXX,OBST,TREE,533211.60N,0002217.25W,322,136.24,447,N,376673.45,404383.54,98.15,322,1001,10/01/00,
AB47A43,EGXX,OBST,CHURCH_SPIRE,533659.04N,0002001.07W,121.31,398,,399978.89,413280.67,74.98,246,
1002,10/01/00,86789C79,EGXX,OBST,MAST,532725.46N,0001918.10W,222.20,729,Y,511435.5,396978.78,175.8
7,577,1003,10/01/00,5A6B1656,EGXX,OBST,RADAR,532619.85N,0001818.85W,249.63,819,Y,512713.38,394913.
55,203.30,667,1005,10/01/00,EB6EB575,EGXX,OBST,PYLON,533029.93N,0001819.19W,223.42,733,N,512407.4
5,402640.98,177.09,581,1008,10/01/00,230E3C1D

Special Notes:

- Decimal places shall not be rounded
- Only decimal places, underscores and forward slashes shall be used within fields (no hyphens, word spaces, commas or backslashes, etc.).
- All text shall be upper case.
- All fields shall be populated with the exception of the aerodrome facilities file Field 3, which must be blank if there is no associated identification (Duplicate data in a record is not acceptable).

Appendix C : SURVEYING METHODS

1. SURVEYING (Definition)

A method of data collection by observation and measurements

1.2 Conventional Surveying Techniques

1.2.1 WGS 84 coordinates can be obtained by collocating the point(s) with a WGS84 (ITRF) station (measurement of relative coordinate differences).

1.2.2 Conventional surveying techniques determine

- a) directions and angles using a theodolite (accuracy of directions up to 0.01mgon (or 0.1" ; one gon is also called the grad which is 1/400 of a circumference). The technique is also called triangulation; and
- b) distances by EDM (electronic distance measurement) metres. The accuracy derived can be up to 1 mm. The technique is also called *trilateration*.

1.3 Total Stations

1.3.1 Modern total stations combine a self-recording, high precision electronic theodolite with an EDM instrument which is mounted (often) co-axially. A total station is set up over a reference point whose coordinates are known and the telescope is pointed towards a target/reflector to measure distance, horizontal and vertical angles. These are recorded automatically either for immediate display (on-line field computation capabilities) or for post-processing.

√√√√

1.4 Spirit Levelling

1.4.1 Fig.III-C-1 shows the principle of Spirit levelling, which is used to determine height differences relative to a point of known (orthometric) height. The accuracy derived can be up to $\pm 0.3 \text{ mm} / \sqrt{s} \text{ (km)}$. Although automated instruments with complete digital data handling are available, the technique is very time-consuming, elaborate and expensive and the error propagation formula mentioned above is only applicable in a local area, say up to 50 km. Hence, the main application of spirit levelling is with respect to the local area.

1.4.2 Heights, which are derived using a trigonometric technique (measuring zenith or height angles), can be considered as "orthometric heights" (neglecting gravity data: accuracy in decimetre level).

1.5 Advantages/Disadvantages of Conventional Surveying

- 1.5.1 Field operations with modern total stations take a very short time and a surveyor with an assistant can, typically, survey up to 1000 points per day in favourable meteorological circumstances (theodolite, EDM instruments as well as spirit levelling instruments are less efficient). However, this technique has a number of drawbacks.
- 1.5.2 Firstly, the observations are limited by intervisibility between theodolite and target and, to a lesser extent, by range. The technique requires a number of evenly distributed control- reference stations, whose coordinates are either known in advance or determined separately. Horizontal control coordinates are normally provided by triangulation points and heights by benchmarks, both obtainable from the respective national mapping organization. National survey organizations, in turn, survey these points and compute their coordinates or heights by using a series of hierarchical networks, starting at primary level and broken down successively into second order and third order, etc. In a densely surveyed country, lower order triangulation points are to be found, at best, at a density of say, one every 5 km. This is not sufficient for general surveying and additional control stations have to be established, prior to a detail survey, by well known control survey techniques such as triangulation, trilateration and traversing. GPS surveying and photogrammetric techniques are becoming progressively more efficient

1.6 Heights

- 1.6.1 Processing of vertical angle and distance measurements results in so-called trigonometric height differences (= ellipsoidal height differences).
- 1.6.2 Orthometric heights of high accuracy can be only derived by measuring gravity potential differences $C = W = \int g \, dh$ (combination of gravity observations g and spirit levelled height differences dh) and dividing it by normal gravity. Or in other words: To come up with high accuracy orthometric heights *orthometric corrections* have to be applied.
- 1.6.3 In a local non-mountainous region (e.g. say 50 km x 50 km) the geoid variation might be $< 0.1\text{m}$. Neglecting these geoid differences the type of height becomes irrelevant (orthometric height diff = trigonometric height diff = levelled height diff)

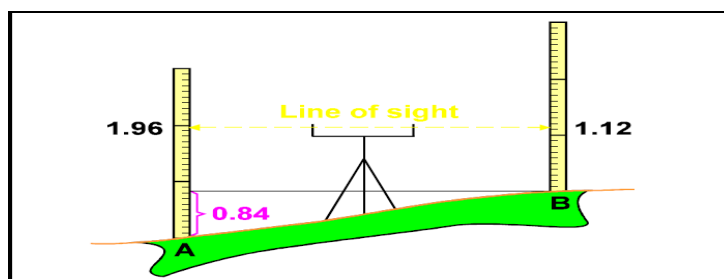


Figure III-C-1 : Principle of spirit levelling

Appendix D : INTERNATIONAL TERRESTRIAL REFERENCE SYSTEM (ITRS)

1. The most precise geodetic measuring techniques for long base-lines are at present Satellite Laser Ranging (SLR) and Very Long Base-Line Interferometry (VLBI). Both techniques guarantee a precision of 1-3 cm over distances up to about 5000 km. Global networks of up to 70 SLR- and up to 81 VLBI-stations are observing continuously, respectively were observed for limited periods. Since 1987 a new International Earth Rotation Service (IERS) is operating making use of SLR- and VLBI-results predominantly and producing every year a new global set of x, y, z coordinates by combining various SLR- and VLBI-solutions.

2. The precise satellite laser ranging technique has led to a precise worldwide terrestrial coordinates system, called the International Terrestrial Reference System (ITRS). The ITRS is maintained by the IERS and the realization of the ITRS is the International Terrestrial Reference Frame (ITRF).

3. Plate tectonic movement was incorporated in that coordinate system using results of recent measurements and a global geophysical model. Thus, it is a model with changing coordinates due to movements of tectonic plates on which the ground stations are located. However, this reference system provides the fundamental position of the Earth to within 10 cm and the orientation of the axes to correspondingly high accuracies. Since 1988, the IERS has defined the mean spin axis, the IERS Reference Pole (IRP) and the zero meridian and the IERS Reference Meridian (IRM).

4. The maintenance of a datum at this level of accuracy requires constant monitoring of the rotation of the Earth, the motion of the pole and the movement of the plates of the crust of the Earth, on which the ground stations are located. The current definition of ITRF is known as ITRF 97, which means the computation of the ITRF coordinates at epoch 1997.0.

Appendix E : DIFFERENTIAL GPS (DGPS)

1. DIFFERENTIAL GPS SURVEYING

The elimination of the various errors of single point positioning can be achieved by forming 'differences' between observations. The positioning of a static or roving user, relative to a fixed reference station with known WGS 84 coordinates, is called *Differential GPS Positioning*. Such a reference station can be used for an infinitely large number of users around it, say in a radius of up to 100 km. The three-dimensional relative baseline vector, between the reference station and the user station, results from processing using GPS analysis software. Processing can be done in baseline or network mode.

2. DIFFERENTIAL GPS (DGPS) REAL-TIME POSITIONING

Quite recently (mid-1994) differential GPS real-time surveying has been offered by several companies. The real-time aspect came about, not because of any necessity for immediate results, but in order to carry out a quality control in the field. Fig. III-E-1 demonstrates the principle of Differential GPS Real-Time Positioning:

- Positioning of a (roving) user relative to a reference station with known coordinates
- Determination of GPS PCP (Pseudorange and/or Carrier Phase) corrections at the reference station
- Transmission of the corrections to the mobile user by telemetry
- Quality and error control by monitor stations

3. GPS DIFFERENTIAL POSITIONING TECHNIQUES

GPS differential positioning techniques have the following advantages and disadvantages:

Advantages;

- GPS provides an all-weather 24 hour positioning capability.
- Various levels of accuracies are possible, depending on the available hardware and software.
- GPS is easy to use.

Disadvantages:

- Since certain signal obstruction by buildings, trees, etc. may occur; a certain amount of conventional surveying must be still be carried out.
- Only ellipsoid height differences can be determined by DGPS. In

order to get orthometric heights one has to use a geoid model of appropriate

- No line of sight between target (user station) and the reference station required; however, line of sight to at least four satellites is needed

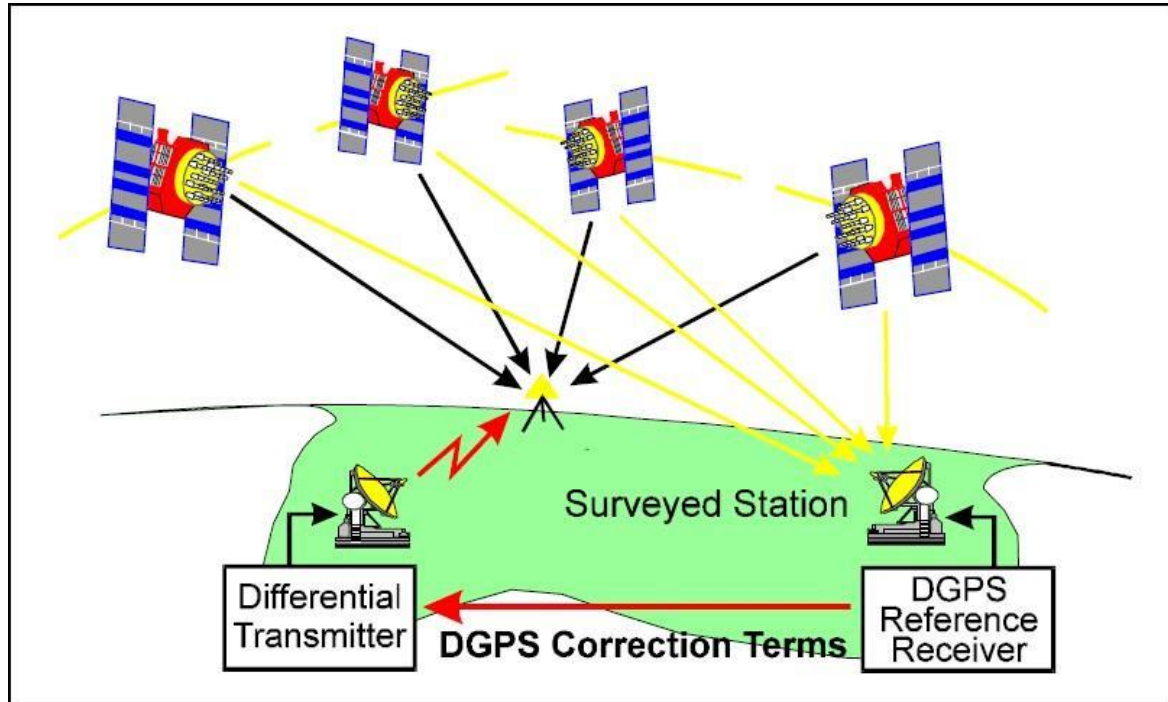


Figure III-E-1 : Differential GPS Real Time Positioning

Appendix F: The Earth as a GEOID

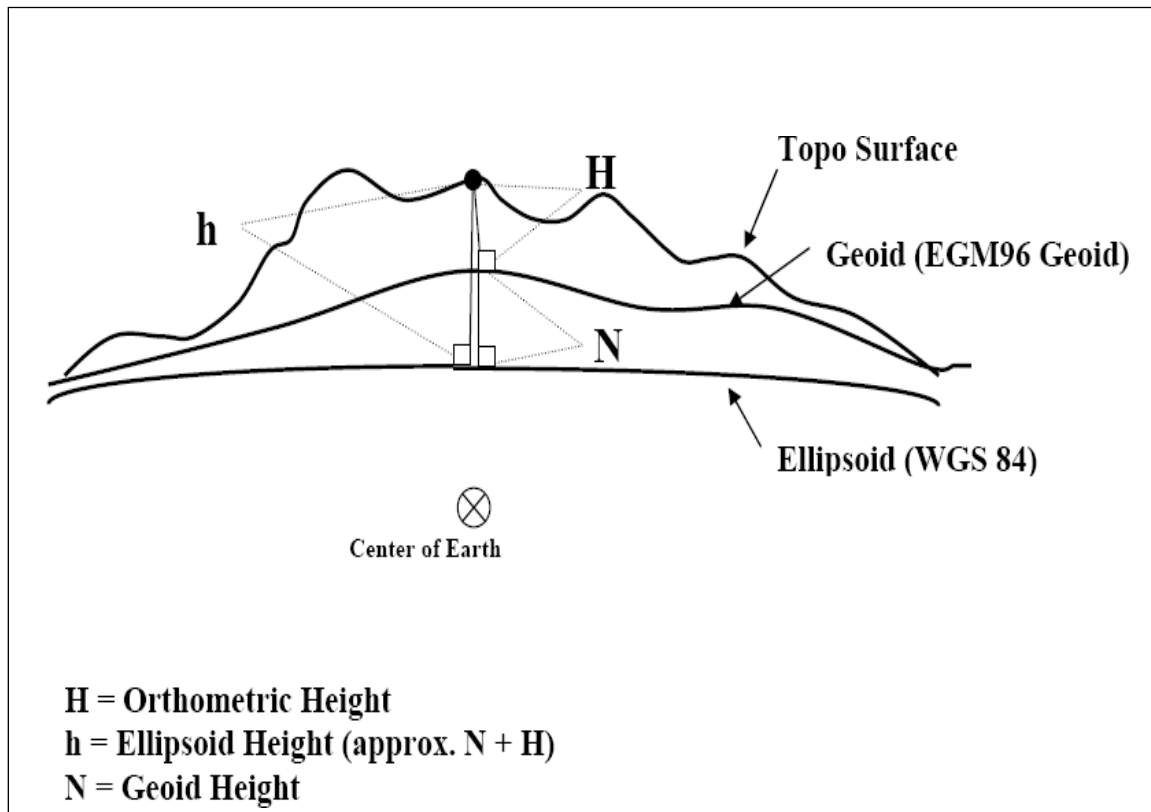
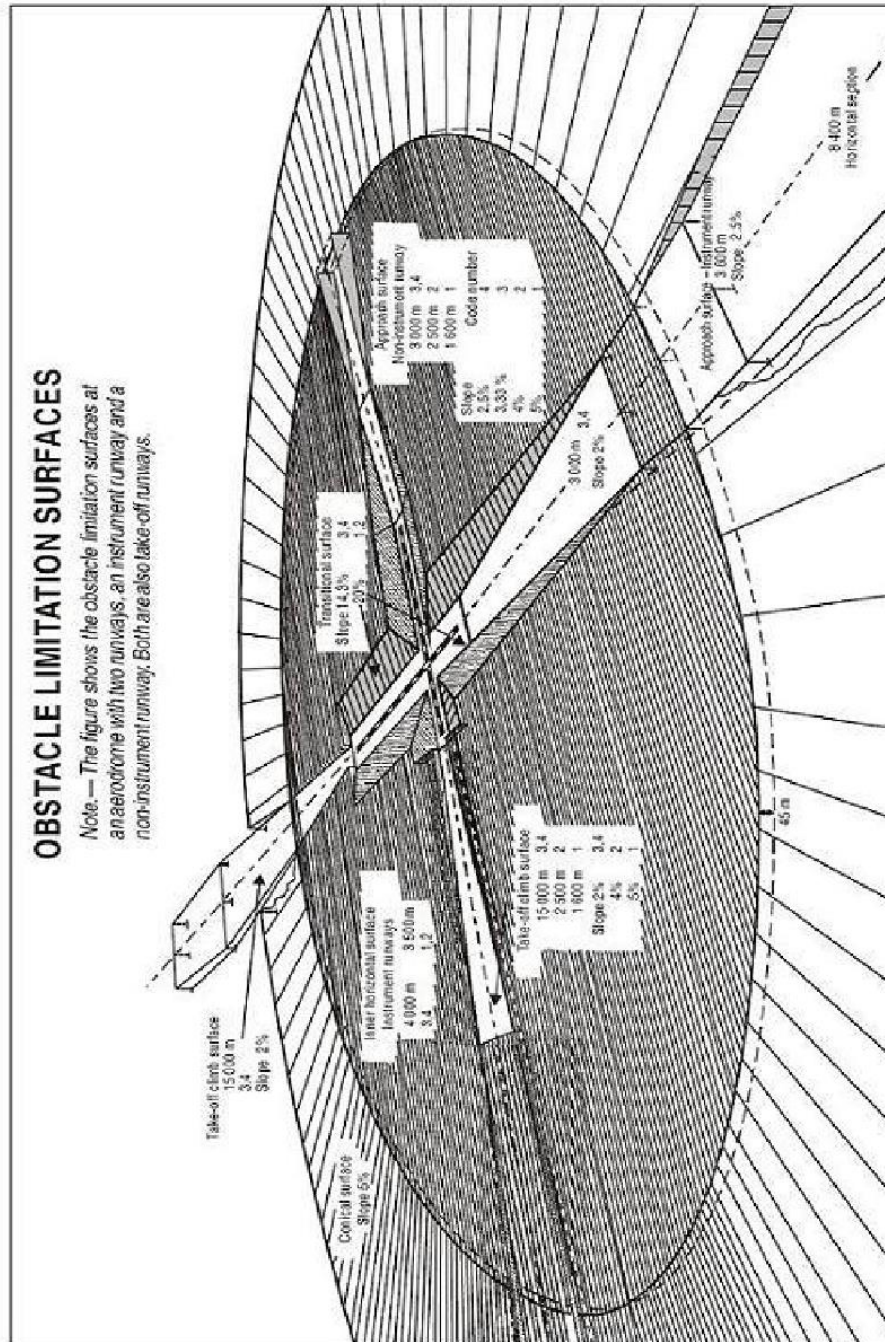


Figure III-F-1 : Illustration of GEOID, ELLIPSOID and ORTHOMETRIC Heights

Appendix - G

OLS Surfaces



Appendix - H

DIGITAL DATA ERROR DETECTION TECHNIQUE IN USE DURING THE TRANSMISSION AND/OR STORAGE OF AERONAUTICAL DATA AND DIGITAL DATA SETS.

Aeronautical Digital Data Sets:

Procedure:

Transmission / Storage digital data in various scale of map and integrity check.

Resource:

Data capture & finalized during field survey.

Processes:

- 1.) Retrieve / Export data of prominent features from particular user and software.
 - i.) ARP (Aerodrome Reference Point)
 - ii.) Runway Threshold
 - iii.) Runway End
 - iv.) Runway holding position
 - v.) Significant Obstacles in Approach & Circling area
 - vi.) Nav-Aids located at Aerodrome and outside aerodrome

Traceability:

1. Correlate with origin / source survey data provided in the tabulated/Excel format and preparing comparative statement to find the difference, if any.

Data anomalies:

Ensuring the data anomaly are within the limit given in Annex-15, Appendix 7. (Survey & Carto. Manual)

Error:

- 1.) Accordingly the correction procedure applied based on Error.

Appendix - I

MECHANISM OF INTIGRITY OF AERONAUTICAL DATA

Mechanism of Integrity of Aeronautical Data :

Procedure:

Data capturing at airport and ensuring data integrity with previous data.

Resource:

Old survey data and current survey data.

Processes:

Every revision / check survey the new data required for updation of Aeronautical Charts along with prominent features given bellow:

- ARP (Aerodrome Reference Point)
- Runway Threshold
- Runway End
- Runway holding position
- Significant Obstacles in Approach & Circling area
- Nav-Aids located at Aerodrome and outside aerodrome

Traceability:

Correlate with the current survey data captured and previous surveyed data of same features.

Data anomalies:

Ensuring the data anomaly are within the limit given in Doc. 9674 WGS-84 & (Survey & Carto. Manual)

Error:

Accordingly the integrity mechanism maintained with in the limit of Doc. 9674 WGS-84 table of chapter – 2.

Appendix – J

QUALITY MANAGEMENT SYSTEM CONTAINING PROCEDURES, PROCESSES AND RESOURCES AT EACH FUNCTION STAGE OF AERONAUTICAL CHART DEVELOPMENT

Aeronautical mapping provides critical information about airport features, obstructions, and navigational aids. The criticalness of this data is due to its need for safe aircraft operation. Airport mapping needs extensive knowledge of DGCA CAR documents related to aerodromes and its environs.

Procedure:

After finalization of survey data, preparation of the Maps & Charts done in the section as per DGCA CAR /Survey manual and Aeronautical Chart Manual.

Processes:

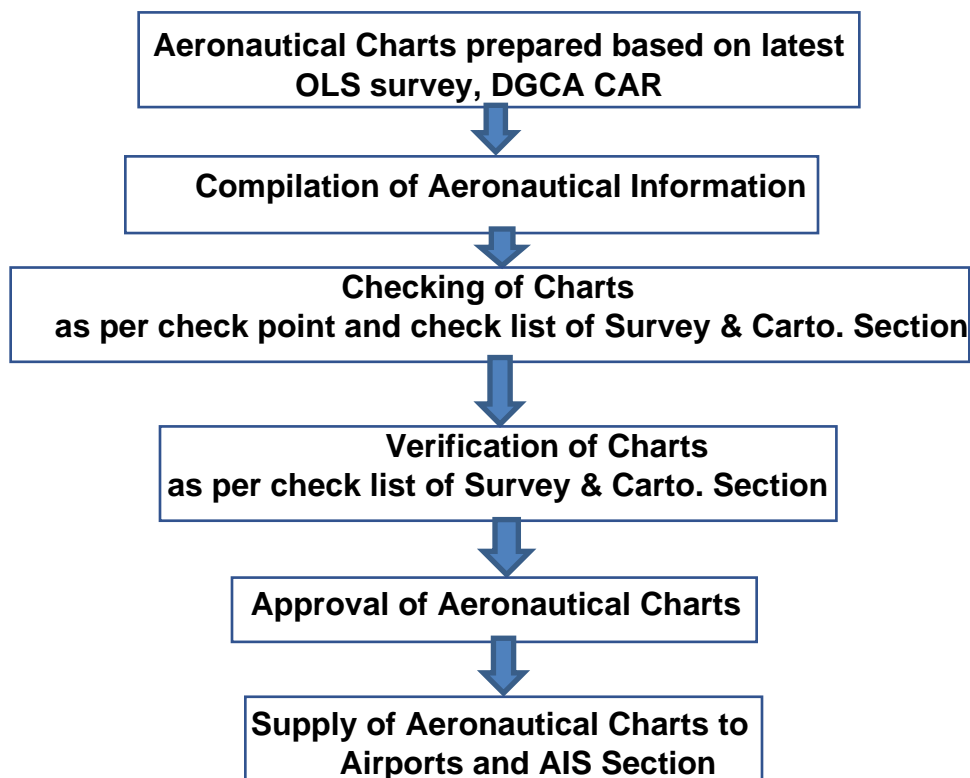
1. Preparation of Aeronautical Chart.
2. Checking of Maps as per attached check point list and check list of Survey & Cartography.
3. Supply of Maps & Charts for publication to AIS CHQ.

Resource:

All Maps & Charts prepared by ArcMap (GIS) and AutoCAD Map software.

Appendix – K

PROCEDURES FOR AERONAUTICAL CHARTS MADE ARE COMPREHENSIVE AND ACCURATE AND UP TO DATE BY A REVISION SERVICE



- (a) All Aeronautical Maps & Charts revision maintained as per Aerodrome Operator.
- (b) Aeronautical Maps & Charts revision maintained as per GIS Circular 01/2023.
- (c) Chart revised based on latest published aeronautical information through eAIP.

Appendix - L

PROCEDURES FOR VERIFICATION AND VALIDATION OF AERONAUTICAL DATA

- ❖ Aeronautical surveying plays a crucial role in ensuring the safety and efficiency of airport operations, particularly in the context of aviation safety. These surveys collect vital data on airport features, navigational aids, and obstructions, and the accuracy of this data is essential for aircraft operations, air traffic control, and maintaining the aerodrome license.
- ❖ In India, the privatization of airports, including major civil airports, has added complexity to the process of conducting regular aeronautical surveys. The Airports Authority of India (AAI) has traditionally been responsible for performing these surveys, but due to a shortage of manpower and the growing number of private airports, it has become increasingly difficult for AAI to conduct surveys for all airports on a regular basis. This has led to private aerodrome operators seeking alternative methods to complete these surveys by contracting experienced private survey firms.
- ❖ However, Directorate General of Civil Aviation (DGCA) requirement for any aeronautical survey data generated by private or state airport operators be Verified and Validated (V & V) by AAI before it can be endorsed for official use. This process ensures that the data adheres to the necessary standards, maintaining the safety and operational integrity of the airports and their surrounding environments. The V & V process involves a thorough review of the collected data, comparing it with existing standards, and confirming that it is accurate and reliable for aviation operations.
- ❖ Given the growing demand for aeronautical surveys in the privatized airport sector, a potential solution could be the use of advanced technologies such as unmanned aerial vehicles (UAVs), remote sensing, and geospatial tools. These technologies could help private operators and survey firms collect the necessary data more efficiently and cost-effectively. Additionally, ensuring that the V & V process is streamlined and consistent across both public and private operators will be key in maintaining safety standards and regulatory compliance.
- ❖ Validation and Verification are indeed two distinct but complementary processes, especially in the context of aeronautical surveys, and understanding the difference between them is essential for ensuring the accuracy and reliability of the survey data.

Validation and Verification:

Validation refers to the process of ensuring that the data is correct, meaningful, and accurate for the intended use. It typically involves checking if the data meets certain criteria or standards before it is considered for further processing. Validation checks are aimed at identifying any gross errors or inconsistencies in the data, such as out-of-tolerance limit, incorrect formats, or data that does not make sense geographically. Validation is often done before verification to filter out any obvious issues and streamline the more time-consuming verification process.

- ❖ **Verification**, on the other hand, is the process of confirming that the data is accurate and complete by comparing it against known standards, benchmarks, or reference data. This often includes performing more detailed checks, such as comparing the surveyed data with external, independent data sources or performing transformations to ensure consistency across various reference systems (e.g., transforming data from a local datum to a global system like WGS 84).

Importance of Validation before Verification:

Validation should ideally occur before verification because it helps to eliminate any glaring errors early in the process. By addressing gross errors at the validation stage (e.g., data that is clearly out of tolerance limit or incorrectly formatted), the verification process can be more focused and efficient, avoiding unnecessary rework and time spent on verifying data that is already known to be problematic.

Survey Quality Checks:

Survey quality checks can be made in several ways, including:

1. **Comparison with Independent Data:** This is a common approach in aeronautical surveying, where the newly collected survey data is compared against existing reference data, or independent measurements derived from established sources. For example, previously surveyed data may be used to check if new data points align correctly when transformed to a global reference system like WGS 84 (World Geodetic System 1984). By transforming both datasets to a common reference

system, surveyors can confirm that the new data is consistent with the historical or authoritative data.

2. **Manual Data Entry Checks:** For surveys where manual data entry is involved, software can be used to perform automatic checks on the input data. This ensures that:

- The data is in the correct field format (e.g., numeric values for latitude and longitude).
- The values fall within tolerance limitations.
- The geographical location is consistent with expected patterns (e.g., verifying that an airport's coordinates are not showing up in an ocean or far from any known landmass).

Benefits of Proper Validation and Verification:

- **Increased Accuracy:** By validating the data first, major errors are removed, which improves the accuracy of the verification process.
- **Efficiency:** Validation helps to minimize the time spent on verifying incorrect data, making the overall data management process more efficient.
- **Improved Data Integrity:** When the data passes both validation and verification processes, it ensures that the final dataset is reliable and can be confidently used for important decision-making, such as aircraft operations, navigation, and compliance with safety regulations.
- **Regulatory Compliance:** For private and state-operated airports, meeting the standards set by aviation regulatory bodies like DGCA requires that data undergoes thorough validation and verification. This is especially important for maintaining aerodrome licenses and for ensuring ongoing safety and operational standards.

VERIFICATION AND VALIDATION (V & V) PROCEDURES

The V & V process will be provide the aerodrome operator authentication of otherwise of the aeronautical survey data carried out by third party meeting the DGCA CAR requirements.

1. **The process will comprise of a minimum of two-step process as follows:**

Step1: Preliminary Assessment Process – An expert team from AAI will make an assessment of the airport and its environs, conduct meeting with the aerodrome operator and the Aeronautical Surveyor to assess the data collection methodology used, equipment and quality checks, data traceability, including integrity processes adopted.

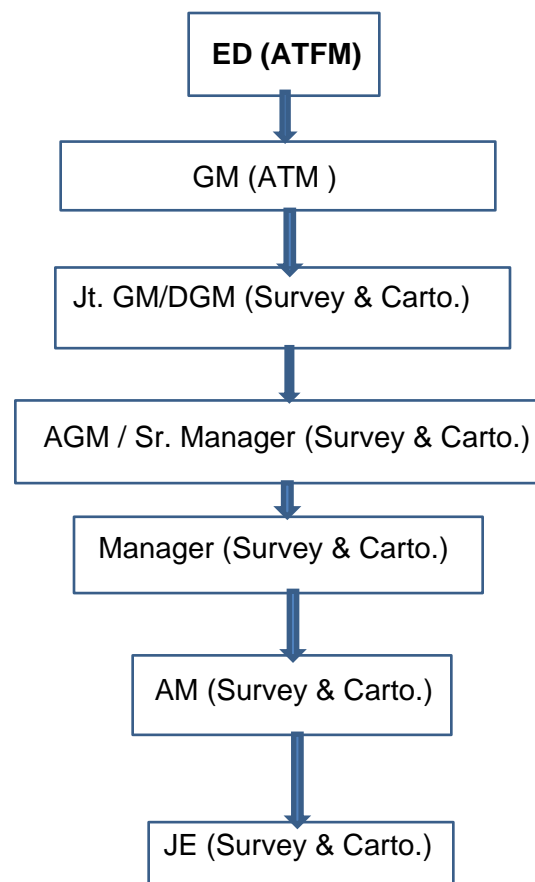
Step 2: Check Survey of critical points, points identified during preliminary assessment and controlling obstacle verification for meeting Flight Procedure design requirements. The number of days required for step 2 will be arrived at depending on the quantum of work assessed by the preliminary assessment committee. Step 2 may also involve the requirement of geo referenced Aerial imagery / Satellite imagery or Photogrammetry depending on terrain profiles, which will require to be arranged by the aerodrome operator.

2. OLS survey are conducted by the Survey & Cartography section of the AAI (inside and outside of the airport) as per AGA surface with a random collection of 10% to 20%. After processing and filtering the data, AAI prepares a comparison sheet of the data provided by the Aerodrome Operator. If the data is within the tolerance limit as per DGCA CAR, the V&V certificate will be issued.

Summary Validating data early in the process helps to identify and address errors before they complicate the more detailed and time-consuming verification process. Utilizing automated software tools for data entry and quality checks further enhances the accuracy and efficiency of the overall data management workflow.

Appendix – M**ORGANIZATION STRUCTURE OF SURVEY AND CARTO. SECTION**

- I. Airports Authority of India has various Directorates, in which ATFM Dte. under Executive Director (ATFM) manages Survey & Cartography unit.
- II. Competent Authority has accorded approval for restructuring of post in merged Survey & Cartography cadre (upto Jt.GM/DGM level) vide establishment order No. A.60012/13/2023/MPP (193393) dated 26-02-2025, is appended below:

STRUCTURE OF SURVEY & CARTOGRAPHY**Reporting Structure:**

- The General Manager (ATM - Survey & Cartography) will report to the ED (ATFM).
- The Jt. General Manager / DGM (Survey & Carto) will report to the General Manager (ATM – Survey & Carto.).

- The Sr. Manager / AGM (Survey & Cartography) will report to the Jt. General Manager / DGM (Survey & Carto.).
- The Manager (Survey & Cartography) will report to the AGM / Sr. Manager (Survey & Carto.).
- The Assistant Manager (Survey & Cartography) will report to the respective Manager (Survey & Carto.).
- The JE (Survey & Cartography) will report to the respective Assistant Manager (Survey & Carto.).

JOB DESCRIPTION OF SURVEY AND CARTO. SECTION

Introduction:- OLS survey plays a crucial role in ensuring the safety and efficiency of airport operations, particularly in the context of aviation safety. These surveys collect vital data on airport features, navigational aids, and obstructions, and the accuracy of this data is essential for aircraft operations.

OLS Survey:- The purpose of the Obstacle Limitation surface (OLS survey) is to observe critical data to identify obstacles that infringe the prescribed AGA surface in and around existing or proposed Airport.

The Survey & Cartography section conducts detailed OLS survey (in and around) of all airport in India as per AGA surface.

All necessary defined survey method adopted to meet the requirement of quality assurance to OLS survey and also to ensure the airport critical data is compliance with DGCA CAR / Survey Manual.

Type of Survey conduct by AAI team:

- i.) OLS survey of existing & proposed airport.
- ii.) OLS survey of Water Aerodrome.
- iii.) OLS survey of Heliport.

Survey requirement: -

Periodicity OLS survey of the Airport with reference to GIS Circular 01/2023,

- a) IFR Airport - 4 years
- b) VFR Airport - 5 years
- c) Verification & Validation of surveyed data.

Aeronautical Chart & Maps:

Airport Map/Base Map, Approach Chart, Vertical Significance Chart, Obstacle free zone (OFZ), Preparation of contour map. Grid map, Aerodrome Chart, Aircraft parking docking chart, Type-A & B, Precision Approach terrain chart, PAPI protection surface chart, Take-Off climb surface, Aerodrome vicinity map, Zoning Map, Longitudinal profile, Laser Beam protection, 30NM, Colour Coded Zoning Map (CCZM), NOC site – location / permissible height calculation etc.

DUTIES & RESPONSIBILITIES OF SURVEY AND CARTO. PERSONNEL

Subject: Re-organization of Survey & Cartography section

1. The DGM (Cartography) was the In-charge of the Survey and Maps & Charts sections in the past.
2. AAI Board has further approved to merge Survey and Maps & Charts sections as Survey & Cartography section and shall jointly undertake Survey & Cartography functions. The official in cadre shall be responsible for conducting OLS Surveys, data management, Quality control of Surveyed data preparation of Survey & Aeronautical charts.
3. In view of the above, Duties and Responsibilities of the personnel in Survey & Cartography section have been re-organized.

The tasks of Survey and Cartography have been bifurcated as follows:

Duties and Responsibilities:

GM (ATM) is In-Charge of the Survey and Cartography section. The following lists the duties and responsibilities of the various positions in the Survey & Cartography section:

General Manager (ATM):

The General Manager (ATM) is accountable to ED (AFTM) and is responsible for:

- i. Standardizing the Aeronautical Survey & Charting job to ensure long term goals of creating secure aeronautical database for multiple user operations.
- ii. To ensure the periodicity of Aeronautical Survey based on AAI Survey manual by AAI Survey team/empanelled Survey firms.
- iii. Ensure training and development of Survey & Cartography team.
- iv. Ensure procurement of Survey equipment, other tools & software and empanelment of Survey firms for effective functioning of the section.
- v. DGCA / ICAO related audit matters.
- vi. Any other tasks assigned from time to time.

Jt. GM (Survey & Cartography) / DGM (Survey & Cartography):

The Jt. General Manager (Survey & Cartography) is accountable to the General Manager (ATM) and is responsible for overall management and administration of Survey and Cartography Section.

AGM/SM (Survey & Cartography):

- i. The AGM/SM (Survey & Cartography) is accountable to the Jt. GM / AGM (ATM) and is responsible for overall management/administration of Survey & Cartography Section.
- ii. Monitor and inspect the OLS Survey work in the field.
- iii. Any other work assigned by the senior officer.

Manager (Survey & Cartography)

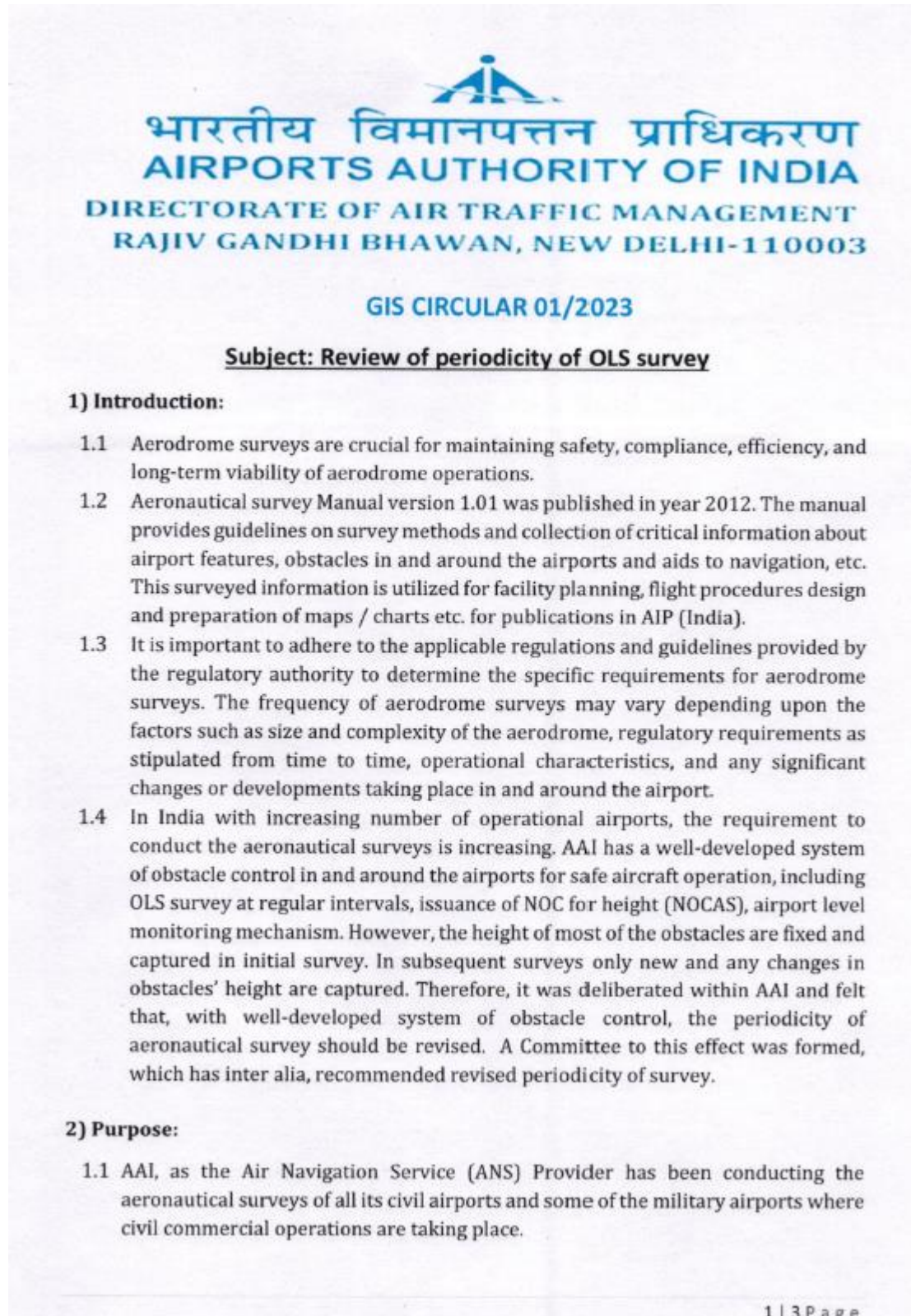
- i. Execute the annual survey plan, tour plan, record and database management.
- ii. Maintain records for periodicity of aeronautical surveys based on the AAI Survey manual by the AAI Survey team or empanelled surveyors.
- iii. Coordination, supervision, and inspection of survey field work as and when required and assigned.
- iv. Preparation of survey tour programs for survey officials.
- v. To undertake survey field work if necessary.
- vi. Assist in executing SAP payments in case of the non-availability of the Data Operator.
- vii. Monitoring the progress of survey work and providing guidance to subordinates on survey matters and ICAO requirements on a regular basis.
- viii. The attendance record of contractual GIS staff and salary payments.
- ix. Assist in budget preparation and procurement actions as per section requirements.
- x. Assist in the preparation and updating of training manuals, survey and Cartography manuals, SOPs, and relevant handouts for various training programs.
- xi. Assist in maintaining administrative and filing work records related to the Survey and Cartography Section.
- xii. Any other work assigned by the senior officer.


Assistant Manager (Survey & Cartography):

- i. Day-to-day planning of field survey work, handling contingency expenses, maintaining liaison with the Aerodrome In-Charge, and informing CHQ about the progress of the field survey work.
- ii. All survey charts and GPS results must be thoroughly checked, which were prepared or processed by another member of the Survey team.
- iii. Providing information about airports for AIP publication.
- iv. Checking and verifying maps and charts.
- v. Any other work assigned by the senior officer.

JE (Survey & Cartography):

- i. To conduct a detailed OLS survey of all airports in India (both inside and outside the airport) using the AGA surface.
- ii. OLS survey of proposed airport sites.
- iii. After completion of the OLS Survey, prepare charts and maps as per operational requirements.
- iv. Daily work related to OLS Survey of airports.
- v. Prepare airport data for publication in AIP.
- vi. Any other work assigned by the senior officer.

GIS CIRCULAR No. 01 OF 2023


भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA
DIRECTORATE OF AIR TRAFFIC MANAGEMENT
RAJIV GANDHI BHAWAN, NEW DELHI-110003

GIS CIRCULAR 01/2023

Subject: Review of periodicity of OLS survey

1) Introduction:

- 1.1 Aerodrome surveys are crucial for maintaining safety, compliance, efficiency, and long-term viability of aerodrome operations.
- 1.2 Aeronautical survey Manual version 1.01 was published in year 2012. The manual provides guidelines on survey methods and collection of critical information about airport features, obstacles in and around the airports and aids to navigation, etc. This surveyed information is utilized for facility planning, flight procedures design and preparation of maps / charts etc. for publications in AIP (India).
- 1.3 It is important to adhere to the applicable regulations and guidelines provided by the regulatory authority to determine the specific requirements for aerodrome surveys. The frequency of aerodrome surveys may vary depending upon the factors such as size and complexity of the aerodrome, regulatory requirements as stipulated from time to time, operational characteristics, and any significant changes or developments taking place in and around the airport.
- 1.4 In India with increasing number of operational airports, the requirement to conduct the aeronautical surveys is increasing. AAI has a well-developed system of obstacle control in and around the airports for safe aircraft operation, including OLS survey at regular intervals, issuance of NOC for height (NOCAS), airport level monitoring mechanism. However, the height of most of the obstacles are fixed and captured in initial survey. In subsequent surveys only new and any changes in obstacles' height are captured. Therefore, it was deliberated within AAI and felt that, with well-developed system of obstacle control, the periodicity of aeronautical survey should be revised. A Committee to this effect was formed, which has inter alia, recommended revised periodicity of survey.

2) Purpose:

- 1.1 AAI, as the Air Navigation Service (ANS) Provider has been conducting the aeronautical surveys of all its civil airports and some of the military airports where civil commercial operations are taking place.

1 | 3 Page

1.2 The purpose of this Circular is to communicate the revised requirement for conducting full (detailed) OLS Survey and Check Survey (limited Area Survey) for all the civil aerodrome operators (as per Aeronautical Survey Manual para1.7) and requirement of the private and state-owned aerodrome operators for Verification & Validation of Surveyed data from AAI.

3) Scope:

This Circular is applicable to all civil Aerodromes including AAI, private and those owned by the State Governments.

4) Survey Requirement:

I. Full (detailed) survey [as per Aeronautical Survey Manual para1.7.1 & 1.7.2]

- a) The procedures for a full survey includes the geodetic connections of airport, airport facilities including navigation aids, and obstacle survey of obstacle limitation surfaces (OLS) within 20 km around the airport.
- b) Full (detailed) survey shall be conducted at the initial commissioning of the aerodrome and thereafter it is required to get an airport resurveyed after every 4 years for IFR and 5 years for VFR airports.

II. Check Survey [as per Aeronautical Survey Manual para1.7.3]

- a) Check survey is to identify any changes in the aerodrome lay out such as addition/modifications of new stands, shifting of threshold or holding positions, new locations/trans-installation of nav. aids, addition or removal of obstacles including significant tree growth or reduction, since the previous survey.
- b) The check surveys may also be conducted on the specific request of Airport Director/Airport Operator whenever commissioning of a new facility (i.e. parking stand, new or displaced threshold, nav-aids etc) at the airport is needed for the purpose of certification.
- c) Check survey may be restricted to the particular area of aerodrome or to a particular runway in case of any extension.
- d) Check survey may also be conducted if the operations from a particular runway needs to be upgraded, i.e. non-instrument to instrument, or, non-precision to precision.
- e) All Check Survey requirement shall be communicated by Airport Director /Airport operator to Survey & Cartography section, AAI, CHQ.
- f) **However, as per Aerodrome Advisory Circular No. 1 of 2006 and Aerodrome Manual Part-4 Para-4.13, all Airport Director/Airport operator Shall be responsible for**
 - i) Monitoring the obstacle limitation surface and Type A chart take-off surface for obstacles.
 - ii) Controlling obstacles within the authority of the operator.

- iii) Monitoring buildings or structure development in relation to their height within the boundaries of the obstacle limitation surface.
- iv) The control of new developments in the vicinity of aerodromes.

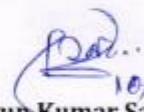
5) Validity:

This GIS circular is valid from 10.08.2023 and will remain valid till it is amended or withdrawn or incorporated in the Aeronautical Survey Manual.

6) Queries:

Any queries or further guidance required on the contents of this GIS circular should be addressed to:

General Manager (ATM-Survey/Carro)
Airports Authority of India,
4th Floor, Core-6, Scope Complex, Jor Bagh, New Delhi-110003
Email: gmatmsurvey@aai.aero
LL-011-24632950 Extn:3202


10/08/2023.
(Barun Kumar Sarkar)
Executive Director (ATM-ATFM)
Airports Authority of India

GIS CIRCULAR No. 01 OF 2024

**DIRECTORATE OF AIR TRAFFIC MANAGEMENT
RAJIV GANDHI BHAWAN, NEW DELHI-110003**

GIS CIRCULAR NO. 01 of 2024

Sub : Verification & Validation charges by AAI for Aeronautical surveyed data provided by State/PSU/Private/Defence owned airport/ Heliport

1. Introduction

- 1.1 Aeronautical surveying is a highly specialised activity requiring specific skill and expertise. Aeronautical survey programme provides critical information about airport features, obstructions & navigational aids. This data is needed for safe aircraft operation and therefore is safety critical. Airport surveying needs extensive knowledge of ICAO documents related to aerodromes and its environs in respect of the operational areas, obstacle limitation surfaces, navigational facilities, PANS-OPS surfaces etc. Surveyors must also have the knowledge of ICAO requirement of accuracies and integrity of the data collected and the adoption of the World Geodetic System-1984 as standard geodetic reference system for international civil aviation.

2. Purpose

- 2.1 In the past, AAI as the Aeronautical Service (ANS) Provider had been conducting the aeronautical surveys of all its civil airports and some of the military airports where civil commercial operations had been taking place. But with the privatisation of some of the major civil airports in India and entry of private Operators in developing new green field airports and requirement to conduct the aeronautical surveys at regular intervals for maintaining the currency of the aerodrome licence, it is not feasible for AAI to conduct the aeronautical surveys of all airports at regular interval. This has forced the private aerodrome Operators to look at various options to complete the aeronautical surveys through experienced private survey firms.
- 2.2 However, in view of regulatory requirement for accuracy/integrity of the published survey data in AIP India, DGCA requires private/state Operators to get the data validated from AAI through Verification & Validation (V & V) process.
- 2.3 The purpose of this Circular is to standardize the Verification & Validation procedure for all the Aerodrome Operators requiring V & V certificate from AAI for the survey data.



3. Scope

- 3.1 This Circular is applicable to all Aerodromes Operators including those owned by Airports Authority of India.
- 3.2 Verification & Validation charges in Table 2 are applicable charges for non-AAI airports like State/Private/ PSU/Defence owned airports and heliports.

4. Mandatory Survey Requirement

- 4.1 Aerodrome Operators, including aerodromes owned by Airports Authority of India, shall follow AAI Aerodrome Survey Manual and GIS circular 01/2023 for survey requirement and periodicity, respectively. Airport Director/Airport Operator are advised to provide accurate information of their aerodrome and environs as per requirement defined in Table-1.
- 4.2 Aerodrome Operator is expected to keep all the records of No Objection Certificates (NOC) issued during the period, since the last survey was conducted. List of the NOC cases located within the survey areas should be provided to the survey team so that it may be taken into the consideration for verification. In addition, any change in the location of Navigational Aids, threshold or parking stand shall be informed to the survey team.
- 4.3 Surveys shall be undertaken for all Survey Areas required to measure any changes at the periodic intervals prescribed in Table-1 below:

Table 1

| Survey Type | Periodicity |
|---------------------|--|
| Geodetic Connection | a) Together with an initial full survey. b) When a more accurate reference frame for WGS-84 becomes available. c) When an aerodrome facility, e.g. new parking stand, taxiway or threshold, nav-aid etc. needs to be commissioned. |
| Full Survey | a) Initial commissioning of the aerodrome. b) If a check survey is not carried out as specified in para 4.4. c) After every 4 years for IFR and 5 years for VFR as specified in GIS Circular 01/2023. d) If any doubt exists, regarding the quality of previous survey. |
| Check Survey | As defined in para 4.4 below and on the specific request of Airport Director/Airport Operator. |



4.4 Check Survey

- a) The check survey is to identify any changes in the aerodrome lay-out, such as, addition/modifications of new stands, shifting of threshold or holding positions, new locations/tans-installation of nav-aids, addition or removal of obstacles, including significant tree growth or reduction, etc since the previous survey.
- b) The check surveys may also be conducted on the specific request of Airport Director/Airport Operator, whenever commissioning of a new facility (i.e. parking stand, new or displaced threshold, nav-aids, etc) at the airport is needed for the purpose of certification.
- c) Check survey may be restricted to the particular area of aerodrome or to a particular runway in case of any extension.
- d) Check survey may also be conducted if the operations from a particular runway needs to be upgraded, i.e. non-instrument to instrument, or, non-precision to precision.
- e) All check surveys shall be notified by Airport Director/Airport Operator to Survey & Cartography section, CHQ, AAI.
- f) However, as per DGCA Aerodrome Advisory circular no. 1 of 2006, para 4.13 on Obstacle control, Airport Director/Airport Operator shall be responsible for:
 - ❖ Monitoring the obstacle limitation surface and Type A chart take off surface for obstacles;
 - ❖ Controlling obstacle within the authority of the Operator;
 - ❖ Monitoring building or structure development in relation to the height within the boundaries of obstacle limitation surface;
 - ❖ Control of new developments in the vicinity of the aerodrome; and
 - ❖ Notifying the DGCA of the nature and location of obstacles and any subsequent addition or removal of obstacle for necessary including amendment of the AIS publications.

4.5 Verification and Validation Certification

- 4.5.1 The V & V certificate from AAI will be valid depending on the periodicity of survey requirement based on Aerodrome classification or till the new survey carried out due to any changes in the aerodrome environs, whichever is earlier.
- 4.5.2 Information regarding any comments on specific coordinates received from any source shall also be communicated to the assessment team during the conduct of the process by Airport Director/Airport Operator.



- 4.5.3 Airport Director/Airport Operator shall be responsible for the control of obstacles around the airport as per the existing notifications or any such notifications issued by Government of India from time to time.
- 4.5.4 05 casual labourers per day and suitable transportation for the survey will be provided by State/Private/PSU/Defence aerodrome Operator during the field survey at their own cost.
- 4.5.5 Airport Director/Airport Operator shall ensure that all statutory clearances are taken and will be responsible for any non-adherence of V & V process.
- 4.5.6 Airport Director/Airport Operator shall be responsible for the entire accuracy, currency and validity of the aeronautical data, as AAI will only carry out random checks and evaluate the process adopted by Operator for collection and maintenance of data.
- 4.5.7 AAI shall not be held liable for the wrong usage or otherwise of aeronautical data by the Operator/airline causing loss to property or life.

5. Checklist for Airport Director/Aerodrome Operators for the V & V process

In order to reduce delay in V & V process, certain compliances are required to be done by the concerned Airport Director/Airport Operator before commencement of V & V process by AAI. A compliance certificate of the following checklist is to be submitted to AAI by the concerned Airport Director/Airport Operator before commencement of V & V process by AAI:

| S.No. | V&V process Compliances | Compliance (Yes/No) | Remarks |
|-------|---|---------------------|---------|
| 1 | Airport features viz. runway, Taxiway, NAV-aids if any, must exist physically in complete state with proper markings. | | |
| 2 | ARP, PACS (Primary Airport Control station) & SACS (Secondary Airport Control Station) must be established as per standard requirement. | | |
| 3 | Duly filled & Signed Survey Report as per AAI format. | | |
| 4 | Survey charts viz. Airport map (Base Map), Approach charts, Objects of vertical Significance chart and Parking & Docking Chart as per AAI standards to be submitted in hard copy. | | |
| 5 | Runway End Permanent Markers on both ends of the runway as per AAI operational circular 06 of 2011. | | |



6 Verification & Validation charges – Aerodrome category wise

6.1 Competent authority has approved following V & V process charges payable by an Airport Director/Airport Operator to AAJ w.e.f. 06/12/2023, as per its aerodrome category: -

Table 2

| Aerodrome Category | Fixed Charges in INR (A) | Variable Charges in INR (Variable fee × no. of days) (B) | Total Charges in INR = A+B (excl taxes/GST as applicable) |
|--|-----------------------------|---|---|
| Helipad/Heliport | 11,61,000 | 82000 × 4 = 3.28 Lakh | 14.89 Lakh |
| Single Runway Airport (Non- Metro/ others) | 13,01,000 | 82000 × 7 = 5.74 Lakh | 18.75 Lakh |
| Single Runway Airport (Metro, State Capital) | 14,41,000 | 82000 × 8 = 6.56 Lakh | 20.97 Lakh |
| Two or more than two Runway Airport | 15,82,000 | 82000 × 13 = 10.66 Lakh | 26.48 Lakh |
| Check Survey of Airport/Heliport | 9,08,000 | 82000 × No. of days | 11.54 Lakh* |

*Calculated for 3 days of V&V of surveyed data

6.2 Above V & V charges are applicable for 03 years i.e. up to 05/12/2026.

6.3 Full address and GST IN of the payee for generation of tax invoice may be provided. GST challan shall be issued with all details for the purpose of payment. Further, as per notification no. 50/2018-Central tax and notification no. 73/2018- Central tax, TDS under GST provisions shall not apply on transactions which are undertaken between notified persons who are liable to deduct TDS under GST. Therefore, TDS under GST shall not be deducted by any party while making payment to AAJ, since AAJ is a public sector undertaking notified under section 51 of CGST Act.

6.4 Request for V & V of surveyed data along with all the document shall be submitted to:

Executive Director (ATFM)
Airports Authority of India
Rajiv Gandhi Bhawan
Safdarjung Airport
New Delhi-110003
E-mail: edatfm@aaai.aero

GIS Circular 01 of 2024



Directorate of Air Traffic Management

7. Queries

- 7.1 Any queries or further guidance required on the contents of this Circular should be addressed to:

The General Manager (ATM-Survey)
Airports Authority of India
4th Floor, Core-6, Scope Complex,
Lodhi Road, New Delhi-110003
Email: gmatresurvey@aai.aero
Ph-111-24632950; Extn:3202

8. Validity

This Circular is effective from the 06/12/2023 to 05/12/2026.



17/05/2024

VIKAS BHALLA
EXECUTIVE DIRECTOR [ATFM]
AIRPORTS AUTHORITY OF INDIA

GIS CIRCULAR No. 02 OF 2024


 भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA

 DIRECTORATE OF AIR TRAFFIC MANAGEMENT
RAJIV GANDHI BHAWAN, NEW DELHI-110003

GIS Circular No. 02 of 2024

Charges for Aeronautical Survey & Cartography work**1) Introduction:**

AAI is a premier organization under the Ministry of Civil Aviation responsible for creating, upgrading, maintaining and managing civil aviation infrastructure in India. AAI has in-house survey & cartography section under ATM Directorate. The section is responsible for conducting Airport survey and preparation of Aeronautical maps & charting work of all the AAI managed airports.

2) Scope:

AAI provides the Survey & Cartography service to joint-venture airports, airports under state govt., private airports, Defence airports etc. as and when requested by concerned airport operator on payment basis.

3) Charges for Aeronautical Survey & Cartography work

Competent Authority has approved following charges payable by the concerned Aerodrome operator to AAI for aeronautical survey & cartography work as per the category of the aerodrome appended below: -

| S. No. | Aerodrome Category | Total Charges* (excluding GST**) in INR |
|--------|---|---|
| 1. | Helipport/Helipad | 33.25 Lakh |
| 2. | Single Runway Airport (Non- Metro/ others) | 41.09 Lakh |
| 3. | Single Runway Airport (Metro/State Capital) | 45.62 Lakh |
| 4. | Two or more than two Runway Airport | 71.87 Lakh |
| 5. | Check Survey Charges | 20,57,000 + 1,21,000 x No. of days |

*Applicable charges are to be paid full in advance to AAI.
**GST will be applicable as per the prevailing rates.

4) Validity: -

This GIS circular shall remain in force from 01/04/2024 to 31/03/2027.

5) Queries: -

Any queries or further guidance required on the contents of this GIS circular should be addressed to:

General Manager (ATM-Survey & Cartography)
Airports Authority of India,
4th Floor, Core-6, Scope Complex,
Jawaharlal Nehru Stadium Marg,
Pragati Vihar, New Delhi-110003
Email: gmatmsurvey@aai.aero
LL-011-24632950 Extn:3202



Vikas Bhalla

Executive Director (ATM-ATFM)

Airports Authority of India

विकास भाल्ला / VIKAS BHALLA
 अधिकारी (ATM-ATFM) / Executive Director (ATM-ATFM)
 भारतीय विमानपत्तन प्राधिकरण / Airports Authority of India
 जवाहर लाल नेहरू स्टेडियम मार्ग / Jawahar Lal Nehru Stadium Marg
 प्रगति विहार नए दिल्ली / Pragati Vihar, New Delhi-110003

PART - V

CARTOGRAPHY

AERONAUTICAL CHARTS

TABLE OF CONTENTS

AERONAUTICAL CHARTS

| Chapter No. | Topic | Page No. |
|--|---|------------|
| CHAPTER 1 DEFINITIONS, APPLICABILITY AND AVAILABILITY | | 207 |
| 1.1 | Definitions | 207 |
| 1.2 | Applicability | 207 |
| 1.3 | Availability | 207 |
| CHAPTER 2 GENERAL SPECIFICATIONS FOR AERONAUTICAL CHARTS | | 209 |
| 2.1 | Operational requirements for charts | 209 |
| 2.2 | Titles | 210 |
| 2.3 | Miscellaneous information | 210 |
| 2.4 | Symbols | 210 |
| 2.5 | Units of measurement | 211 |
| 2.6 | Scale and projection | 211 |
| 2.7 | Date of Validity | 211 |
| 2.8 | Spelling of geographical names | 212 |
| 2.9 | Abbreviations | 212 |
| 2.10 | Political boundaries | 212 |
| 2.11 | Colours | 212 |
| 2.12 | Relief | 212 |
| 2.13 | Prohibited, restricted and danger areas | 213 |
| 2.14 | Air traffic services airspaces | 213 |
| 2.15 | Magnetic variation | 213 |
| 2.16 | Typography | 214 |
| 2.17 | Aeronautical data | 214 |
| 2.18 | Common reference systems | 214-215 |
| CHAPTER 3 AERODROME OBSTACLE CHART — TYPE A (OPERATING LIMITATIONS) | | 216 |
| 3.1 | Function | 216 |

| | | |
|--|--|------------|
| 3.2 | Availability | 216 |
| 3.3 | Units of measurement | 216 |
| 3.4 | General Requirements | 216 |
| 3.5 | Format | 217 |
| 3.6 | Identification | 217 |
| 3.7 | Magnetic variation | 217 |
| 3.8 | Aeronautical data | 217-220 |
| 3.9 | Accuracy | 220 |
| CHAPTER 4 AERODROME OBSTACLE CHART — TYPE B | | 222 |
| 4.1 | Function | 222 |
| 4.2 | Availability | 222 |
| 4.3 | Units of measurement | 222 |
| 4.4 | Coverage and scale | 222 |
| 4.5 | Format | 223 |
| 4.6 | Identification | 223 |
| 4.7 | Culture and topography | 223 |
| 4.8 | Magnetic variation | 223 |
| 4.9 | Aeronautical data | 224 |
| 4.10 | Accuracy | 225 |
| CHAPTER 5 RESERVED | | 227 |
| CHAPTER 6 PRECISION APPROACH TERRAIN CHART | | 228 |
| 6.1 | Function | 228 |
| 6.2 | Availability | 228 |
| 6.3 | Scale | 228 |
| 6.4-6.5 | Identification, Plan and profile information | 228-229 |
| CHAPTER 7 ENROUTE CHART | | 230 |
| 7.1 | Function | 230 |
| 7.2 | Availability | 230 |

| | | |
|--|------------------------------|------------|
| 7.3 | Coverage and scale | 230 |
| 7.4 | Projection | 230 |
| 7.5 | Identification | 231 |
| 7.6 | Culture and topography | 231 |
| 7.7 | Magnetic variation | 231 |
| 7.8 | Bearings, tracks and radials | 231 |
| 7.9 | Aeronautical data | 231-233 |
| CHAPTER 8 AREA CHART | | 235 |
| 8.1 | Function | 235 |
| 8.2 | Availability | 235 |
| 8.3 | Coverage and scale | 235 |
| 8.4 | Projection | 235 |
| 8.5 | Identification | 235 |
| 8.6 | Culture and topography | 236 |
| 8.7 | Magnetic variation | 236 |
| 8.8 | Bearings, tracks and radials | 236 |
| 8.9 | Aeronautical data | 236-238 |
| CHAPTER 9 STANDARD DEPARTURE CHART — INSTRUMENT (SID) | | 240 |
| 9.1 | Function | 240 |
| 9.2 | Availability | 240 |
| 9.3 | Coverage and scale | 240 |
| 9.4 | Projection | 240 |
| 9.5 | Identification | 240 |
| 9.6 | Culture and topography | 241 |
| 9.7 | Magnetic variation | 241 |
| 9.8 | Bearings, tracks and radials | 241 |
| 9.9 | Aeronautical data | 241-244 |

| | | |
|--|------------------------------|------------|
| CHAPTER 10 STANDARD ARRIVAL CHART — INSTRUMENT (STAR) | | 246 |
| 10.1 | Function | 246 |
| 10.2 | Availability | 246 |
| 10.3 | Coverage and scale | 246 |
| 10.4 | Projection | 246 |
| 10.5 | Identification | 246 |
| 10.6 | Culture and topography | 247 |
| 10.7 | Magnetic variation | 247 |
| 10.8 | Bearings, tracks and radials | 247 |
| 10.9 | Aeronautical data | 247-250 |
| CHAPTER 11 INSTRUMENT APPROACH CHART | | 252 |
| 11.1 | Function | 252 |
| 11.2 | Availability | 252 |
| 11.3 | Coverage and scale | 252 |
| 11.4 | Format | 252 |
| 11.5 | Projection | 252 |
| 11.6 | Identification | 253 |
| 11.7 | Culture and topography | 253-254 |
| 11.8 | Magnetic variation | 254 |
| 11.9 | Bearings, tracks and radials | 254 |
| 11.10 | Aeronautical data | 254-259 |
| CHAPTER 12 | RESERVED | 261 |
| CHAPTER 13 AERODROME/HELIPORT CHART | | 262 |
| 13.1 | Function | 262 |
| 13.2 | Availability | 262 |
| 13.3 | Coverage and scale | 262 |
| 13.4 | Identification | 262 |

| | | |
|-------------------|---|------------|
| 13.5 | Magnetic variation | 262 |
| 13.6 | Aerodrome/heliport data | 262-265 |
| CHAPTER 14 | AERODROME GROUND MOVEMENT CHART | 267 |
| 14.1 | Function | 267 |
| 14.2 | Availability | 267 |
| 14.3 | Coverage and scale | 267 |
| 14.4 | Identification | 267 |
| 14.5 | Magnetic variation | 267 |
| 14.6 | Aerodrome data | 267 - 268 |
| CHAPTER 15 | AIRCRAFT PARKING/DOCKING CHART | 270 |
| 15.1 | Function | 270 |
| 15.2 | Availability | 270 |
| 15.3 | Coverage and scale | 270 |
| 15.4 | Identification | 270 |
| 15.5 | Magnetic variation | 270 |
| 15.6 | Aerodrome data | 270-271 |
| CHAPTER 16 | RESERVED | 273 |
| CHAPTER 17 | RESERVED | 274 |
| CHAPTER 18 | RESERVED | 275 |
| CHAPTER 19 | RESERVED | 276 |
| CHAPTER 20 | ELECTRONIC AERONAUTICAL CHART DISPLAY | 277 |
| 20.1 | Function | 277 |
| 20.2 | Information available for display | 277 |
| 20.3 | Display requirements | 277-278 |
| 20.4 | Provision and updating of data | 278-279 |
| 20.5 | Performance tests, malfunction alarms and indications | 279 |
| 20.6 | Back-up arrangements | 279 |

| CHAPTER 21 ATC SURVEILLANCE MINIMUM ALTITUDE CHART | | 280 |
|---|------------------------------|------------|
| 21.1 | Function | 280 |
| 21.2 | Availability | 280 |
| 21.3 | Coverage and scale | 280 |
| 21.4 | Projection | 280 |
| 21.5 | Identification | 280 |
| 21.6 | Culture and topography | 280 |
| 21.7 | Magnetic variation | 281 |
| 21.8 | Bearings, tracks and radials | 281 |
| 21.9 | Aeronautical data | 281 - 282 |

| CARTOGRAPHY SAMPLE CHART | | |
|---------------------------------|--|-----------------|
| S. No. | Name of Chart | Page No. |
| 1. | Type-A Chart (Aerodrome Obstacle Chart – ICAO) | 221 |
| 2. | Type-B Chart (Aerodrome Obstacle Chart – ICAO) | 226 |
| 3. | Precision Approach Terrain Chart | 229 |
| 4. | Enroute Chart - ICAO | 234 |
| 5. | Area Chart - ICAO | 239 |
| 6. | Standard Departure Chart – Instrument (SID) | 245 |
| 7. | Standard Arrival Chart – Instrument (STAR) | 251 |
| 8. | Instrument Approach Chart (IAL) | 260 |
| 9. | Aerodrome Chart | 266 |
| 10. | Aerodrome Ground Movement Chart - ICAO | 269 |
| 11. | Aircraft Parking Docking Chart | 272 |
| 12. | ATC Surveillance Minimum Altitude Chart - ICAO | 283 |

CHAPTER 1

DEFINITIONS, APPLICABILITY AND AVAILABILITY

1.1 Definition - available at P-13 & 15.

1.1.1 Reserved

1.2 Applicability

1.2.1 Reserved

1.2.2 All charts coming within the scope of this CAR shall conform to the specifications and requirements relevant to the particular chart.

1.2.3 Reserved

1.3 Availability

1.3.1 Information. Necessary information relating to the territory of India shall be provided on request to another Contracting State to enable it to meet the Annex 4 requirements.

1.3.2 Charts or single sheet of a chart series entirely contained within the territory of India shall be produced. For chart or single sheet of a chart series, which includes the territory of another Contracting State(s), the State having jurisdiction over the territory so included shall determine the manner in which the chart or sheet will be made available. This determination shall be made with due regard being given to regional air navigation agreements and to any programme of allocation established by the Council of ICAO.

Note. — The phrase “regional air navigation agreements” refers to the agreements approved by the Council of ICAO normally on the advice of regional air navigation meetings.

1.3.3 All reasonable measures shall be taken to ensure that the information provided and the aeronautical charts made available are adequate and accurate and that they are maintained up to date by an adequate revision service.

1.3.4 To improve worldwide dissemination of information on new charting techniques and production methods, appropriate charts produced shall be made available without charge to other Contracting States on request on a reciprocal basis.

Note. — Guidance material on the preparation of aeronautical charts, including sample formats, is contained in the ICAO Aeronautical Chart Manual (Doc 8697).

* ISO Standard

19101, Geographic information — Reference model
19104, Geographic information — Terminology
19108, Geographic information — Temporal schema
19115, Geographic information — Metadata
19117, Geographic information — Portrayal
19131, Geographic information — Data product specification

CHAPTER 2

GENERAL SPECIFICATIONS FOR AERONAUTICAL CHARTS

2. GENERAL

Note. — The standards contained in this para are applicable to all ICAO aeronautical charts unless otherwise stated in the specifications of the chart concerned.

2.1 Operational requirements for charts

Note. — For the purpose of this CAR, the total flight is divided into the following phases:

- Phase 1 - Taxi from aircraft stand to take-off point
- Phase 2 - Take-off and climb to en-route ATS route structure
- Phase 3 - En-route ATS route structure
- Phase 4 - Descent to approach
- Phase 5 - Approach to land missed approach
- Phase 6 - Landing and taxi to aircraft stand.

2.1.1 Each type of chart shall provide information relevant to the function of the chart and its design shall observe Human Factors principles which facilitate its optimum use.

Note. — Guidance material on the application of Human Factors principals is available in the ICAO Human Factors Training Manual (Doc 9683)

2.1.2 Each type of chart shall provide information appropriate to the phase of flight, to ensure the safe and expeditious operation of the aircraft.

2.1.3 The presentation of information shall be accurate, free from distortion and clutter, unambiguous, and be readable under all normal operating conditions.

2.1.4 Colours or tints and type size used shall be such that the chart can be easily read and interpreted by the pilot in varying conditions of natural and artificial light.

2.1.5 The information shall be in a form which enables the pilot to acquire it in a reasonable time consistent with workload and operating conditions.

2.1.6 The presentation of information provided on each type of chart shall permit smooth transition from chart to chart as appropriate to the phase of flight.

- 2.1.7 The charts shall be True North orientated.
- 2.1.8 The basic sheet size of the charts should be 210 X 297 mm (A4) or any other suitable size keeping legibility factors into account.

2.2 Tiles

The title of a chart or chart series prepared in accordance with the specifications contained in this CAR and intended to satisfy the function of the chart, shall be that of the relevant para heading as modified by application of any Standard contained therein, except that such title shall not include "ICAO" unless the chart conforms with all standards specified in this Para 2 and any specified for the particular chart.

2.3 Miscellaneous information

- 2.3.1 The marginal note layout shall be as given in Appendix 1, except as otherwise specified for a particular chart.
- 2.3.2 The following information shall be shown on the face of each chart unless otherwise stated in the specification of the chart concerned:
- 1) designation or title of the chart series;

Note. — The title may be abbreviated.
 - 2) name and reference of the sheet;
 - 3) on each margin an indication of the adjoining sheet (when applicable).
- 2.3.3 A legend to the symbols and abbreviations used shall be provided. The legend shall be on the face or reverse of each chart except that, where it is impracticable for reasons of space, a legend may be published separately.
- 2.3.4 The name and adequate address of the producing agency shall be shown in the margin of the chart except that, where the chart is published as part of an aeronautical document, this information may be placed in the front of that document.

2.4 Symbols

- 2.4.1 Symbols used shall conform to those shown in Appendix 2 – ICAO Chart Symbols, except that where it is desired to show on an aeronautical chart special features or items of importance to civil aviation for which no ICAO symbol is at present provided, any appropriate symbol may be chosen for this purpose, provided that it does not cause confusion with any existing ICAO chart symbol or impair the legibility of the chart.

Note. — The size and prominence of symbols and the thickness and spacing of

lines may be varied according to the scale and functions of the chart, with due regard to the importance of the information they convey.

- 2.4.2 To represent ground-based navigation aids, intersections and waypoints, the same basic symbol shall be used on all charts on which they appear, regardless of chart purpose.
- 2.4.3 The symbol used for significant points shall be based on a hierarchy of symbols and selected in the following order: ground-based navigation aid, intersection, waypoint symbol. A waypoint symbol shall be used only when a particular significant point does not already exist as either a ground-based navigation aid or intersection.
- 2.4.4 Symbols shall be shown in the manner specified in 2.4.2, 2.4.3 and Appendix 2 – ICAO Chart Symbols, symbol number 121.
- 2.4.5 Reserved

2.5 Units of measurement

- 2.5.1 Distance shall be derived as geodesic distances.
- 2.5.2 Distance shall be expressed in either kilo or nautical miles or both, provided the units are clearly differentiated.
- 2.5.3 Altitudes, elevations and heights shall be expressed in either or feet or both, provided the units are clearly differentiated.
- 2.5.4 Linear dimensions on aerodromes and short distances shall be expressed in metres.
- 2.5.5 The order of resolution of distances, dimensions, elevations and heights shall be that as specified for a particular chart.
- 2.5.6 The units of measurement used to express distances, altitudes, elevations and heights shall be conspicuously stated on the face of each chart.
- 2.5.7 Conversion scales (kilo/nautical miles, /feet) shall be provided on each chart on which distances, elevations or altitudes are shown. The conversion scales shall be placed on the face of each chart.

2.6 Scale and projection

- 2.6.1 For charts of large areas, the name and basic parameters and scale of the projection shall be indicated.
- 2.6.2 For charts of small areas, a linear scale only shall be indicated.

2.7 Date of validity

The date of validity of aeronautical information shall be clearly indicated on the face of each chart.

2.8 Spelling of geographical names

2.8.1 The symbols of the Roman alphabet shall be used for all writing.

2.8.2 Reserved

2.8.3 Where a geographical term such as “cape”, “point”, “gulf”, “river”, is abbreviated on any particular chart, that word shall be spelt out in full in the English language, in respect of the most important example of each type. Punctuation marks shall not be used in abbreviations within the body of a chart.

2.8.4 Reserved

2.9 Abbreviations

2.9.1 Abbreviations shall be used on aeronautical charts whenever they are appropriate.

2.9.2 Where applicable, abbreviations shall be selected from the Procedures for Air Navigation Services – ICAO Abbreviations and Codes (Doc 8400).

2.10 Political boundaries

2.10.1 International boundaries shall be shown, but may be interrupted if data more important to the use of the chart would be obscured.

2.10.2 Where the territory of more than one State appears on a chart, the names identifying the countries shall be indicated.

Note. — In the case of a dependent territory, the name of the sovereign State may be added in brackets.

2.11 Colours

Colours used on charts shall conform to Appendix 3 – Colour Guide.

2.12 Relief

2.12.1 Relief, where shown, shall be portrayed in a manner that will satisfy the chart users' need for:

- a) orientation and identification;
- b) safe terrain clearance;
- c) clarity of aeronautical information when shown;
- d) planning.

Note.—Relief is usually portrayed by combinations of contours, hypsometric tints, spot elevations and hill shading, the choice of method being affected by the nature and scale of the chart and its intended use.

- 2.12.2 Where relief is shown by hypsometric tints, the tints used shall be based on those shown in the Hypsometric Tint Guide in Appendix 4.
- 2.12.3 Where spot elevations are used, they shall be shown for selected critical points.
- 2.12.4 The value of spot elevations of doubtful accuracy shall be followed by the sign \pm .

2.13 Prohibited, restricted and danger areas

When prohibited, restricted or danger areas are shown, the reference or other identification shall be included, except that the nationality letters may be omitted.

2.14 Air traffic services airspaces

- 2.14.1 When ATS airspace is shown on a chart, the class of airspace, the type, name or call sign, the vertical limits and the radio frequency(ies) to be used shall be indicated and the horizontal limits depicted in accordance with Appendix 2 -- ICAO Chart Symbols.
- 2.14.2 On charts used for visual flight, those parts of the ATS Airspace Classifications table in CAR Section 9 Series 'E' Part I applicable to the airspace depicted on the chart shall be on the face or reverse of each chart.

2.15 Magnetic variation

- 2.15.1 True North and magnetic variation shall be indicated. The order of resolution of magnetic variation shall be that as specified for a particular chart.
- 2.15.2 When magnetic variation is shown on a chart, the values shown shall be those for the year nearest to the date of publication that is divisible by 5, i.e. 1980, 1985, etc. In exceptional cases where the current value would be more than one degree different, after applying the calculation for annual change, an interim date and value should be quoted.

Note. — The date and the annual change may be shown.

- 2.15.3 For instrument procedure charts, the publication of a magnetic variation change shall be completed within a maximum of six AIRAC cycles.
- 2.15.4 In large terminal areas with multiple aerodromes, a single rounded value of magnetic variation shall be applied so that the procedures that service multiple aerodromes use a single, common variation value.

2.16 Typography

Note. — Samples of type suitable for use on aeronautical charts are included in the ICAO Aeronautical Chart Manual (Doc 8697).

2.17 Aeronautical data

2.17.1 All necessary measures shall be taken to introduce a properly organized quality system containing procedures, processes and resources necessary to implement quality management at each function stage. The execution of such quality management shall be made demonstrable for each function stage, when required. In addition, it shall be ensured that established procedures exist in order that aeronautical data at any moment is traceable to its origin so to allow any data anomalies or errors, detected during the production/ maintenance phases or in the operational use, to be corrected.

Note. — Specifications governing the quality system are given in CAR Section 9, Series 'I' Part I (Aeronautical Information Services).

2.17.2 It shall be ensured that the chart resolution of aeronautical data shall be that as specified for a particular chart.

Note. — Specifications concerning the chart resolution for aeronautical data are contained in PANS-AIM (Doc 10066), Appendix 1.

2.17.3 It shall be ensured that integrity of aeronautical data is maintained throughout the data process from origination to distribution to the next intended user.

Note. — Specifications concerning the integrity classification related to aeronautical data are provided in PANS-AIM (Doc 10066), Appendix 1.

2.17.4 Digital data error detection techniques shall be used during the transmission and/or storage of aeronautical data and digital data sets.

Note. — Detailed specifications concerning digital data error detection techniques are contained in PANS-AIM (Doc 10066).

2.18 Common reference systems

2.18.1 Horizontal reference system

2.18.1.1 World Geodetic System - 1984 (WGS-84) shall be used as the horizontal (geodetic) reference system. Published aeronautical geographical coordinates (indicating latitude and longitude) shall be expressed in terms of the WGS-84 geodetic reference datum.

2.18.1.2 Geographical coordinates which have been transformed into WGS-84 coordinates but whose accuracy of original field work does not meet the requirements in CAR

Section 9 Series 'E' Part I (Air Traffic Services) and CAR Section 'B' Part I (Aerodrome Design and Operations), shall be identified by an asterisk.

2.18.1.3 The chart resolution of geographical coordinates shall be that specified for a particular chart series.

Note. — Specifications concerning the accuracy and integrity classification of WGS-84- related aeronautical data are contained in PANS-AIM (Doc 10066), Appendix 1.

2.18.2 Vertical reference system

2.18.2.1 Mean sea level (MSL) datum, which gives the relationship of gravity-related height (elevation) to a surface known as the geoid, shall be used as the vertical reference system.

Note 1. — The geoid globally most closely approximates MSL. It is defined as the equipotential surface in the gravity field of the Earth that coincides with the undisturbed MSL extended continuously through the continents.

Note 2. — Gravity-related heights (elevations) are also referred to as orthometric heights while distances of points above the ellipsoid are referred to as ellipsoidal heights.

2.18.2.2 In addition to the elevations referenced to MSL, for the specific surveyed ground positions, geoid undulation (referenced to the WGS-84 ellipsoid) for those positions shall also be published as specified for a particular chart.

Note. — Specifications concerning the accuracy and integrity classification of elevation and geoid undulation at specific positions at aerodromes/heliports are contained in PANS-AIM (Doc 10066), Appendix 1.

2.18.2.3 The chart resolution of elevation and geoid undulation shall be that specified for a particular chart series.

Note. — Specifications concerning the chart resolution of elevation and geoid undulation are contained in PANS-AIM (Doc 10066), Appendix 1.

2.18.3 Temporal reference system

2.18.3.1 The Gregorian calendar and Coordinated Universal Time (UTC) shall be used as the temporal reference system.

2.18.3.2 When a different temporal reference system is used for charting, this shall be indicated in GEN 2.1.2 of the Aeronautical Information Publication (AIP).

CHAPTER 3

3. AERODROME OBSTACLE CHART—ICAO TYPE A (OPERATING LIMITATIONS)

3.1 Function

This chart, in combination with the relevant information published in the AIP, shall provide the data necessary to enable an operator to comply with the operating limitations of CAR Section 8 Series 'O' Part II, III, IV and V.

3.2 Availability

- 3.2.1 Aerodrome Obstacle Charts — ICAO Type A (Operating Limitations) shall be made available in the manner prescribed in 1.3.2 for all aerodromes regularly used, except for those aerodromes where there are no obstacles in the take-off flight path areas or where the Aerodrome Terrain and Obstacle Chart — ICAO (Electronic) is provided.
- 3.2.2 Where a chart is not required because no obstacles exist in the take-off flight path area, a notification to this effect shall be published in AIP.

3.3 Units of measurement

- 3.3.1 Elevations shall be shown to the nearest half-meter or to the nearest foot.
- 3.3.2 Linear dimensions shall be shown to the nearest half-meter.

3.4 GENERAL REQUIREMENTS

- 3.4.1 The extent of each plan shall be sufficient to cover all significant obstacles.

Note. — Isolated distant obstacles that would unnecessarily increase the sheet size may be indicated by the appropriate symbol and an arrow, provided that the distance and bearing from the end of the runway farthest removed and the elevation are given.

- 3.4.2 The horizontal scale shall be within the range of 1:10 000 to 1:15 000.
- 3.4.3 A horizontal scale of 1: 10 000 is preferred.
- 3.4.4 The vertical scale shall be ten times the horizontal scale.
- 3.4.5 Linear scales. Horizontal and vertical linear scales showing both and feet shall be included in the charts.

3.5 Format

- 3.5.1 The charts shall depict a plan and profile of each runway, any associated stopway or clearway, the take-off flight path area and obstacles.
- 3.5.2 The profile for each runway, stopway, clearway and the obstacles in the take-off flight path area shall be shown above its corresponding plan. The profile of an alternative take-off flight path area shall comprise a linear projection of the full take-off flight path and shall be disposed above its corresponding plan in the manner most suited to the ready interpretation of the information.
- 3.5.3 A profile grid shall be ruled over the entire profile area exclusive of the runway. The zero for vertical coordinates shall be mean sea level. The zero for horizontal coordinates shall be the end of the runway furthest from the take-off flight path area concerned. Graduation marks indicating the subdivisions of intervals shall be shown along the base of the grid and along the vertical margins.
- 3.5.4 The vertical grid shall have intervals of 30 m (100 ft) and the horizontal grid should have intervals of 300 m (1 000 ft).
- 3.5.5 The chart shall include:
- a) a box for recording the operational data specified in 3.8.3;
 - b) a box for recording amendments and dates thereof.

3.6 Identification

The chart shall be identified by the name of the country in which the aerodrome is located, the name of the city or town, or area, which the aerodrome serves, the name of the aerodrome and the designator(s) of the runway(s).

3.7 Magnetic variation

The magnetic variation to the nearest degree and date of information shall be indicated.

3.8 Aeronautical data

3.8.1 Obstacles

- 3.8.1.1 Objects in the take-off flight path area which project above a plane surface having a 1.2 per cent slope and having a common origin with the take-off flight path area, shall be regarded as obstacles, except that obstacles lying wholly below the shadow of other obstacles as defined in 3.8.1.2 need not be shown. Mobile objects such as boats, trains and trucks, which may project above the 1.2 per cent plane, shall be considered obstacles but shall not be considered as being capable of creating a shadow.
- 3.8.1.2 The shadow of an obstacle is considered to be a plane surface originating at a horizontal line passing through the top of the obstacle at right angles to the centre line of the take-off flight path area. The plane covers the complete width of the take-off flight path area and extends to the plane defined in 3.8.1.1 or to the next higher

obstacle if it occurs first. For the first 300 m (1 000 ft) of the take-off flight path area, the shadow planes are horizontal and beyond this point such planes have an upward slope of 1.2 per cent.

- 3.8.1.3 If the obstacle creating a shadow is likely to be removed, objects that would become obstacles by its removal shall be shown.

3.8.2 Take-off flight path area

3.8.2.1 The take-off flight path area consists of a quadrilateral area on the surface of the earth lying directly below, and symmetrically disposed about, the take-off flight path. This area has the following characteristics:

- 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.

3.8.2.2 For runways serving aircraft having operating limitations which do not preclude the use of a take-off flight path gradient of less than 1.2 per cent, the extent of the takeoff flight path area specified in 3.8.2.1 c) shall be increased to not less than 12.0 km (6.5 NM) and the slope of the plane surface specified in 3.8.1.1 and 3.8.1.2 shall be reduced to 1.0 per cent or less.

Note. — When a 1.0 per cent survey plane touches no obstacles, this plane may be lowered until it touches the first obstacle.

3.8.3 Declared distances

3.8.3.1 The following information for each direction of each runway shall be entered in the space provided:

- take-off run available;
- accelerate-stop distance available;
- take-off distance available;
- landing distance available;
- take-off run available;
- accelerate-stop distance available;
- take-off distance available;
- landing distance available.

3.8.3.2 Where a declared distance is not provided because a runway is usable in one direction only, that runway shall be identified as “not usable for take-off, landing or both”.

3.8.4 Plan and profile views

3.8.4.1 The plan view shall show:

- a) the outline of the runways by a solid line, including the length and width, the magnetic bearing to the nearest degree, and the runway number;
- b) the outline of the clearways by a broken line, including the length and identification as such;
- c) take-off flight path areas by a dashed line and the centre line by a fine line consisting of short and long dashes;
- d) alternative take-off flight path areas. When alternative take-off flight path areas not centred on the extension of the runway centre line are shown, notes shall be provided explaining the significance of such areas;
- e) obstacles, including:
 - 1) the exact location of each obstacle together with a symbol indicative of its type;
 - 2) the elevation and identification of each obstacle;
 - 3) the limits of penetration of obstacles of large extent in a distinctive manner identified in the legend.

Note. — This does not exclude the necessity for indicating critical spot elevations within the take-off flight path area.

3.8.4.1.1 The nature of the runway and stopway surfaces shall be indicated.

3.8.4.1.2 Stopways shall be identified as such and shall be shown by a broken line.

3.8.4.1.3 When stopways are shown, the length of each stopway shall be indicated.

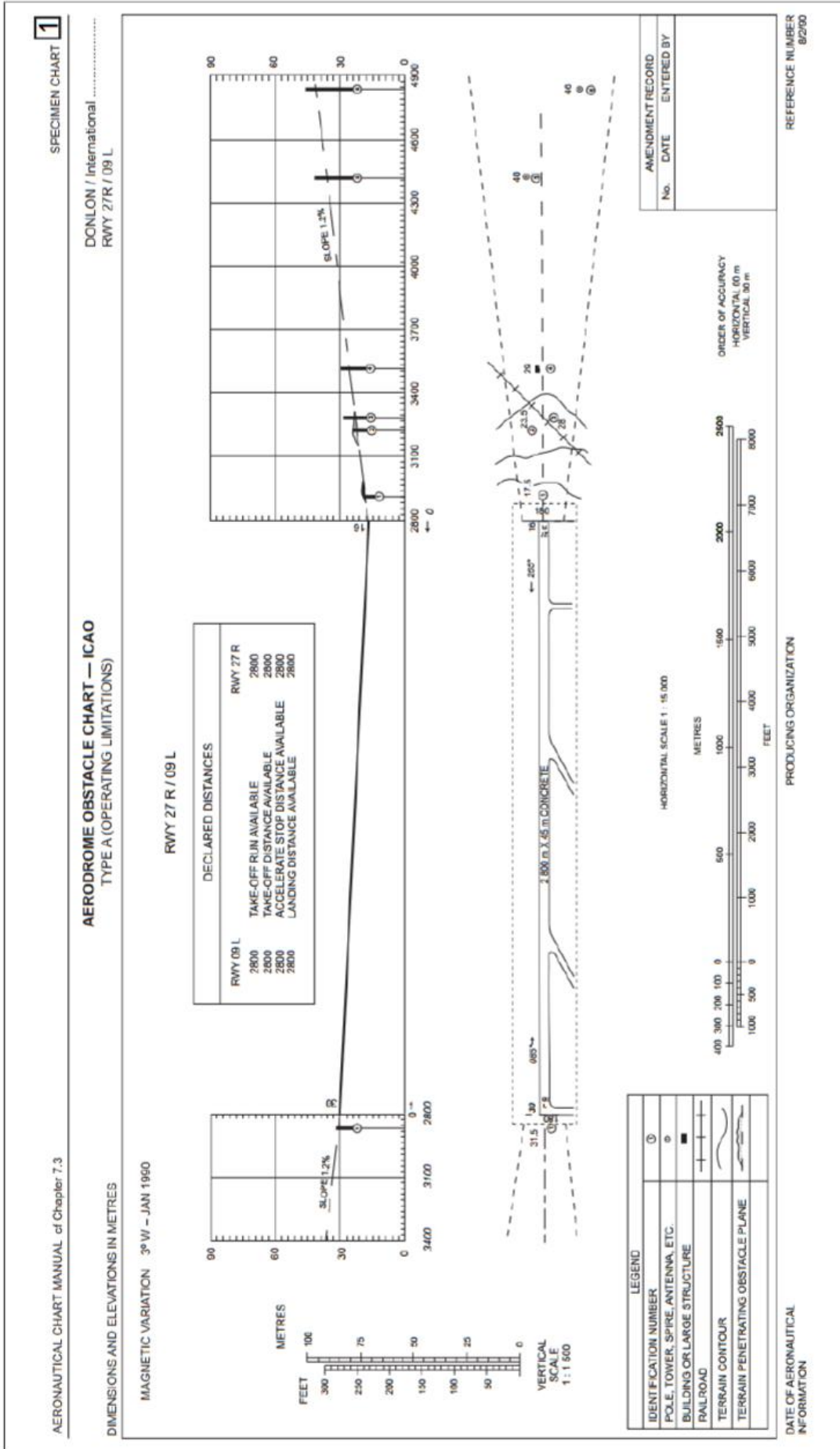
3.8.4.2 The profile view shall show:

- a) the profile of the centre line of the runway by a solid line and the profile of the centre line of any associated stopways and clearways by a broken line;
- b) the elevation of the runway centre line at each end of the runway, at the stopway and at the origin of each takeoff flight path area, and at each significant change in slope of runway and stopway;
- c) obstacles, including:
 - 1) each obstacle by a solid vertical line extending from a convenient grid line over at least one other grid line to the elevation of the top of the obstacle;
 - 2) identification of each obstacle;
 - 3) the limits of penetration of obstacles of large extent in a distinctive manner identified in the legend.

Note. — An obstacle profile consisting of a line joining the tops of each obstacle and representing the shadow created by successive obstacles may be shown.

3.9 Accuracy

- 3.9.1 The order of accuracy attained shall be shown on the chart.
- 3.9.2 The horizontal dimensions and the elevations of the runway, stopway and clearway to be printed on the chart shall be determined to the nearest 0.5 m (1 ft).
- 3.9.3 The order of accuracy of the field work and the precision of chart production shall be such that measurements in the take-off flight path areas can be taken from the chart within the following maximum deviations:
- 1) horizontal distances: 5 m (15 ft) at a point of origin increasing at a rate of 1 per 500;
 - 2) vertical distances: 0.5 m (1.5 ft) in the first 300 m (1 000 ft) and increasing at a rate of 1 per 1 000.
- 3.9.4 Datum. Where no accurate datum for vertical reference is available, the elevation of the datum used shall be stated and shall be identified as assumed.



CHAPTER 4

4. AERODROME OBSTACLE CHART — ICAO TYPE B

4.1 Function

This chart shall provide information to satisfy the following functions:

- a) the determination of minimum safe altitudes/heights including those for circling procedures;
- b) the determination of procedures for use in the event of an emergency during take-off or landing;
- c) the application of obstacle clearing and marking criteria; and
- d) the provision of source material for aeronautical charts.

4.2 Availability

- 4.2.1 Aerodrome Obstacle Charts — ICAO Type B shall be made available, in the manner prescribed in 1.3.2, for all aerodromes except for those aerodromes where the Aerodrome Terrain and Obstacle Chart — ICAO (Electronic) is provided.
- 4.2.2 When a chart combining the specifications of para 3 and 4 is made available, it shall be called the Aerodrome Obstacle Chart — ICAO (Comprehensive).

4.3 Units of measurement

- 4.3.1 Elevations shall be shown to the nearest half-metre or to the nearest foot.
- 4.3.2 Linear dimensions shall be shown to the nearest half-metre.

4.4 Coverage and scale

- 4.4.1 The extent of each plan shall be sufficient to cover all obstacles.

Note. — Isolated distant obstacles that would unnecessarily increase the sheet size may be indicated by the appropriate symbol and an arrow, provided that the distance and bearing from the aerodrome reference point and elevation are given.

- 4.4.2 The horizontal scale shall be within the range of 1:10 000 to 1:20 000.
- 4.4.3 A horizontal linear scale showing both and feet shall be included in the chart. When necessary, a linear scale for kilo and a linear scale for nautical miles shall also be

shown.

4.5 Format

The charts shall include:

- a) any necessary explanation of the projection used;
- b) any necessary identification of the grid used;
- c) a notation indicating that obstacles are those which penetrate the surfaces specified in CAR Section 4, Series 'B' Part I (Aerodrome Design and Operations);
- d) a box for recording amendments and dates thereof;
- e) outside the neat line, every minute of latitude and longitude marked in degrees and minutes.

Note. — Lines of latitude and longitude may be shown across the face of the chart.

4.6 Identification

The chart shall be identified by the name of the country in which the aerodrome is located, the name of the city or town, or area, which the aerodrome serves and the name of the aerodrome.

4.7 Culture and topography

- 4.7.1 Drainage and hydrographic details shall be kept to a minimum.
- 4.7.2 Buildings and other salient features associated with the aerodrome shall be shown. Wherever possible, they shall be shown to scale.
- 4.7.3 All objects, either cultural or natural, that project above the take-off and approach surfaces specified in 4.9 or the clearing and marking surfaces specified in CAR Section 4, Series 'B' Part I (Aerodrome Design and Operations);
- 4.7.4 Roads and railroads within the take-off and approach area, and less than 600 m (2 000 ft) from the end of the runway or runway extensions, shall be shown.

Note. — Geographical names of features may be shown if of significance.

4.8 Magnetic variation

The chart shall show a compass rose orientated to the True North, or a North point, showing the magnetic variation to the nearest degree with the date of magnetic information and annual change.

4.9 Aeronautical data

4.9.1 The charts shall show:

- a) the aerodrome reference point and its geographical coordinates in degrees, minutes and seconds;
- b) the outline of the runways by a solid line;
- c) the length and width of the runway;
- d) the magnetic bearing to the nearest degree of the runway and the runway number;
- e) the elevation of the runway centre line at each end of the runway, at the stopway, at the origin of each takeoff and approach area, and at each significant change of slope of runway and stopway;
- f) taxiways, aprons and parking areas identified as such, and the outlines by a solid line;
- g) stopways identified as such and depicted by a broken line;
- h) the length of each stopway;
- i) clearways identified as such and depicted by a broken line;
- j) the length of each clearway;
- k) take-off and approach surfaces identified as such and depicted by a broken line;
- l) take-off and approach areas;
- m) obstacles at their exact location, including:
 - 1) a symbol indicative of their type;
 - 2) elevation;
 - 3) identification;
 - 4) limits of penetration of large extent in a distinctive manner identified in the legend;

Note. — This does not exclude the necessity for indicating critical spot elevations within the take-off and approach areas.

- n) any additional obstacles, as determined by 3.8.1.1 including the obstacles in the shadow of an obstacle, which would otherwise be exempted.

4.9.1.1 The nature of the runway and stopway surfaces shall be given.

4.9.1.2 Wherever practicable, the highest object or obstacle between adjacent approach areas within a radius of 5 000 m (15 000 ft) from the aerodrome reference point shall be indicated in a prominent manner.

4.9.1.3 The extent of tree areas and relief features, part of which constitute obstacles, shall be shown.

4.10 Accuracy

4.10.1 The order of accuracy attained shall be shown on the chart.

4.10.2 The horizontal dimensions and the elevations of the movement area, stopways and clearways to be printed on the chart shall be determined to the nearest 0.5 m (1 ft).

4.10.3 The order or accuracy of the field work and the precision of chart production shall be such that the resulting data will be within the maximum deviations indicated herein:

a) Take-off and approach areas:

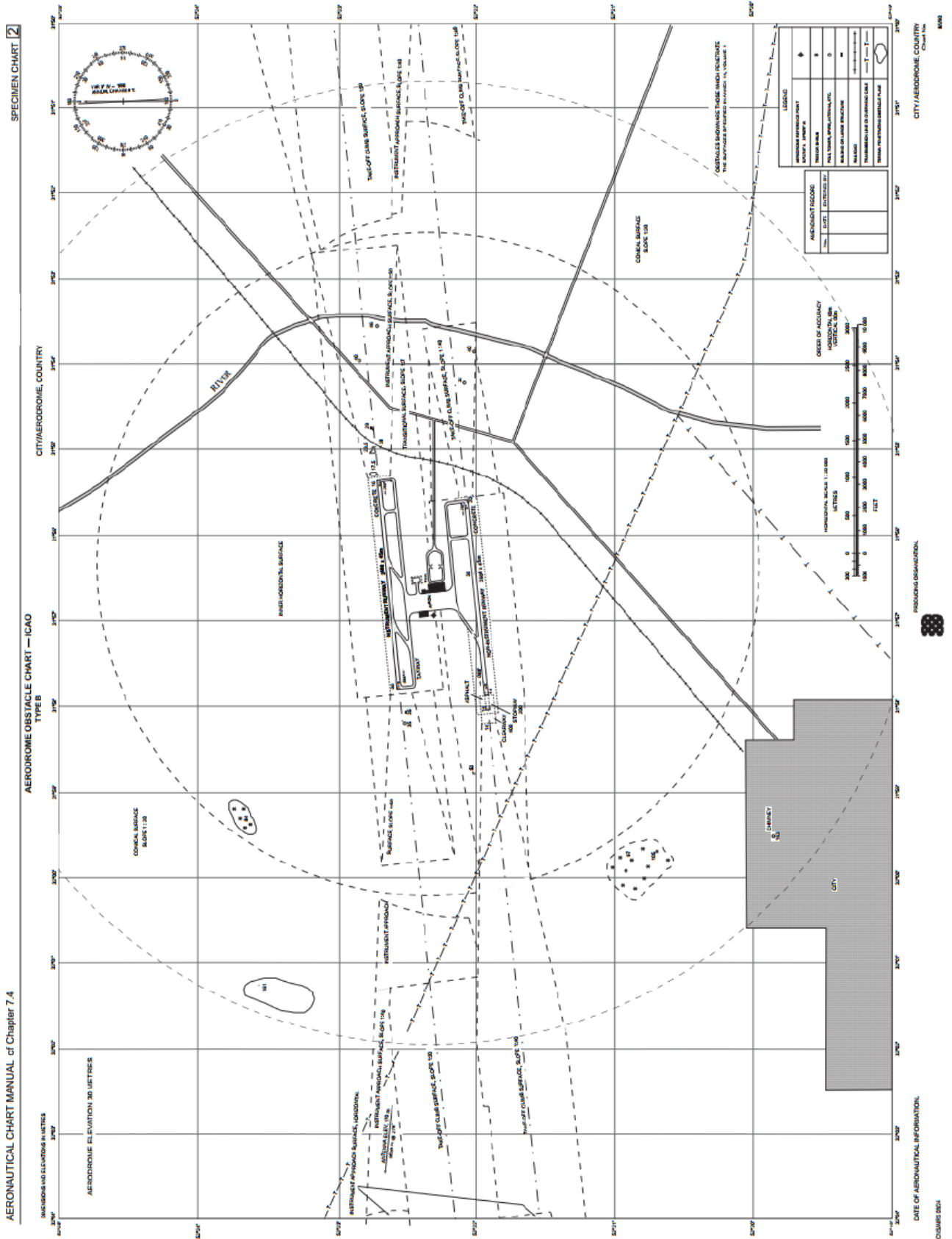
- 1) horizontal distances: 5 m (15 ft) at point of origin increasing at a rate of 1 per 500;
- 2) vertical distances: 0.5 m (1.5 ft) in the first 300 m (1 000 ft) and increasing at a rate of 1 per 1 000.

b) Other areas:

- 1) horizontal distances: 5 m (15 ft) within 5 000 m (15 000 ft) of the aerodrome reference point and 12 m (40 ft) beyond that area;
- 2) vertical distances: 1 m (3 ft) within 1 500 m (5 000 ft) of the aerodrome reference point increasing at a rate of 1 per 1 000.

4.10.4 *Datum*. Where no accurate datum for vertical reference is available, the elevation of the datum used shall be stated and identified as assumed.

ICAO TYPE B



CHAPTER 5

RESERVED

CHAPTER 6

PRECISION APPROACH TERRAIN CHART - ICAO

6.1 Function

The chart shall provide detailed terrain profile information within a defined portion of the final approach so as to enable aircraft operating agencies to assess the effect of the terrain on decision height determination by the use of radio altimeters.

6.2 Availability

6.2.1 The Precision Approach Terrain Chart — ICAO shall be made available for all precision approach runways Categories II and III except where the requisite information is provided in the Aerodrome Terrain and Obstacle Chart — ICAO (Electronic).

6.2.2 The Precision Approach Terrain Chart — ICAO shall be revised whenever any significant change occurs.

6.3 Scale

6.3.1 The horizontal scale shall be 1:2500, and the vertical scale 1:500.

6.3.2 When a chart includes a profile of the terrain to a distance greater than 900 m (3000 ft) from the runway threshold, the horizontal scale shall be 1:5000.

6.4 Identification

The chart shall be identified by the name of the country in which the aerodrome is located, the name of the city or town or area which the aerodrome serves, the name of the aerodrome and the designator of the runway.

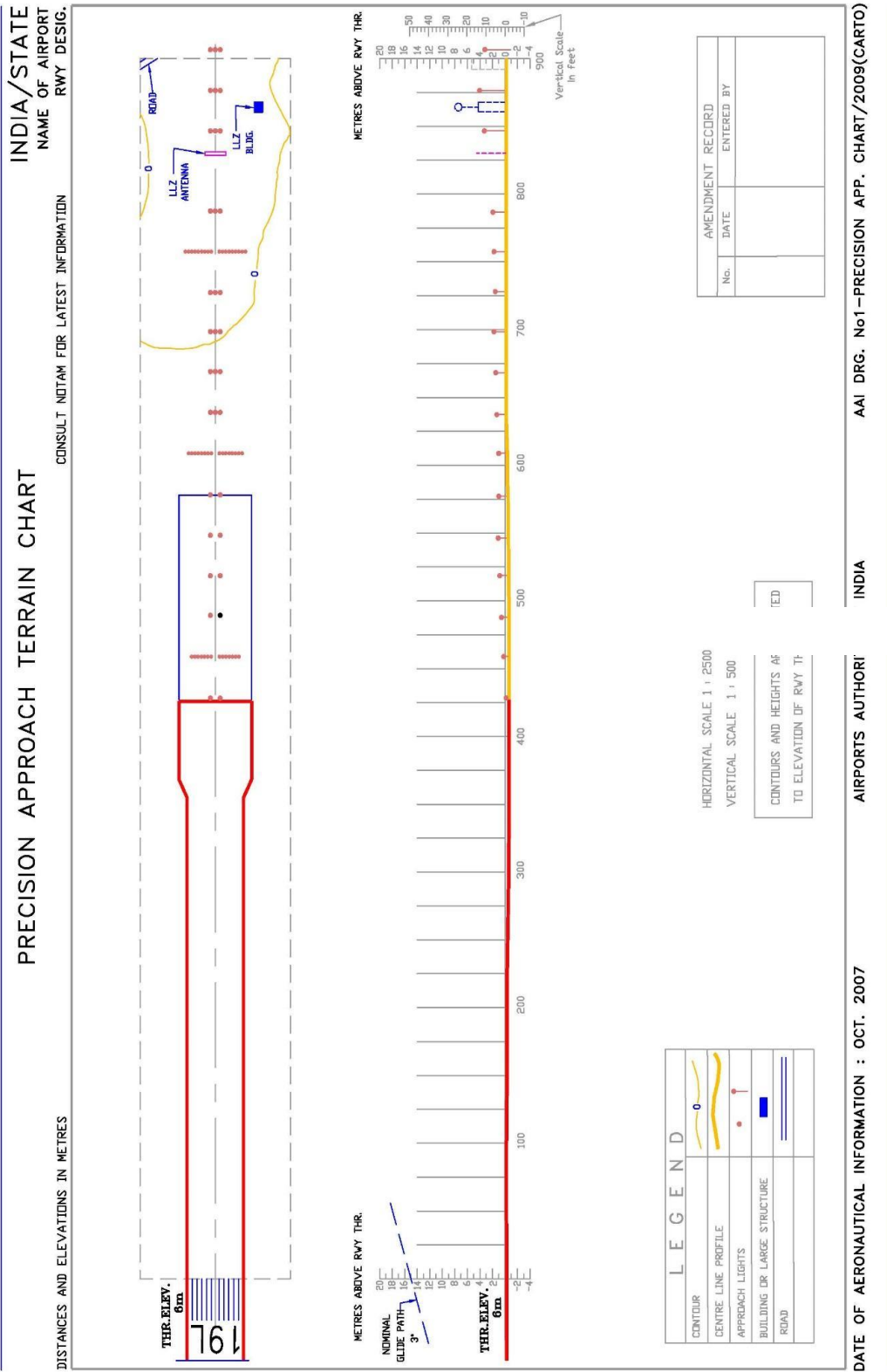
6.5 Plan and profile information

6.5.1 The chart shall include:

- (1) a plan showing contours at 1 m (3 ft) intervals in the area 60 m (200 ft) on either side of the extended centre line of the runway, to the same distance as the profile, the contours to be related to the runway threshold;
- (2) an indication where the terrain or any object thereon, within the plan defined in 1) above, differs by ± 3 m (10 ft) in height from the centre line profile and is likely to affect a radio altimeter;
- (3) a profile of the terrain to a distance of 900 m (3000 ft) from the threshold along the extended centre line of the runway.

6.5.2 Where the terrain at a distance greater than 900 m (3000 ft) from the runway threshold is mountainous or otherwise significant to users of the chart, the profile of the terrain shall be shown to a distance not exceeding 2 000 m (6500 ft) from the runway threshold.

6.5.3 The ILS reference datum height shall be shown to the nearest half metre or foot.



CHAPTER 7

ENROUTE CHART — ICAO

7.1 Function

This chart shall provide flight crews with information to facilitate navigation along ATS routes in compliance with air traffic services procedures.

Note. — Simplified versions of these charts are appropriate for inclusion in Aeronautical Information Publications to complement the tabulation of communication and navigation facilities.

7.2 Availability

7.2.1 The Enroute Chart — ICAO shall be made available in the manner prescribed in 1.3.2 for all areas where flight information regions have been established.

7.2.2 Where different air traffic services routes, position reporting requirements or lateral limits of flight information regions or control areas exist in different layers of airspace and cannot be shown with sufficient clarity on one chart, separate charts shall be provided.

7.3 Coverage and scale

Note 1. — A uniform scale for charts of this type cannot be specified due to the varying degree of congestion of information in certain areas.

Note 2. — A linear scale based on the mean scale of the chart may be shown.

7.3.1 Layout of sheet line shall be determined by the density and pattern of the ATS route structure.

7.3.2 Large variations of scale between adjacent charts showing a continuous route structure shall be avoided.

7.3.3 An adequate overlap of charts shall be provided to ensure continuity of navigation.

7.4 Projection

7.4.1 A conformal projection on which a straight line approximates a great circle shall be used.

Note: Existing charts where Mercator projection is used will continue to be in use till, they are modified/ amended. New chart shall conform to the above provision.

7.4.2 Parallels and meridians shall be shown at suitable intervals.

7.4.3 Graduation marks shall be placed at consistent intervals along selected parallels and meridians.

7.5 Identification

Each sheet shall be identified by chart series and number.

7.6 Culture and topography

7.6.1 Generalized shore lines of all open water areas, large lakes and rivers shall be shown except where they conflict with data more applicable to the function of the chart.

7.6.2 Within each quadrilateral formed by the parallels and meridians, the area minimum altitude shall be shown, except as provided for in 7.6.3.

Note 1. — Quadrilaterals formed by the parallels and meridians normally correspond to the whole degree of latitude and longitude. Regardless of the chart scale being used, the area minimum altitude relates to the consequent quadrilateral.

Note 2. — Refer to the Procedures for Air Navigation — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part I, Section 2, Chapter 1, paragraph 1.8 for method for determination of area minimum altitude.

7.6.3 In areas of high latitude where it is determined by the appropriate authority that True North orientation of the chart is impractical, the area minimum altitude shall be shown within each quadrilateral formed by reference lines of the graticule (grid) used.

7.6.4 Where charts are not True North orientated, this fact and the selected orientation used shall be clearly indicated.

7.7 Magnetic variation

Isogonals shall be indicated and the date of the isogonic information given.

7.8 Bearings, tracks and radials

7.8.1 Bearings, tracks and radials shall be magnetic, where bearings and tracks are additionally provided as true values for RNAV segments, they shall be shown in parentheses to the nearest tenth of a degree, e.g. 290° (294.9°T).

7.8.2 Reserved

7.8.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used, its reference grid meridian shall be identified.

7.9 Aeronautical data

7.9.1 Aerodromes

All aerodromes to which an instrument approach can be made shall be shown.

7.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas relevant to the layer of airspace shall be depicted with their identification and vertical limits.

7.9.3 Air traffic services system

7.9.3.1 Where appropriate, the components of the established air traffic services system shall be shown.

7.9.3.1.1 The components shall include the following:

(1) the radio navigation aids associated with the air traffic services system together with their names, identifications, frequencies and geographical coordinates in degrees, minutes and seconds;

(2) in respect of DME, additionally the elevation of the transmitting antenna of the DME to the nearest 30 m (100 ft);

(3) an indication of all designated airspace, including lateral and vertical limits and the appropriate class of airspace;

(4) All ATS routes for en-route flight including route designators, the track to the nearest degree in both directions along each segment of the routes and, where established, the designation of the navigation specification(s) including any limitations and the direction of traffic flow;

Note. — Guidance material on the organization of ATS routes for en-route flight publication which may be used to facilitate charting is contained in the Aeronautical Information Services Manual. (Doc 8126)

(5) all significant points which define the ATS routes and are not marked by the position of a radio navigation aid, together with their name-codes and geographical coordinates in degrees, minutes and seconds;

(6) in respect of waypoints defining VOR/DME area navigation routes, additionally,

(a) the station identification and radio frequency of the reference VOR/DME;

(b) the bearing to the nearest tenth of a degree and the distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference VOR / DME, if the waypoint is not co-located with it;

(7) an indication of all compulsory and “on-request” reporting points and ATS/MET reporting points;

(8) the distances to the nearest kilometre or nautical mile between significant points constituting turning points or reporting points;

- (9) change-over points on route segments defined by reference to very high frequency omnidirectional radio ranges, indicating the distances to the nearest kilometre or nautical mile to the navigation aids;

Note. — Change-over points established at the midpoint between two aids, or at the intersection of two radials in the case of a route which changes direction between the aids, need not be shown for each route segment if a general statement regarding their existence is made.

- (10) en-route altitudes and minimum obstacle clearance altitudes, on ATS routes to the nearest higher 50 or 100 feet;
- (11) communication facilities listed with their frequencies channels and, if applicable, logon address and satellite voice communications (SATVOICE); and
- (12) air defence identification zone (ADIZ) properly identified.

Note. — ADIZ procedures may be described in the chart legend.

7.9.4 Supplementary information

7.9.4.1 Details of departure and arrival routes and associated holding patterns in terminal areas shall

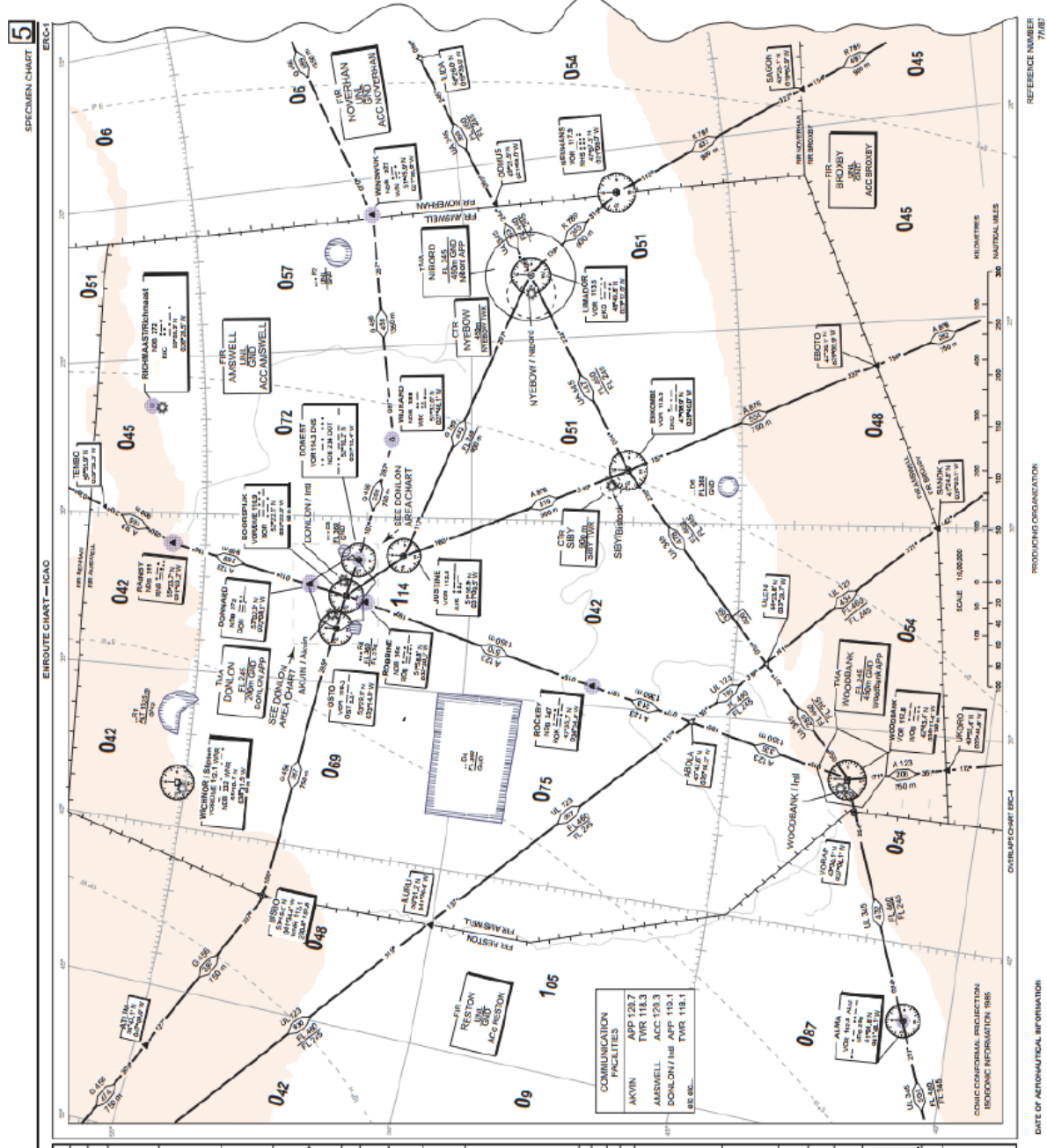
Be shown unless they are shown on an Area Chart, a Standard Departure Chart — Instrument (SID) — ICAO or a Standard Arrival Chart — Instrument (STAR) — ICAO.

Note 1. — For specifications of these charts see para 8, 9 and 10.

Note 2. — Departure routes normally originate at the end of a runway; arrival routes normally terminate at the point where an instrument approach is initiated.

7.9.4.2 Where established, altimeter setting regions shall be shown and identified.

ENROUTE CHART - ICAO



AERONAUTICAL CHART MANUAL of Chapter 7.7

| LEGEND | |
|---|---|
| Aerodromes | |
| Flight Information Region (FIR) | <p>Name of FIR: AMSWELL</p> <p>Lower limit: 0000 ft</p> <p>Upper limit: ACC AMSWELL</p> |
| Terminal Control Area (TMA) | <p>Name of TMA: TMA</p> <p>Upper limit: 0000 ft</p> <p>Lower limit: 0000 ft</p> <p>Upper limit: 0000 ft</p> <p>Lower limit: 0000 ft</p> |
| Control Zone (CTR) | <p>Name of CTR: CTR</p> <p>Upper limit: 0000 ft</p> <p>Lower limit: 0000 ft</p> |
| ATS route (with L, NM) | <p>Route designator: R 789</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Advisory Route (ADR) | <p>Name of ADR: ADR</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Area navigation route (RNAV) | <p>Name of RNAV: RNAV</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Change-over point (COP) | <p>Name of COP: COP</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Waypoint (WPT) | <p>Name of WPT: WPT</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Reporting point (REP) | <p>Name of REP: REP</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| ATS/MET reporting point (MRP) | <p>Name of MRP: MRP</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Restricted airspace | <p>Name of Restricted Airspace: Restricted Airspace</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| VHF omnidirectional radio range (VOR) | <p>Name of VOR: VOR</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Distance measuring equipment (DME) | <p>Name of DME: DME</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Co-located VOR and DME navigation aids (VOR/DME) | <p>Name of VOR/DME: VOR/DME</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |
| Isogonic line of Isogonic | <p>Name of Isogonic: Isogonic</p> <p>Altitude: FL 245</p> <p>Distance: 900 m</p> |

DATE OF AERONAUTICAL INFORMATION: 114

CHAPTER 8

AREA CHART — ICAO

8.1 Function

This chart shall provide the flight crew with information to facilitate the following phases of instrument flight:

- (a) the transition between the en-route phase and approach to an aerodrome;
- (b) the transition between take-off/missed approach and en-route phase of flight; and
- (c) flights through areas of complex ATS routes or airspace structure.

Note. — The function described in 8.1 c) may be satisfied by a separate chart or an inset on an Enroute Chart — ICAO.

8.2 Availability

8.2.1 The Area Chart — ICAO shall be made available in the manner prescribed in 1.3.2 where the air traffic services routes or position reporting requirements are complex and cannot be adequately shown on an Enroute Chart — ICAO.

8.2.2 Where air traffic services routes or position reporting requirements are different for arrivals and for departures, and these cannot be shown with sufficient clarity on one chart, separate charts shall be provided.

8.3 Coverage and scale

8.3.1 The coverage of each chart shall extend to points that effectively show departure and arrival routes.

8.3.2 A chart shall be drawn to scale and a scale-bar shown.

8.4 Projection

8.4.1 A conformal projection on which a straight line approximates a great circle shall be used.

Note: Existing charts where Mercator projection is used will continue to be in use till they are modified/ amended. New chart shall conform to the above provision.

8.4.2 Parallels and meridians shall be shown at suitable intervals.

8.5 Identification

The chart shall be identified by a name associated with the airspace portrayed.

Note. — The name may be that of the air traffic services centre, the name of the largest city or town situated in the area covered by the chart or the name of the city that the aerodrome serves. Where more than one aerodrome serves the city

or town, the name of the aerodrome on which the procedures are based should be added.

8.6 Culture and topography

8.6.1 Generalized shorelines of all open water areas, large lakes and rivers shall be shown except where they conflict with data more applicable to the function of the chart.

8.6.2 To improve situational awareness in areas where significant relief exists, all relief exceeding 300 m (1 000 ft) above the elevation of the primary aerodrome shall be shown by smoothed contour lines, contour values and layer tints printed in brown. Appropriate spot elevations, including the highest elevation within each top contour line, shall be shown printed in black. Obstacles shall also be shown.

Note 1. — The next higher suitable contour line appearing on base topographic maps exceeding 300 m (1 000 ft) above the elevation of the primary aerodrome may be selected to start layer tinting.

Note 2.— An appropriate brown colour, on which half-tone layer tinting is to be based, is specified in Appendix 3 — Colour Guide for contours and topographic features.

Note 3. — Appropriate spot elevations and obstacles are those provided by the procedures specialist.

8.7 Magnetic variation

The average magnetic variation of the area covered by a chart shall be shown to the nearest degree.

8.8 Bearings, tracks and radials

8.8.1 Bearings, tracks and radials shall be magnetic. Where bearings and tracks are additionally provided as true values for RNAV segments, they shall be shown in parentheses to the nearest tenth of a degree, e.g. 290° (294.9°T).

8.8.2 Reserved

8.8.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used, its reference grid meridian shall be identified.

8.9 Aeronautical data

8.9.1 Aerodromes

All aerodromes which affect the terminal routings shall be shown. Where appropriate, a runway pattern symbol shall be used.

8.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas shall be depicted with their identification and vertical limits.

8.9.3 Area minimum altitudes

Area minimum altitudes shall be shown within quadrilaterals formed by the parallels and meridians.

Note 1. — Quadrilaterals formed by the parallels and meridians normally correspond to the whole degree of latitude and longitude. Regardless of the chart scale being used, the area minimum altitude relates to the consequent quadrilateral.

Note 2.— Refer to the Procedures for Air Navigation — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part I, Section 2, Chapter 1, paragraph 1.8 for method for determination of area minimum altitude.

8.9.4 Air traffic services system

8.9.4.1 The components of the established relevant air traffic services system shall be shown.

8.9.4.1.1 The components shall include the following:

- (1) the radio navigation aids associated with the air traffic services system, together with their names, identifications, frequencies and geographical coordinates in degrees, minutes and seconds;
- (2) in respect of DME, additionally the elevation of the transmitting antenna of the DME to the nearest 30 m (100 ft);
- (3) terminal radio aids which are required for outbound and inbound traffic and for holding patterns;
- (4) the lateral and vertical limits of all designated airspace and the appropriate class of airspace;
- (5) the designation of the navigation specification(s) including any limitations, where established;
- (6) holding patterns and terminal routings, together with the route designators, and the track to the nearest degree along each segment of the prescribed airways and terminal routings;
- (7) all significant points which define the terminal routings and are not marked by the position of a radio navigation aid, together with their name-codes and geographical coordinates in degrees, minutes and seconds;
- (8) in respect of waypoints defining VOR/DME area navigation routes, additionally,
 - (a) the station identification and radio frequency of the reference VOR/DME;

(b) the bearing to the nearest tenth of a degree and the distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference VOR/DME, if the waypoint is not collocated with it;

- (9) an indication of all compulsory and “on-request” reporting points;
- (10) the distances to the nearest kilometre or nautical mile between significant points constituting turning points or reporting points;

Note. — Overall distances between radio navigation aids may also be shown.

- (11) change-over points on route segments defined by reference to very high frequency omnidirectional radio ranges, indicating the distances to the nearest kilometre or nautical mile to the radio navigation aids;

Note: Change-over points established at midpoint between two aids, or at the intersection of two radials in the case of a route which changes direction between the aids, need not be shown for each route segment if a general statement regarding their existence is made.

- (12) minimum flight altitudes on ATS routes to the nearest higher 50 or 100 feet;
- (13) established minimum vectoring altitudes to the nearest higher 50 m or 100 ft, clearly identified;

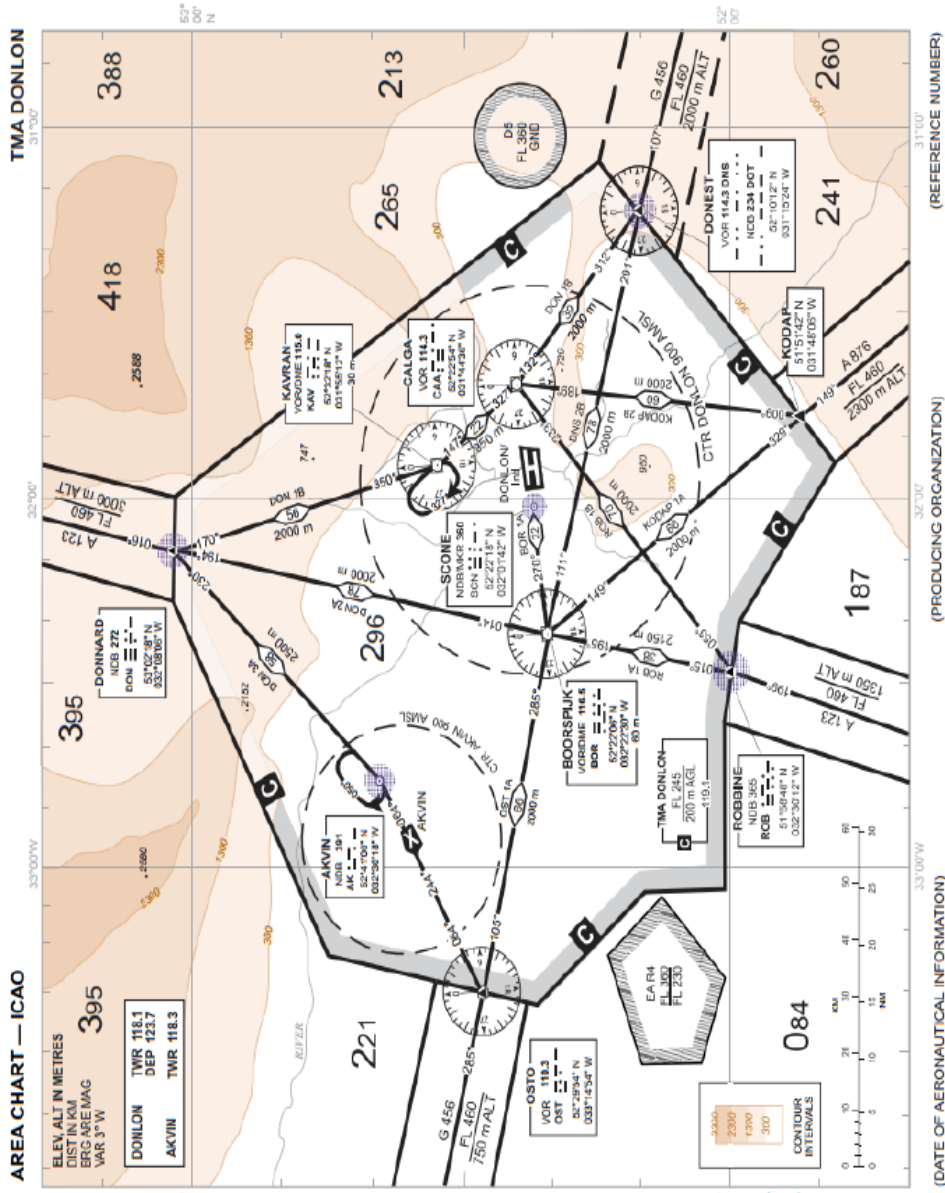
Note 1.— Where radar procedures are used to vector aircraft to or from significant points on a published standard departure or arrival route or to issue clearance for descent below the minimum sector altitude during arrival, the radar procedures may be shown on the Area Chart — ICAO unless excessive chart clutter will result.

Note 2. — Where excessive chart clutter will result, a ATC Surveillance Minimum Altitude Chart — ICAO may be provided (see Para 21), in which case the elements indicated by 8.9.4.1.1, 12), need not be duplicated on the Area Chart — ICAO.

- (14) area speed and level/altitude restrictions where established;
- (15) radio communication facilities listed with their channels and, if applicable, logon address and SATVOICE number; and
- (16) an indication of “flyover” significant points.

AREA CHART - ICAO

6 SPECIMEN CHART



AERONAUTICAL CHART MANUAL of Chapter 7.8

| LEGEND | |
|------------------------------|-----------------------------|
| CONTROL AREA (TMA) (AWY) | ————— |
| ADVISORY ROUTE (ADR) | ----- |
| CONTROL ZONE (CTR) | ----- |
| REPORTING POINT (Compulsory) | ▲ |
| DEPARTURE/ARRIVAL ROUTING | ————— |
| DISTANCE IN KILOMETRES | ————— |
| MINIMUM FLIGHT ALTITUDE | ————— |
| MAGNETIC BEARING | ————— |
| RADIO NAVIGATION AID | ————— |
| NAME | BOORSPIJK |
| NAV AID TYPE AND FREQUENCY | VOR/DME 116.9 |
| IDENTIFICATION | BOOR |
| COORDINATES | 52°22'00" N 032°27'30" W |
| ELEVATION OF DME ANTENNA | 50 m |
| Area minimum altitude (AMA) | 114 |

Each 1° quadrilateral contains an area minimum altitude (AMA) which represents the lowest altitude which may be used under instrument meteorological conditions (IMC). The AMA provides a minimum clearance of 300 metres (900 ft) in mountainous areas above all obstacles in the quadrilateral. It is represented in thousands and tens of metres above mean sea level.
Example: 1140 metres

COM FAILURE
Set transponder code 7500
If you are unable to contact ATIS and LVL, or MNM FLT ALT, if higher for 7 MIN following time of:
a) reaching assigned LVL or MNM FLT ALT; or
b) reaching transponder code 7500; or
c) failure to REP over compulsory REP, whichever is later.
Thereafter, adjust LVL and speed according to PPL.

CHAPTER 9

STANDARD DEPARTURE CHART — INSTRUMENT (SID) — ICAO

9.1 Function

This chart shall provide the flight crew with information to enable it to comply with the designated standard departure route — instrument from take-off phase to the en-route phase.

9.2 Availability

The Standard Departure Chart — Instrument (SID) — shall be made available wherever a standard departure route — instrument has been established and cannot be shown with sufficient clarity on the Area Chart — ICAO.

9.3 Coverage and scale

9.3.1 The coverage of the chart shall be sufficient to indicate the point where the departure route begins and the specified significant point at which the en-route phase of flight along a designated air traffic services route can be commenced.

Note: The departure route normally originates at the end of a runway.

9.3.2 The chart shall be drawn to scale.

9.3.3 If the chart is drawn to scale, a scale-bar shall be shown.

9.3.4 Reserved.

9.4 Projection

9.4.1 A conformal projection on which a straight line approximates a great circle shall be used.

9.4.2 When the chart is drawn to scale, parallels and meridians shall be shown at suitable intervals.

9.4.3 Graduation marks shall be placed at consistent intervals along the neat lines.

9.5 Identification

The chart shall be identified by the name of the city or town or area which the aerodrome serves, the name of the aerodrome and the identification of the standard departure route(s) — instrument as established in accordance with the Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part I, Section 3, Chapter 5.

Note. — The identification of the standard departure route(s) — instrument is provided by the procedures specialist.

9.6 Culture and topography

- 9.6.1 Where the chart is drawn to scale, generalized shore lines of all open water areas, large lakes and rivers shall be shown except where they conflict with data more applicable to the function of a chart.
- 9.6.2 To improve situational awareness in areas where significant relief exists, the chart shall be drawn to scale and all relief exceeding 300 m (1 000 ft) above the aerodrome elevation should be shown by smoothed contour lines, contour values and layer tints printed in brown. Appropriate spot elevations, including the highest elevation within each top contour line, shall be shown printed in black. Obstacles shall also be shown.

Note 1. — The next higher suitable contour line appearing on base topographic maps exceeding 300 m (1 000 ft) above the aerodrome elevation may be selected to start layer tinting.

Note 2.— An appropriate brown colour, on which half-tone layer tinting is to be based, is specified in Appendix 3 — Colour Guide for contours and topographic features.

Note 3. — Appropriate spot elevations and obstacles are those provided by the procedures specialist.

9.7 Magnetic variation

Magnetic variation used in determining the magnetic bearings, tracks and radials shall be shown to the nearest degree.

9.8 Bearings, tracks and radials

- 9.8.1 Bearings, tracks and radials shall normally be magnetic, Where bearings and tracks are additionally provided as true values for RNAV segments, they shall be shown in parentheses to the nearest tenth of a degree, e.g. 290° (294.9°T).
- 9.8.2 Reserved.
- 9.8.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used its reference grid meridian shall be identified.

9.9 Aeronautical data

9.9.1 Aerodromes

9.9.1.1 The aerodrome of departure shall be shown by the runway pattern.

9.9.1.2 All aerodromes which affect the designated standard departure route — instrument shall be shown and identified. Where appropriate, the aerodrome runway patterns shall be shown.

9.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas which may affect the execution of the procedures shall be shown with their identification and vertical limits.

9.9.3 Minimum sector altitude

9.9.3.1 The established minimum sector altitude shall be shown with a clear indication of the sector to which it applies.

9.9.3.2 Where the minimum sector altitude has not been established, the chart shall be drawn to scale and area minimum altitudes shall be shown within quadrilaterals formed by the parallels and meridians. Area minimum altitudes shall also be shown in those parts of the chart not covered by the minimum sector altitude.

Note 1. — Quadrilaterals formed by the parallels and meridians normally correspond to the half degree of latitude and longitude. Regardless of the chart scale being used, the area minimum altitude relates to the consequent quadrilateral.

Note 2. — Refer to the Procedures for Air Navigation — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part I, Section 2, Chapter 1, paragraph 1.8 for method for determination of area minimum altitude.

9.9.4 Air traffic services system

9.9.4.1 The components of the established relevant air traffic services system shall be shown.

9.9.4.1.1 The components shall comprise the following:

- (1) a graphic portrayal of each standard departure route — instrument, including:
 - (a) for departure procedures designed specifically for helicopters, the term “CAT H” shall be depicted in the departure chart plan view;
 - (b) route designator;
 - (c) significant points defining the route;
 - (d) track or radial to the nearest degree along each segment of the route;
 - (e) distances to the nearest kilometre or nautical mile between significant points;
 - (f) minimum flight altitudes along the route or route segments and altitudes required by the procedure to the nearest higher 50 m or 100 ft and flight level restrictions where established;
 - (g) where the chart is drawn to scale and Radar vectoring on departure is provided, established minimum vectoring altitudes to the nearest higher 50 m or 100 ft, clearly identified;
 - (h) for PBN procedures, a PBN requirement box:

Note: Refer to the procedures for Air Navigation Services – Aircraft Operations (PANS-OPS), Doc 8186), Volume II, Part III, Section 5

for information on a PBN requirement Box.

Note 1.— Where radar procedures are used to vector aircraft to or from significant points on a published standard departure route, the radar procedures may be shown on the Standard Departure Chart — Instrument (SID) — ICAO unless excessive chart clutter will result.

Note 2. — Where excessive chart clutter will result, a ATC Surveillance Minimum Altitude Chart — ICAO may be provided (see para 21), in which case the elements indicated by 9.9.4.1.1, 1) f), need not be duplicated on the Standard Departure Chart — Instrument (SID) — ICAO.

- (2) the radio navigation aid(s) associated with the route(s) including:
- (i) when the radio navigation aid is used for conventional navigation;
 - (a) plain language name;
 - (b) identification;
 - (c) Morse code;
 - (d) frequency;
 - (e) geographical coordinates in degrees, minutes and seconds; and
 - (f) for DME, the channel and the elevation of the transmitting antenna of the DME to the nearest 30 m (100 ft);
 - (ii) when the radio navigation aid is used as a significant point for area navigation;
 - (a) plain language name;
 - (b) identification;
- (3) significant points not marked by the position of a radio navigation aid including:
- (i) when the significant point is used for conventional navigation:
 - (a) name-code;
 - (b) geographical coordinates in degrees, minutes and seconds;
 - (c) bearing to the nearest tenth of a degree from the reference radio navigation aid;
 - (d) distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference radio navigation aid; and
 - (e) identification of the reference radio navigation aid;

- (ii) when the significant point is used for area navigation:
 - (a) name-code;
- (4) applicable holding patterns;
- (5) transition altitude/height to the nearest higher 300 m or 1000 ft;
- (6) the position and height of close-in obstacles which penetrate the obstacle identification surface (OIS). A note shall be included whenever close-in obstacles penetrating the OIS exist but which were not considered for the published procedure design gradient;

Note. — In accordance with PANS-OPS, Volume II, information on close-in obstacles is provided by the procedures specialist.
- (7) area speed restrictions, where established;
- (8) the designation of the navigation specification(s) including any limitations, where established;
- (9) all compulsory and “on-request” reporting points;
- (10) radio communication procedures, including:
 - (a) call sign(s) of ATS unit(s);
 - (b) frequency and, if applicable, SATVOICE number;
 - (c) transponder setting, where appropriate;
- (11) an indication of “flyover” significant points.

9.9.4.2 A textual description of standard departure route(s) — instrument (SID) and relevant communication failure procedures in relation to Radar control shall be provided and shall, whenever feasible, be shown on the chart or on the same page which contains the chart.

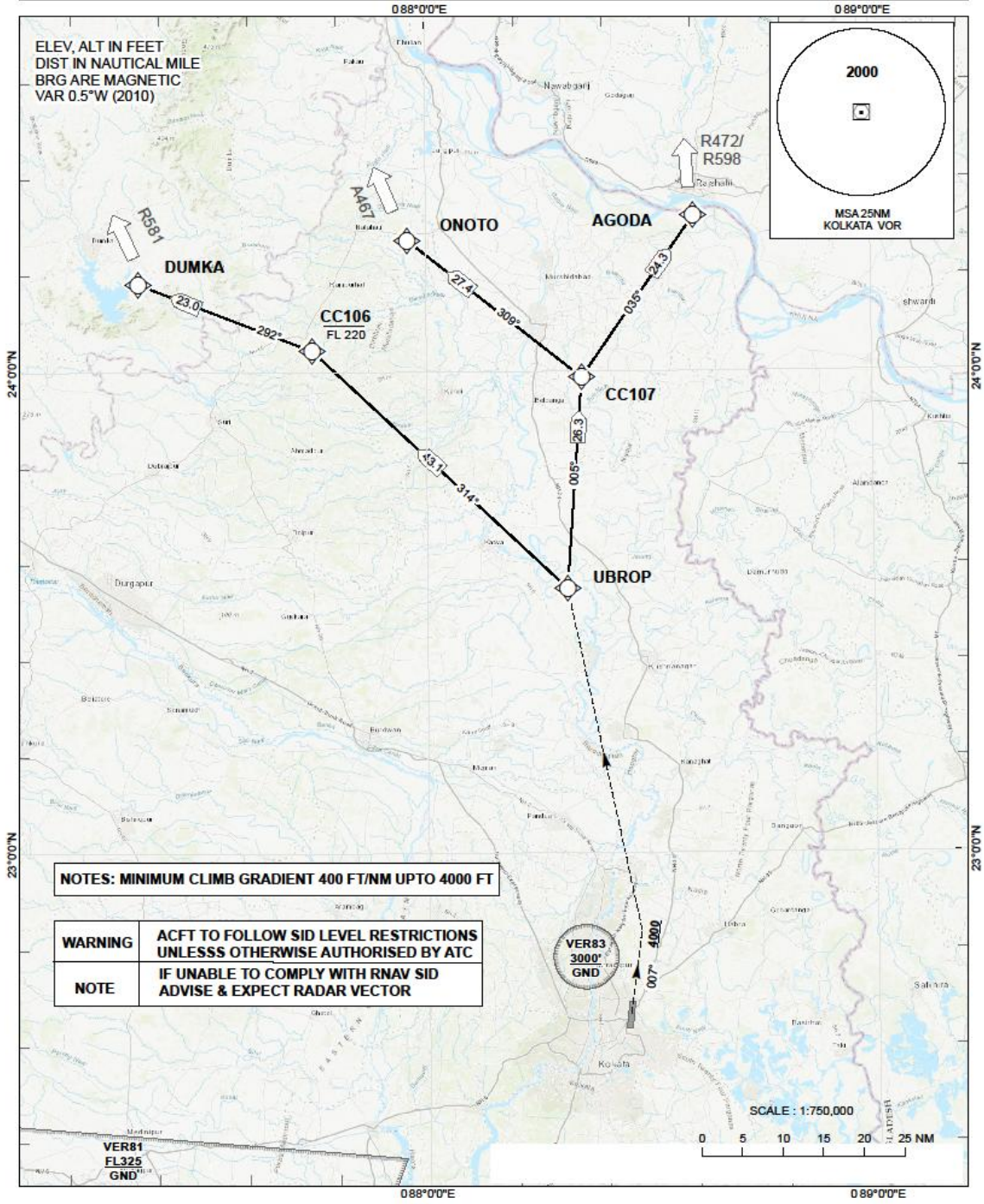
9.9.4.3 Aeronautical database requirements

Appropriate data to support navigation database coding shall be published in accordance with the Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part III, Section 5, Chapter 2, 2.1, on the verso of the chart or as a separate, properly referenced sheet.

Note. — Appropriate data are those provided by the procedures specialist.

SID

| | | | |
|--|---|---|--|
| <p>AIP India</p> <p>STANDARD DEPARTURE CHART INSTRUMENT (SID)</p> <p>RNAV1(GNSS) SURVEILLANCE REQUIRED</p> | <p>TRANSITION ALT</p> <p>4000</p> | <p>SMC/TWR 121.900 / 118.100</p> <p>APP 127.900/119.300</p> <p>ACC 133.750/126.100</p> <p>DATIS 126.400</p> | <p style="text-align: right;">AD 2 VECC 3-101 08 AUG 2024</p> <p style="text-align: center;">AIRPORT, INDIA</p> <p>AGODA 2E, ONOTO 2E, DUMKA 2E - RWY01R</p> <p>AGODA 2F, ONOTO 2F, DUMKA 2F - RWY01L</p> |
|--|---|---|--|



DRG.NO. AAI/114-IALC/23/07/03/2024
Airports Authority of India

AMDT 06/2024

CHAPTER 10

STANDARD ARRIVAL CHART — INSTRUMENT (STAR) — ICAO

10.1 Function

This chart shall provide the flight crew with information to enable it to comply with the designated standard arrival route— instrument from the en-route phase to the approach phase.

10.2 Availability

The Standard Arrival Chart - Instrument (STAR) - ICAO shall be made available wherever a standard arrival route - instrument has been established and cannot be shown with sufficient clarity on the Area Chart.

10.3 Coverage and scale

10.3.1 The coverage of the chart shall be sufficient to indicate the points where the en-route phase ends and the approach phase begins.

10.3.2 The chart shall be drawn to scale.

10.3.3 If the chart is drawn to scale, a scale-bar shall be shown.

10.3.4 Reserved.

10.4 Projection

10.4.1 A conformal projection on which a straight line approximates a great circle shall be used.

10.4.2 When a chart is drawn to scale, parallels and meridians shall be shown at suitable intervals.

10.4.3 Graduation marks shall be placed at consistent intervals along the neat lines.

10.5 Identification

A chart shall be identified by the name of the city or town or area which the aerodrome serves, the name of the aerodrome, and the identification of the standard arrival route(s) — instrument as established in accordance with the Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part I, Section 4, Chapter 2.

Note. — The identification of the standard arrival route(s) — instrument is provided by the procedures specialist.

10.6 Culture and topography

10.6.1 Where the chart is drawn to scale, generalised shore lines of all open water areas, large lakes and rivers shall be shown except where they conflict with data more applicable to the function of the chart.

10.6.2 To improve situational awareness in areas where significant relief exists, charts shall be drawn to scale and all relief exceeding 300 m (1000 ft) above the aerodrome elevation shall be shown by smoothed contour lines, contour values and layer tints printed in brown. Appropriate spot elevations, including the highest elevation within each top contour line, are to be shown printed in black. Obstacles shall also be shown.

Note. — The next higher suitable contour line appearing on base topographic maps exceeding 300 m (1000 ft) above the aerodrome elevation may be selected to start layer tinting.

Note 2.— An appropriate brown colour, on which half-tone layer tinting is to be based, is specified in Appendix 3 — Colour Guide for contours and topographic features.

Note 3. — Appropriate spot elevations and obstacles are those provided by the procedures specialist.

10.7 Magnetic variation

Magnetic variation used in determining the magnetic bearings, tracks and radials shall be shown to the nearest degree.

10.8 Bearings, tracks and radials

10.8.1 Bearings, tracks and radials shall be magnetic, Where bearings and tracks are additionally provided as true values for RNAV segments, they shall be shown in parentheses to the nearest tenth of a degree, e.g. 290° (294.9°T).

Note. — A note to this effect may be included on the chart.

10.8.2 Reserved

10.8.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used, its reference grid meridian shall be identified.

10.9 Aeronautical data

10.9.1 Aerodromes

10.9.1.1 The aerodrome of landing shall be shown by the runway pattern.

10.9.1.2 All aerodromes which affect the designated standard arrival route — instrument shall be shown and identified. Where appropriate, the aerodrome runway patterns shall be shown.

10.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas which may affect the execution of the procedures shall be shown with their identification and vertical limits.

10.9.3 Minimum sector altitude

10.9.3.1 The established minimum sector altitude shall be shown with a clear indication of the sector to which it applies.

10.9.3.2 Where the minimum sector altitude has not been established, a chart shall be drawn to scale and area minimum altitudes shall be shown within quadrilaterals formed by the parallels and meridians. Area minimum altitudes shall also be shown in those parts of the chart not covered by the minimum sector altitude.

Note 1. — Quadrilaterals formed by the parallels and meridians normally correspond to the half degree of latitude and longitude. Regardless of the chart scale being used, the area minimum altitude relates to the consequent quadrilateral.

Note 2. — Refer to the Procedures for Air Navigation — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part I, Section 2, Chapter 1, paragraph 1.8 for method for determination of area minimum altitude.

10.9.4 Air traffic services system

10.9.4.1 The components of the established relevant air traffic services system shall be shown.

10.9.4.1.1 The components shall comprise the following:

- (1) a graphic portrayal of each standard arrival route — instrument, including:
 - (a) route designator;
 - (b) significant points defining the route;
 - (c) track or radial to the nearest degree along each segment of the route;
 - (d) distances to the nearest kilometre or nautical mile between significant points;
 - (e) minimum flight altitudes, along the route or route segments and altitudes required by the procedure to the nearest higher 50 m or 100 ft and flight level restrictions where established;

- (f) where the chart is drawn to scale and Radar vectoring on arrival is provided, established minimum vectoring altitudes to the nearest higher 50 m or 100 ft, clearly identified;
- (g) for PBN procedures, a PBN requirement box;

Note – Refer to the procedures for Air Navigation Services – Aircraft Operations (PANS-OPS), DOC8186), Volume II, Part III, Section 5 for information on a PBN requirement Box.

Note 1.— Where radar procedures are used to vector aircraft to or from significant points on a published standard arrival route or to issue clearance for descent below the minimum sector altitude during arrival, the radar procedures may be shown on the Standard Arrival Chart — Instrument (STAR) — ICAO unless excessive chart clutter will result.

Note 2. — Where excessive chart clutter will result, a ATC Surveillance Minimum Altitude Chart — ICAO may be provided (see para 21), in which case the elements indicated by 10.9.4.1.1, 1) f), need not be duplicated on the Standard Arrival Chart — Instrument (STAR) — ICAO.

- (2) the radio navigation aid(s) associated with the route(s) including:
 - (i) when the radio navigation aid is used for conventional navigation;
 - (a) plain language name;
 - (b) identification;
 - (c) Morse code;
 - (d) frequency;
 - (e) geographical coordinates in degrees, minutes and seconds; and
 - (f) for DME, the channel and the elevation of the transmitting antenna of the DME to the nearest 30 m (100 ft);
 - (ii) when the radio navigation aid is used as a significant point for area navigation;
 - (a) plain language name; and
 - (b) identification;
- (3) significant points not marked by the position of a radio navigation aid including:
 - (i) when the significant point is used for conventional navigation:
 - (a) name-code;
 - (b) geographical coordinates in degrees, minutes and seconds;

- (c) bearing to the nearest tenth of a degree from the reference radio navigation aid;
- (d) distance to the nearest two-tenths of a kilometre (tenth of a nautical mile) from the reference radio navigation aid; and
- (e) identification of the reference radio navigation aid;
- (ii) when the significant point is used for area navigation:
 - (a) name-code;
- (4) applicable holding patterns;
- (5) transition altitude/height to the nearest higher 300 m or 1000 ft;
- (6) area speed restrictions, where established;
- (7) the designation of the navigation specification(s) including any limitations, where established;
- (8) all compulsory and “on-request” reporting points;
- (9) radio communication procedures, including:
 - (a) call sign(s) of ATS unit(s);
 - (b) frequency and, if applicable, SATVOICE number;
 - (c) transponder setting, where appropriate;
- (10) an indication of “flyover” significant waypoints; and
- (11) for arrival procedures to an instrument approach designed specifically for helicopters, the term “CAT H” shall be depicted in the arrival chart plan view.

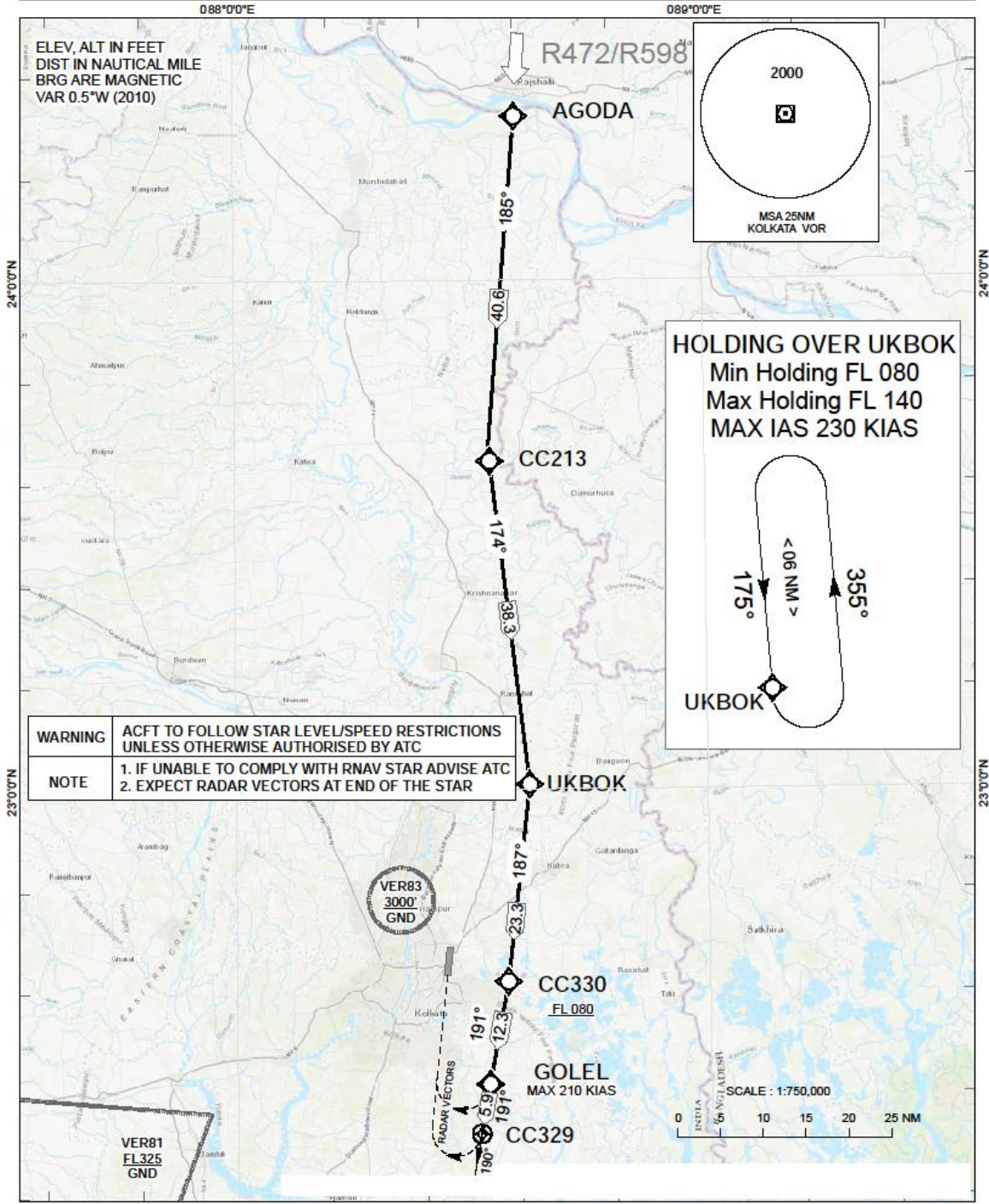
10.9.4.2 A textual description of standard arrival route(s) — instrument (STAR) and communication failure procedures in relation to radar control shall be provided and shall, whenever feasible, be shown on the chart or on the same page which contains the chart.

10.9.4.3 Aeronautical database requirements. Appropriate data to support navigation database coding shall be published in accordance with the Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part III, Section 5, Chapter 2, 2.2 on the verso of the chart or as a separate, properly referenced sheet.

Note. — Appropriate data are those provided by the procedures specialist.

STAR

| | | | |
|--|-------------------------------|--|---|
| AP India STANDARD ARRIVAL CHART INSTRUMENT (STAR) RNAV1(GNSS) SURVEILLANCE REQUIRED | TRANSITION ALT 4000 | SMC/TWR 121.900 / 118.100 APP 127.900/119.300 ACC 125.775/133.750 DATIS 126.400 | AD 2 VECC 3-201 08 AUG 2024 K AIRPORT, INDIA AGODA 2G - RWY01R AGODA 2H - RWY01L |
|--|-------------------------------|--|---|



CHAPTER 11

INSTRUMENT APPROACH CHART — ICAO

11.1 Function

This chart shall provide flight crews with information which will enable them to perform an approved instrument approach procedure to the runway of intended landing including the missed approach procedure and, where applicable, associated holding patterns.

11.2 Availability

11.2.1 Instrument Approach Charts — ICAO shall be made available for all aerodromes used where instrument approach procedures have been established.

11.2.2 A separate Instrument Approach Chart — ICAO shall be provided for each precision / non-precision approach procedure.

11.2.3 Reserved

11.2.4 Reserved

11.2.5 Instrument Approach Charts — ICAO shall be revised whenever information essential to safe operation becomes out of date.

11.3 Coverage and scale

11.3.1 The coverage of the chart shall be sufficient to include all segments of the instrument approach procedure and such additional areas as may be necessary for the type of approach intended.

11.3.2 The scale selected shall ensure optimum legibility consistent with:

11.3.3 The procedure shown on the chart;

11.3.4 sheet size.

11.3.5 A scale indication shall be given.

11.4 Format

The sheet size shall be A4 size (210 x 297mm).

11.5 Projection

11.5.1 A conformal projection on which a straight line approximates a great circle shall be used.

11.5.2 Graduation marks shall be placed at consistent intervals along the neat lines.

11.6 Identification

The chart shall be identified by the name of the city or town or area which the aerodrome serves, the name of the aerodrome and the identification of the instrument approach procedure as established in accordance with the Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, Part I, Section 4, Chapter 9.

Note: The identification of the instrument approach procedure is provided by the procedures specialist.

11.7 Culture and topography

11.7.1 Culture and topographic information pertinent to the safe execution of the instrument approach procedure, including the missed approach procedure, associated holding procedures and visual manoeuvring (circling) procedure when established, shall be shown. Topographic information shall be named, only when necessary, to facilitate the understanding of such information, and the minimum shall be a delineation of land masses and significant lakes and rivers.

11.7.2 Relief shall be shown in a manner best suited to the particular elevation characteristics of the area. In areas where relief exceeds 1200 m (4000 ft) above the aerodrome elevation within the coverage of a chart or 600 m (2000 ft) within 11 km (6 NM) of the aerodrome reference point or when final approach or missed approach procedure gradient is steeper than optimal due to terrain, all relief exceeding 150 m (500 ft) above the aerodrome elevation shall be shown by smoothed contour lines, contour values and layer tints printed in brown. Appropriate spot elevations, including the highest elevation within each top contour line, shall also be shown printed in black.

Note 1: The next higher suitable contour line appearing on base topographic maps exceeding 150 m (500 ft) above the aerodrome elevation may be selected to start layer tinting.

Note 2: An appropriate brown colour, on which half-tone layer tinting is to be based, is specified in Appendix 3 — Colour Guide for contours and topographic features.

Note 3: Appropriate spot elevations are those provided by the procedures specialist.

11.7.3 In areas where relief is lower than specified in 11.7.2, all relief exceeding 150 m (500 ft) above the aerodrome elevation shall be shown by smoothed contour lines, contour values and layer tints printed in brown. Appropriate spot elevations, including the highest elevation within each top contour line, shall also be shown printed in black.

Note 1: The next higher suitable contour line appearing on base topographic maps exceeding 150 m (500 ft) above the aerodrome elevation may be selected to start layer tinting.

Note 2: An appropriate brown colour, on which half-tone layer tinting is to be based, is specified in Appendix 3 — Colour Guide for contours and topographic features.

Note 3: Appropriate spot elevations are those provided by the procedures specialist.

11.8 Magnetic variation

11.8.1 The magnetic variation shall be shown.

11.8.2 The value of the variation, indicated to the nearest degree, shall agree with that used in determining magnetic bearings, tracks and radials.

11.9 Bearings, tracks and radials

11.9.1 Bearings, tracks and radials shall normally be magnetic, Where bearings and tracks are additionally provided as true values for RNAV segments, they shall be shown in parentheses to the nearest tenth of a degree, e.g. 290° (294.9°T).

11.9.2 Reserved

11.9.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used, its reference grid meridian shall be identified.

11.10 Aeronautical data

11.10.1 Aerodromes

11.10.1.1 All aerodromes which show a distinctive pattern from the air shall be shown by the appropriate symbol. Abandoned aerodromes shall be identified as abandoned.

11.10.1.2 The runway pattern, at a scale sufficiently large to show it clearly, shall be shown for:

- (1) the aerodrome on which the procedure is based;
- (2) aerodromes affecting the traffic pattern or so situated as to be likely, under adverse weather conditions, to be mistaken for the aerodrome of intended landing.

11.10.1.3 The aerodrome elevation shall be shown to the nearest metre or foot in a prominent position on the chart.

11.10.1.4 The threshold elevation or, where applicable, the highest elevation of the touchdown zone shall be shown to the nearest metre or foot.

11.10.2 Obstacles

11.10.2.1 Obstacles shall be shown on the plan view of a chart.

Note: Appropriate obstacles are those provided by the procedures specialist.

11.10.2.2 If one or more obstacles are the determining factor of an obstacle clearance altitude/height, those obstacles shall be identified.

11.10.2.3 The elevation of the top of obstacles shall be shown to the nearest (next higher) metre or foot.

11.10.2.4 The heights of obstacles above a datum other than mean sea level (see 11.10.2.3) should be shown. When shown, they shall be given in parentheses on the chart.

11.10.2.5 When the heights of obstacles above a datum other than mean sea level are shown, the datum shall be the aerodrome elevation except that, at aerodromes having an instrument runway (or runways) with a threshold elevation more than 2 m (7 ft) below the aerodrome elevation, a chart datum shall be the threshold elevation of the runway to which the instrument approach is related.

11.10.2.6 Where a datum other than mean sea level is used, it shall be stated in a prominent position on the chart.

11.10.2.7 Where an obstacle free zone has not been established for a precision approach runway Category I, this shall be indicated.

11.10.3 Prohibited, restricted and danger areas

Prohibited areas, restricted areas, and danger areas which may affect the execution of the procedures shall be shown with their identification and vertical limits.

11.10.4 Radio communication facilities and navigation aids

11.10.4.1 Radio navigation aids required for the procedures together with their frequencies, identifications and track-defining characteristics, if any, shall be shown. In the case of a procedure in which more than one station is located on the final approach track, the facility to be used for track guidance for final approach shall be clearly identified. In addition, consideration shall be given to the elimination from the approach chart of those facilities that are not used by the procedure.

11.10.4.1.1 When a radio navigation aid is used as a significant point for area navigation, only its plain language name and identification shall be shown.

11.10.4.2 The initial approach fix (IAF), the intermediate approach fix (IF), the final approach fix (FAF) (or final approach point (FAP) for an ILS approach procedure), the missed approach point (MAPt), where established, and other essential fixes or points comprising the procedure shall be shown and identified.

11.10.4.3 When the final approach fix is used for conventional navigation (or final approach point for an ILS approach procedure), it should be identified with its geographical coordinates in degrees, minutes and seconds.

11.10.4.4 Radio navigation aids that might be used in diversionary procedures together with their track-defining characteristics, if any, shall be shown or indicated on a chart.

11.10.4.5 Radio communication frequencies, including call signs that are required for the execution of the procedures shall be shown.

11.10.4.6 When required by the procedures, the distance to the aerodrome from each radio navigation aid concerned with the final approach shall be shown to the nearest kilometre or nautical mile. When no track-defining aid indicates the bearing of the aerodrome, the bearing shall also be shown to the nearest degree.

11.10.5 Minimum sector altitude or terminal arrival altitude

The minimum sector altitude or terminal arrival altitude established by the competent authority shall be shown, with a clear indication of the sector to which it applies.

11.10.6 Portrayal of procedure tracks

11.10.6.1 The plan view shall show the following information in the manner indicated:

- (a) the approach procedure track by an arrowed continuous line indicating the direction of flight;
- (b) the missed approach procedure track by an arrowed broken line;
- (c) any additional procedure track, other than those specified in a) and b), by an arrowed dotted line;
- (d) bearings, tracks, radials to the nearest degree and distances to the nearest two-tenths of a kilometre or tenth of a nautical mile or times required for the procedure;
- (e) where no track-defining aid is available, the magnetic bearing to the nearest degree to the aerodrome from the radio navigation aids concerned with the final approach;
- (f) the boundaries of any sector in which visual manoeuvring (circling) is prohibited;
- (g) where specified, the holding pattern and minimum holding altitude/height associated with the approach and missed approach;
- (h) caution notes where required, prominently displayed on the face of a chart;
- (i) an indication of "flyover" significant points.

11.10.6.2 The plan view shall show the distance to the aerodrome from each radio navigation aid concerned with the final approach.

11.10.6.3 A profile shall be provided normally below the plan view showing the following data:

- (a) the aerodrome by a solid block at aerodrome elevation;
- (b) the profile of the approach procedure segments by an arrowed continuous line indicating the direction of flight;
- (c) the profile of the missed approach procedure segment by an arrowed broken line and a description of the procedure;

- (d) the profile of any additional procedure segment, other than those specified in b) and c), by an arrowed dotted line;
- (e) bearings, tracks, radials to the nearest degree and distances to the nearest two-tenths of a kilometre or tenth of a nautical mile or times required for the procedure;
- (f) altitudes/heights required by the procedures, including transition altitude, procedure altitudes/heights and heliport crossing height (HCH), where established;
- (g) limiting distance to the nearest kilometre or nautical mile on procedure turn, when specified;
- (h) the intermediate approach fix or point, on procedures where no course reversal is authorised;
- (i) a line representing the aerodrome elevation or threshold elevation, as appropriate, extended across the width of the chart including a distance scale with its origin at the runway threshold.

11.10.6.4 Heights required by procedures shall be shown in parentheses, using the height datum selected in accordance with 11.10.2.5.

11.10.6.5 The profile view shall include a ground profile or a minimum altitude/height portrayal as follows:

- (a) a ground profile shown by a solid line depicting the highest elevations of the relief occurring within the primary area of the final approach segment. The highest elevations of the relief occurring in the secondary areas of the final approach segment shown by a dashed line; or
- (b) minimum altitudes/heights in the intermediate and final approach segments indicated within bounded shaded blocks.

Note 1: For the ground profile portrayal, actual templates of the primary and secondary areas of the final approach segment are provided to the cartographer by the procedures specialist.

Note 2: The minimum altitude/height portrayal is intended for use on charts depicting non-precision approaches with a final approach fix.

11.10.7 Aerodrome operating minima

11.10.7.1 Aerodrome operating minima when established by the State shall be shown.

11.10.7.2 The obstacle clearance altitudes/heights for the aircraft categories for which the procedure is designed shall be shown; for precision approach procedures, additional OCA/H for Cat DL aircraft (wing span between 65 m and 80 m and/or vertical distance between the flight path of the wheels and the glide path antenna between 7 m and 8 m) shall be published, when necessary.

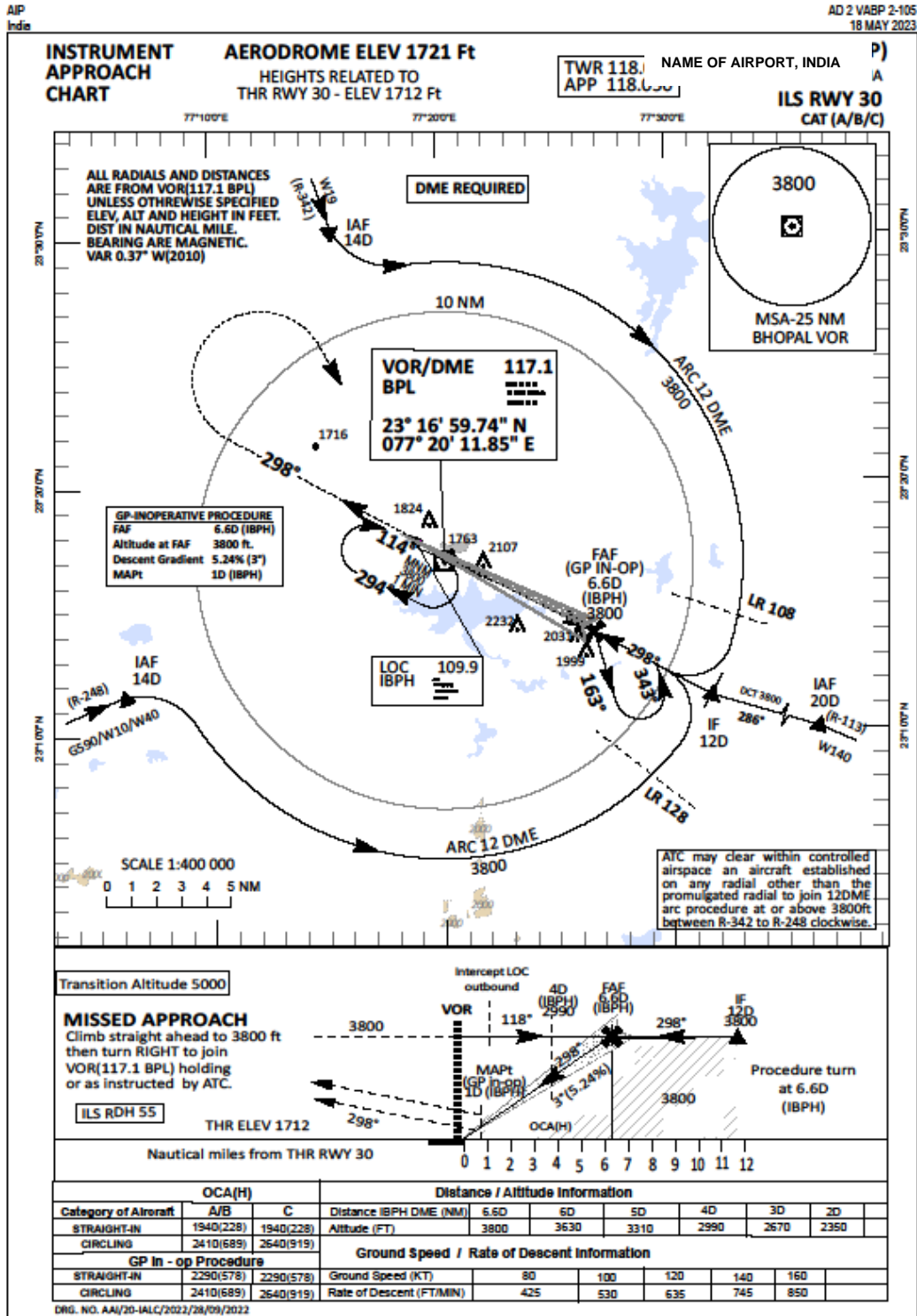
- 11.10.8 Supplementary information
- 11.10.8.1 When the missed approach point is defined by:
- a distance from the final approach fix, or
 - a facility or a fix and the corresponding distance from the final approach fix, the distance to the nearest two-tenths of a kilometre or tenth of a nautical mile and a table showing ground speeds and times from the final approach fix to the missed approach point shall be shown.
- 11.10.8.2 When DME is required for use in the final approach segment, a table showing altitudes/heights for each 2 km or 1 NM, as appropriate, shall be shown. The table shall not include distances which would correspond to altitudes/heights below the OCA/H.
- 11.10.8.3 For procedures in which DME is not required for use in the final approach segment but where a suitably located DME is available to provide advisory descent profile information, a table showing the altitudes/heights shall be included.
- 11.10.8.4 A rate of descent table shall be shown.
- 11.10.8.5 Final approach descent gradient and, in parenthesis, descent angle to the nearest one-tenth of a degree shall be shown for non-precision procedures with a final approach fix.
- 11.10.8.6 For precision approach procedures and approach procedures with vertical guidance, the reference datum height to the nearest half metre or foot and the glide path/elevation/vertical path angle to the nearest one-tenth of a degree shall be shown.
- 11.10.8.7 When a final approach fix is specified at the final approach point for ILS, a clear indication shall be given whether it applies to the ILS, the associated ILS localizer only procedure, or both. In the case of MLS, a clear indication shall be given when an FAF has been specified at the final approach point.
- 11.10.8.8 If the final approach descent gradient/angle for any type of instrument approach procedure exceeds the maximum value specified in the Procedures for Air Navigation Services — Aircraft Operations (PANS-OPS, Doc 8168), Volume II, a cautionary note shall be included.
- 11.10.8.9 A note shall be included on the chart indicating the approach procedures that are authorized for simultaneous independent or dependent operations. The note shall include the runway(s) involved and if they are closely spaced.
- 11.10.8.10 For approach procedures having PBN segments, a PBN requirement box shall be included.

Note.—Refer to the procedures for Air Navigation Services - Aircraft Operations

(PANS-OPS, Doc 8168), Volume II, Section 5 for information on a PBN requirement box.

- 11.10.9 Aeronautical database requirements. Appropriate data to support navigation database coding shall be published in accordance with the Procedures for Air Navigation Services — Aircraft Operations (Doc 8168), Volume II, Part III, Section 5, Chapter 2, 2.3, for RNAV procedures and Volume II, Part I, Section 4, Chapter 9, 9.4.1.3, for non-RNAV procedures, on the verso of the chart or as a separate, properly referenced sheet.

Note. — Appropriate data are those provided by the procedures specialist.



CHAPTER 12

RESERVED

CHAPTER 13

AERODROME / HELIPORT CHART - ICAO

13.1 Function

13.1.1 This chart shall provide flight crews with information which will facilitate the ground movement of aircraft:

- (a) from the aircraft stand to the runway; and
- (b) from the runway to the aircraft stand; and helicopter movement:
- (c) from the helicopter stand to the touchdown and lift-off area and to the final approach and take-off area;
- (d) from the final approach and take-off area to the touchdown and lift-off area and to the helicopter stand;
- (e) along helicopter ground and air taxiways; and
- (f) along air transit routes;

It shall also provide essential operational information at the aerodrome/heliport.

13.2 Availability

13.2.1 The Aerodrome/Heliport Chart – ICAO shall be made available in the manner prescribed in 1.3.2 for all aerodromes/heliports used for schedule operation.

13.2.2 Reserved

13.3 Coverage and scale

13.3.1 The coverage and scale shall be sufficiently large to show clearly all the elements listed in 13.6.1.

13.3.2 A linear scale shall be shown.

13.4 Identification

The chart shall be identified by the name of the city or town, or area, which the aerodrome / heliport serves and the name of the aerodrome / heliport.

13.5 Magnetic variation

True and Magnetic North arrows and magnetic variation to the nearest degree and annual change of the magnetic variation shall be shown.

13.6 Aerodrome/heliport data

13.6.1 This chart shall show:

- (a) geographical coordinates in degrees, minutes and seconds for the aerodrome / heliport reference point;
- (b) elevations, to the nearest metre or foot, of the aerodrome / heliport and apron (altimeter checkpoint locations) where applicable; and for non-precision approaches, elevations and geoid undulations of runway thresholds and the geometric centre of the touchdown and lift-off area;
- (c) elevations and geoid undulations, to the nearest half-metre or foot, of the precision approach runway threshold, the geometric centre of the touchdown and lift-off area, and at the highest elevation of the touchdown zone of a precision approach runway;
- (d) all runways including those under construction with designation number, length and width to the nearest metre, bearing strength, displaced thresholds, stopways, clearways, runway directions to the nearest degree magnetic, type of surface and runway markings;

Note. — Bearing strengths may be shown in tabular form on the face or verso of the chart.

- (e) all aprons, with aircraft / helicopter stands, lighting, markings and other visual guidance and control aids, where applicable, including location and type of visual docking guidance systems, type of surface for heliports, and bearing strengths or aircraft type restrictions where the bearing strength is less than that of the associated runways;

Note. — Bearing strengths or aircraft type restrictions may be shown in tabular form on the face or verso of the chart.

- (f) geographical coordinates in degrees, minutes and seconds for thresholds, geometric centre of touchdown and lift-off area and/or thresholds of the final approach and take-off area (where appropriate);
- (g) all taxiways, helicopter air and ground taxiways with type of surface, helicopter air transit routes, with designations, width, lighting, markings including runway-holding positions and stop bars, other visual guidance and control aids, and bearing strength or aircraft type restrictions where the bearing strength is less than that of the associated runways;

Note. — Bearing strengths or aircraft type restrictions may be shown in tabular form on the face or verso of the chart.

- (h) where established, hot spot locations with additional information properly annotated;

Note. — Additional information regarding hot spots may be shown in tabular form on the face or verso of the chart.

- (i) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for appropriate taxiway centre line points and aircraft stands;
- (j) where established, standard routes for taxiing aircraft with their designators;
- (k) the boundaries of the air traffic control service;
- (l) position of runway visual range (RVR) observation sites;
- (m) approach and runway lighting;
- (n) location and type of the visual approach slope indicator systems with their nominal approach slope angle(s), minimum eye height(s) over the threshold of the on-slope signal(s), and where the axis of the system is not parallel to the runway centre line, the angle and direction of the displacement, i.e. left or right;
- (o) relevant communication facilities listed with their channels and, if applicable, logon address and SATVOICE number;
- (p) obstacles to taxiing;
- (q) aircraft servicing areas and buildings of operational significance;
- (r) VOR checkpoint and radio frequency of the aid concerned;
- (s) any part of the depicted movement area permanently unsuitable for aircraft, clearly identified as such.

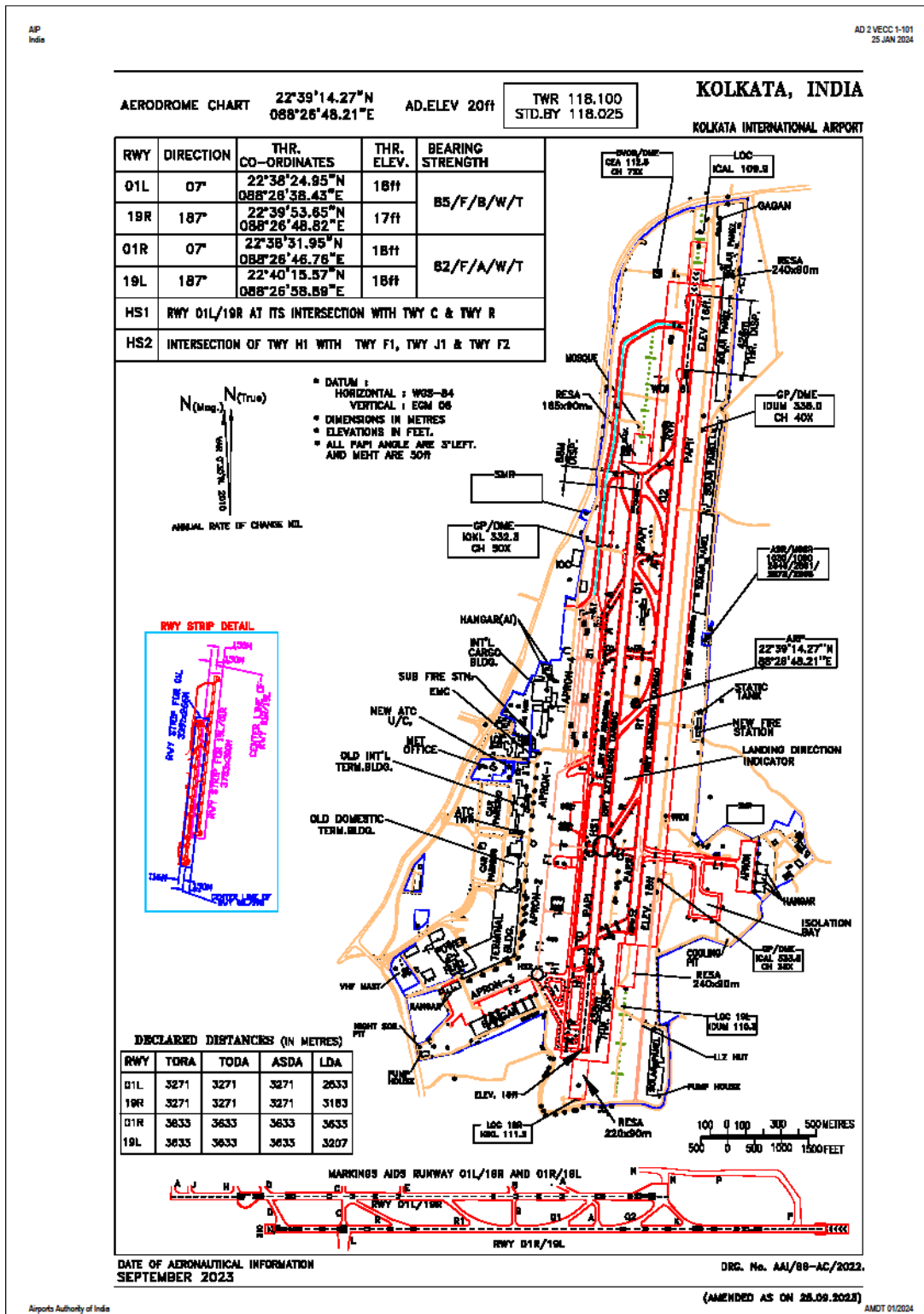
13.6.2 For aerodromes accommodating aeroplanes with folding wing tips, the areas where it is safe the aeroplanes with following wing tips to operate with wings extended, should be shown on the chart.

13.6.3 In addition to the items in 13.6.1 relating to heliports, a chart shall show:

- (a) heliport type;
- (b) touchdown and lift-off area including dimensions to the nearest metre, slope, type of surface and bearing strength in tonnes;
- (c) final approach and take-off area including type, true bearing to the nearest degree, designation number (where appropriate), length and width to the nearest metre, slope and type of surface;
- (d) safety area including length, width and type of surface;
- (e) helicopter clearway including length and ground profile;
- (f) obstacles including type and elevation of the top of the obstacles to the nearest (next higher) metre or foot;
- (g) visual aids for approach procedures, marking and lighting of final approach and take-off area, and of touchdown and lift-off area;
- (h) declared distances to the nearest metre for heliports, where relevant, including:

- (1) take-off distance available;
- (2) rejected take-off distance available;
- (3) landing distance available.

AERODROME CHART



CHAPTER 14

AERODROME GROUND MOVEMENT CHART

14.1 Function

This supplementary chart shall provide flight crews with detailed information to facilitate the ground movement of aircraft to and from the aircraft stands and the parking/docking of aircraft.

14.2 Availability

The Aerodrome Ground Movement Chart — ICAO shall be made available in the manner prescribed in 1.3.2 where, due to congestion of information, details necessary for the ground movement of aircraft along the taxiways to and from the aircraft stands cannot be shown with sufficient clarity on the Aerodrome/Heliport Chart — ICAO.

14.3 Coverage and scale

14.3.1 The coverage and scale shall be sufficiently large to show clearly all the elements listed in 14.6.

14.3.2 A linear scale should be shown.

14.4 Identification

The chart shall be identified by the name of the city or town or area which the aerodrome serves and the name of the aerodrome.

14.5 Magnetic variation

14.5.1 A True North arrow shall be shown.

14.5.2 Magnetic variation to the nearest degree and its annual change shall be shown.

Note: This chart need not be True North orientated.

14.6 Aerodrome data

14.6.1 This chart shall show in a similar manner all the information on the Aerodrome/Heliport Chart –ICAO relevant to the area depicted, including:

- (a) apron elevation to the nearest metre or foot;
- (b) aprons with aircraft stands, bearing strengths or aircraft type restrictions, lighting, marking and other visual guidance and control aids, where applicable, including location and type of visual docking guidance systems;

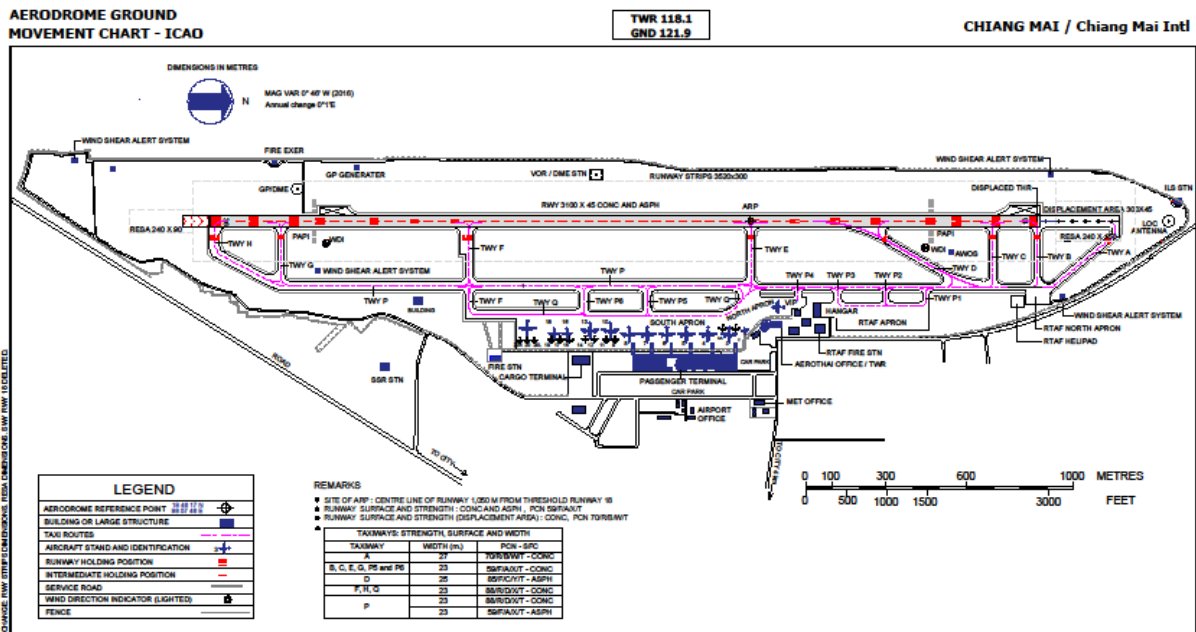
- (c) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for aircraft stands;
- (d) taxiways with designations, width to the nearest metre, bearing strength or aircraft type restrictions where applicable, lighting, markings, including runway-holding positions and stop bars, and other visual guidance and control aids;
- (e) where established, hot spot locations with additional information properly annotated;

Note: Additional information regarding hot Spots may be shown in tabular form on the face or verso of the chart.

- (f) where established, standard routes for taxiing aircraft, with their designators;
- (g) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for appropriate taxiway centre line points;
- (h) the boundaries of the air traffic control service;
- (i) relevant communication facilities listed with their channels and, if applicable, logon address;
- (j) obstacles to taxiing;
- (k) aircraft servicing areas and buildings of operational significance;
- (l) VOR checkpoint and radio frequency of the aid concerned;
- (m) any part of the depicted movement area permanently unsuitable for aircraft, clearly identified as such.

14.6.2 For aerodromes accommodating aeroplanes with folding wing tips, the areas where it is safe for aeroplanes with following wing tops to operate with wings tip extended, should be shown on the chart.

AERODROME GROUND MOVEMENT CHART - ICAO



CHAPTER 15

AIRCRAFT PARKING/DOCKING CHART – ICAO

15.1 Function

This supplementary chart shall provide flight crews with detailed information to facilitate the ground movement of aircraft between the taxiways and the aircraft stands and the parking/docking of aircraft.

15.2 Availability

The Aircraft Parking/Docking Chart – ICAO shall be made available in the manner prescribed in 1.3.2 where, due to the complexity of the terminal facilities, the information cannot be shown with sufficient clarity on the Aerodrome/Heliport Chart or on the Aerodrome Ground Movement Chart - ICAO.

15.3 Coverage and scale

15.3.1 The coverage and scale shall be sufficiently large to show clearly all the elements listed in 15.6.

15.3.2 A linear scale should be shown.

15.4 Identification

The chart shall be identified by the name of the city or town, or area, which the aerodrome serves and the name of the aerodrome.

15.5 Magnetic variation

15.5.1 A True North arrow shall be shown.

15.5.2 Magnetic variation to the nearest degree and its annual change shall be shown.

Note: This chart need not be True North orientated.

15.6 Aerodrome data

This chart shall show in a similar manner all the information on the Aerodrome/Heliport Chart – ICAO and the Aerodrome Ground Movement Chart — ICAO relevant to the area depicted, including:

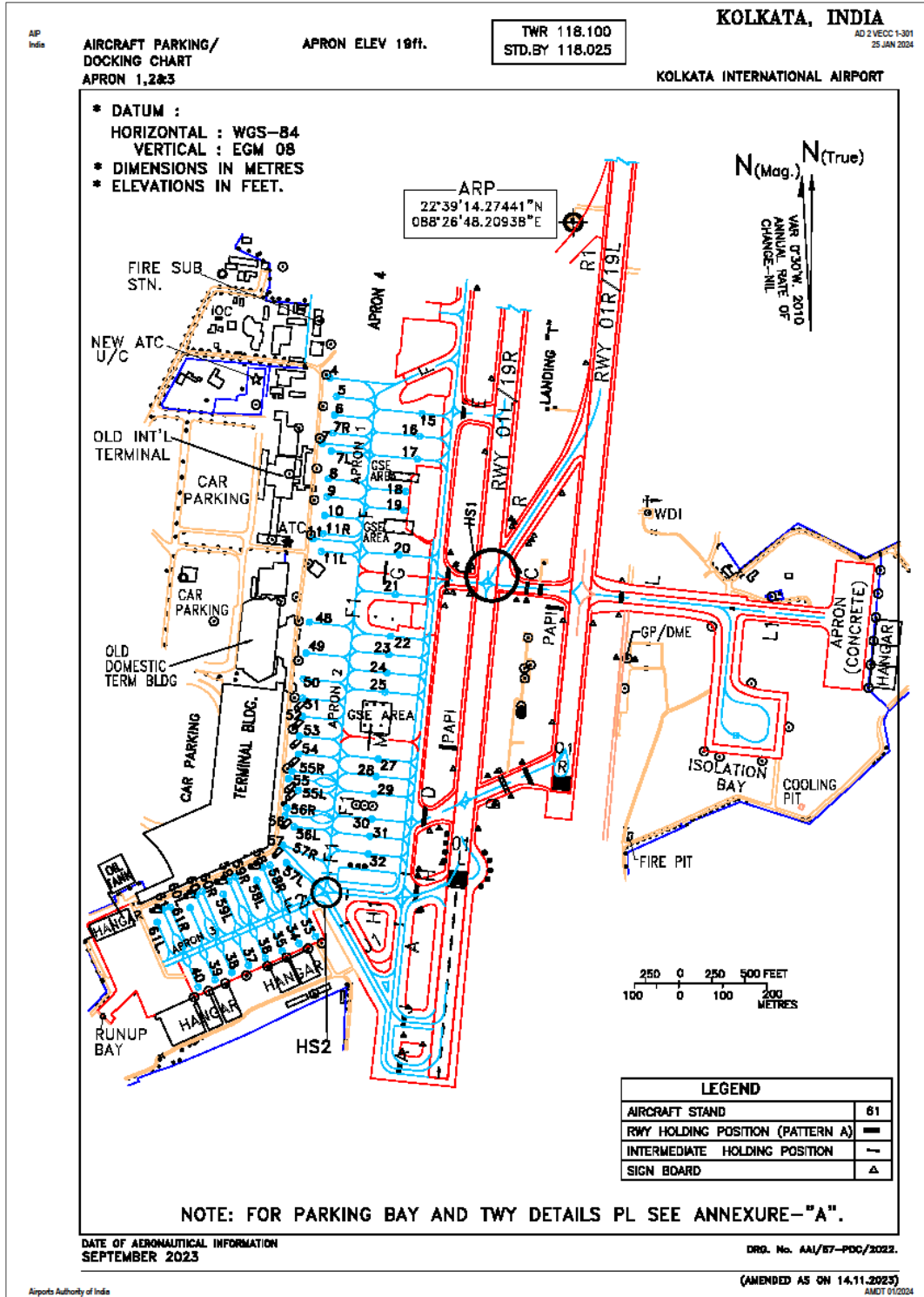
- (a) apron elevation to the nearest metre or foot;
- (b) aprons with aircraft stands, bearing strengths or aircraft type restrictions, lighting, marking and other visual guidance and control aids, where applicable, including location and type of visual docking guidance systems;

- (c) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for aircraft stands;
- (d) taxiway entries with designations, including runway-holding positions and stop bars;
- (e) where established, hot spot locations with additional information properly annotated;

Note: Additional information regarding hot spots may be shown in tabular form on the face or verso of the chart.

- (f) geographical coordinates in degrees, minutes, seconds and hundredths of seconds for appropriate taxiway centre line points;
- (g) the boundaries of the air traffic control service;
- (h) relevant communication facilities listed with their channels and, if applicable, logon address;
- (i) obstacles to taxiing;
- (j) aircraft servicing areas and buildings of operational significance;
- (k) VOR checkpoint and radio frequency of the aid concerned;
- (l) any part of the depicted movement area permanently unsuitable for aircraft, clearly identified as such.

AIRCRAFT PARKING/DOCKING CHART



CHAPTER 16
RESERVED

CHAPTER 17

RESERVED

CHAPTER 18

RESERVED

CHAPTER 19

RESERVED

CHAPTER 20

ELECTRONIC AERONAUTICAL CHART DISPLAY — ICAO

20.1 Function

The Electronic Aeronautical Chart Display — ICAO, with adequate back-up arrangements and in compliance with the requirements of CAR Section 2 series 'O' Part II, III, IV and V for charts, shall enable flight crews to execute, in a convenient and timely manner, route planning, route monitoring and navigation by displaying required information.

20.2 Information available for display

20.2.1 The Electronic Aeronautical Chart Display — ICAO shall be capable of displaying all aeronautical, cultural and topographic information required by Para 7 through 11 and Para 13 through 16 of this CAR.

20.2.2 Reserved

Note. — The Electronic Aeronautical Chart Display — ICAO may display supplementary information, in addition to that required for the equivalent paper chart, which may be considered useful for safe navigation.

20.3 Display requirements

20.3.1 Display categories

20.3.1.1 Information available for display shall be subdivided into the following categories:

- (a) basic display information, permanently retained on the display and consisting of the minimum information essential for the safe conduct of flight; and
- (b) other display information, which may be removed from the display or displayed individually on demand, and consisting of information not considered essential for the safe conduct of flight.

Note. — Other modes, such as static chart displays, may be available.

20.3.1.2 It shall be a simple function to add or remove other display information but shall not be possible to remove information contained in the basic display.

20.3.2 Display mode and generation of neighbouring area

20.3.2.1 The Electronic Aeronautical Chart Display — ICAO shall be capable of continuously plotting the aircraft's position in a true motion mode where reset and generation of the surrounding area shall take place automatically.

20.3.2.2 It shall be possible manually to change a chart area and the position of the aircraft relative to the edge of the display.

20.3.3 Scale.

It shall be possible to vary the scale at which a chart is displayed.

20.3.4 Symbols

Symbols used shall conform to those specified for electronic charts in Appendix 2 — ICAO Chart Symbols except where it is desired to show items for which no ICAO chart symbol is provided. In these cases, electronic chart symbols shall be chosen which:

- (a) employ a minimum use of lines, arcs and area fills;
- (b) do not cause confusion with any existing aeronautical chart symbol;
- (c) do not impair the legibility of the display.

Note. — Additional details for each symbol may be added according to the resolution of the output media, but any enhancements may not change the basic recognizability of the symbol.

20.3.5 Display hardware

20.3.5.1 The effective size of a chart presentation shall be sufficient to display the information required by 20.2 without excessive scrolling.

20.3.5.2 The display shall have the capabilities required to accurately portray required elements of, Appendix 2 — ICAO Chart Symbols.

20.3.5.3 The method of presentation shall ensure that the displayed information is clearly visible to the observer in the conditions of natural and artificial light experienced in the cockpit.

20.3.5.4 The display luminance shall be adjustable by the flight crew.

20.4 Provision and updating of data

20.4.1 The provision and updating of data for use by the display shall be in conformance with the aeronautical data quality system requirements.

20.4.2 The display shall be capable of automatically accepting authorized updates to existing data. A means of ensuring that authorized data and all relevant updates to that data have been correctly loaded into the display shall be provided.

20.4.3 The display shall be capable of accepting updates to authorized data entered manually with simple means for verification prior to final acceptance of the data. Updates entered manually shall be distinguishable on the display from authorized data and its authorized updates and shall not affect display legibility.

20.4.4 A record shall be kept of all updates, including date and time of application.

20.4.5 The display shall allow the flight crew to display updates so that the flight crew may review the contents of the updates and determine that they have been included in the system.

20.5 Performance tests, malfunction alarms and indications

20.5.1 A means shall be provided for carrying out on-board tests of major functions. In case of a failure, the test shall display information to indicate which part of the system is at fault.

20.5.2 A suitable alarm or indication of system malfunction shall be provided.

20.6 Back-up arrangements

20.6.1 To ensure safe navigation in case of a failure of the Electronic Aeronautical Chart Display — ICAO, the provision of adequate back-up arrangements shall include:

- (a) facilities enabling a safe takeover of display functions in order to ensure that a failure does not result in a critical situation; and
- (b) a back-up arrangement facilitating the means for safe navigation of the remaining part of the flight.
- (c) **Note.** — A suitable back-up system may include the carriage of paper charts.

CHAPTER 21

ATC SURVEILLANCE MINIMUM ALTITUDE CHART — ICAO

21.1 Function

- 21.1.1 This supplementary chart shall provide information that will enable flight crews to monitor and cross-check altitudes assigned while under Radar control.
- 21.1.2 A note indicating that the chart may only be used for cross-checking of altitudes assigned while under Radar control shall be prominently displayed on the face of the chart.

21.2 Availability

The ATC Surveillance Minimum Altitude Chart — ICAO shall be made available, in the manner prescribed in 1.3.2, where Radar vectoring procedures are established and minimum vectoring altitudes cannot be shown adequately on the Area Chart — ICAO, Standard Departure Chart — Instrument (SID) — ICAO or Standard Arrival Chart — Instrument (STAR) — ICAO.

21.3 Coverage and scale

- 21.3.1 The coverage of the chart shall be sufficient to effectively show the information associated with Radar vectoring procedures.
- 21.3.2 The chart shall be drawn to scale.
- 21.3.3 The Charts shall be drawn to the same scale as the associated Area Chart — ICAO.

21.4 Projection

- 21.4.1 A conformal projection on which a straight line approximates a geodesic line shall be used.
- 21.4.2 Graduation marks shall be placed at consistent intervals along the neat lines, as appropriate.

21.5 Identification

The chart shall be identified by the name of the aerodrome for which the Radar vectoring procedures are established or, when procedures apply to more than one aerodrome, the name associated with the airspace portrayed.

Note. — The name may be that of the city which the aerodrome serves or, when the procedures apply to more than one aerodrome, that of the air traffic services centre or the largest city or town situated in the area covered by the chart.

21.6 Culture and topography

- 21.6.1 Generalized shorelines of all open water areas, large lakes and rivers shall be shown except where they conflict with data more applicable to the function of the chart.

21.6.2 Appropriate spot elevations and obstacles shall be shown.

Note. — Appropriate spot elevations and obstacles are those provided by the procedures specialist.

21.7 Magnetic variation

The average magnetic variation of the area covered by a chart shall be shown to the nearest degree.

21.8 Bearings, tracks and radials

21.8.1 Bearings, tracks and radials shall be magnetic, except as provided for in 21.8.2.

21.8.2 In areas of high latitude, where it is determined that reference to Magnetic North is impractical, another suitable reference i.e., True North or Grid North, shall be used.

21.8.3 Where bearings, tracks or radials are given with reference to True North or Grid North, this shall be clearly indicated. When Grid North is used, its reference grid meridian shall be identified.

21.9 Aeronautical data

21.9.1 Aerodromes

21.9.1.1 All aerodromes that affect the terminal routings shall be shown. Where appropriate, a runway pattern symbol shall be used.

21.9.1.2 The elevation of the primary aerodrome to the nearest metre or foot shall be shown.

21.9.2 Prohibited, restricted and danger areas

Prohibited, restricted and danger areas shall be depicted with their identification.

21.9.3 Air traffic services system

21.9.3.1 A chart shall show components of the established air traffic services system including:

21.9.3.2

- 1) relevant radio navigation aids together with their identifications;
- 2) lateral limits of relevant designated airspace;
- 3) relevant significant points associated with standard instrument departure and arrival procedures;

Note. — Routes used in the vectoring of aircraft to and from the significant points may be shown.

- 4) transition altitude, where established;
- 5) information associated with Radar vectoring including:

- a) minimum vectoring altitudes to the nearest higher 50 m or 100 ft, clearly identified;
 - b) lateral limits of minimum vectoring altitude sectors normally defined by bearings and radials to/from radio navigation aids to the nearest degree or, if not practicable, geographical coordinates in degrees, minutes and seconds and shown by heavy lines so as to clearly differentiate between established Radar sectors;

Note. — In congested areas geographical coordinates may be omitted in the interest of legibility.
 - c) distance circles at 20-km or 10-NM intervals or, when practicable, 10-km or 5-NM intervals shown as fine dashed lines with the radius indicated on the circumference and centred on the identified aerodrome main VOR radio navigation aid or, if not available, on the aerodrome/heliport reference point;
 - d) notes concerning correction for low temperature effect, as applicable;
- 6) radio communications procedures including call sign(s) and frequency (ies) of approach/radar unit(s).

21.9.3.3 A textual description of communication failure procedures in relation to radar control shall be provided and should, whenever feasible, be shown on the chart or on the same page that contains the chart.

AERONAUTICAL CHART MANUAL of Chapter 7.21

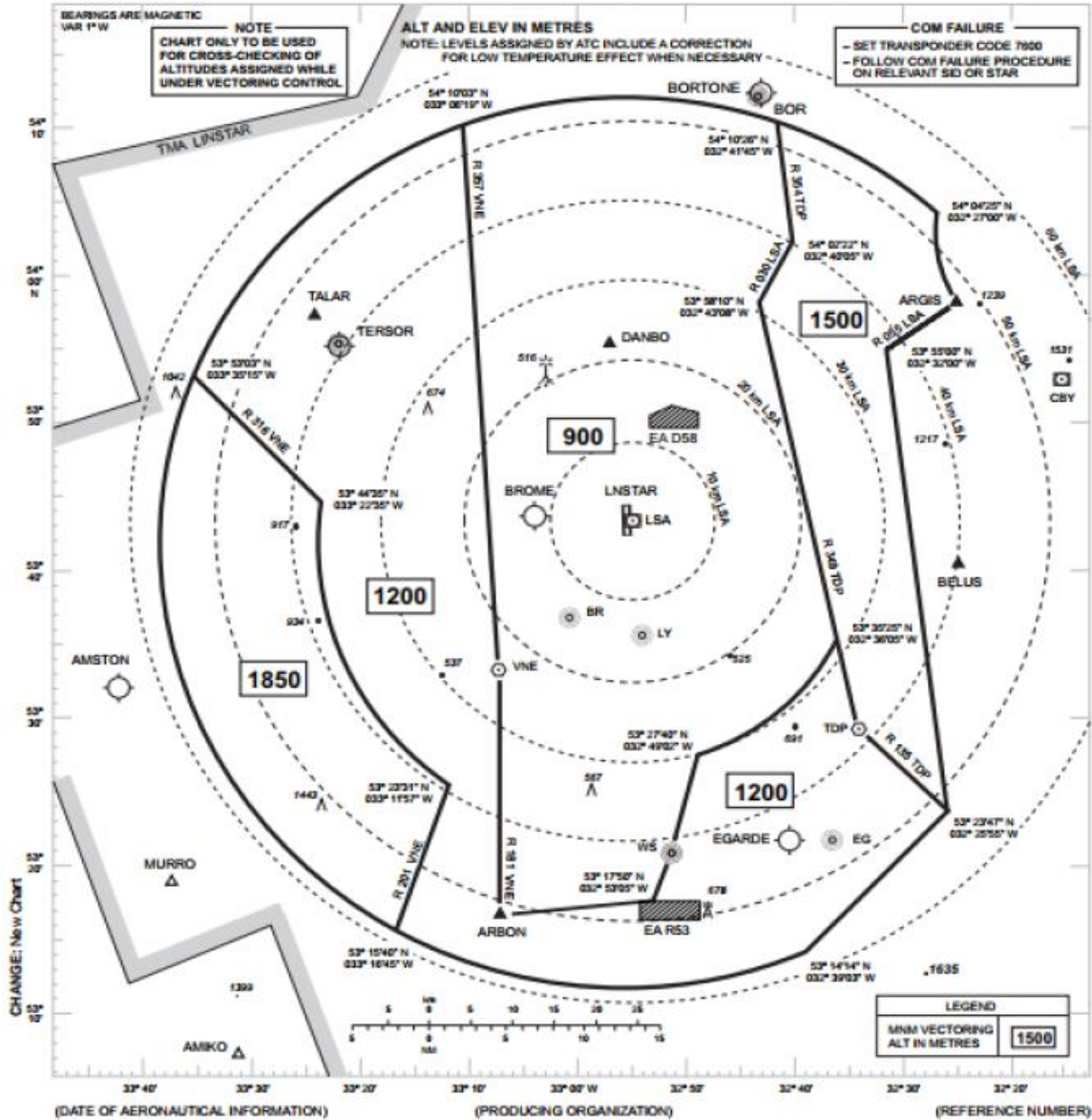
SPECIMEN CHART **14**

ATC SURVEILLANCE MINIMUM
ALTITUDE CHART — ICAO

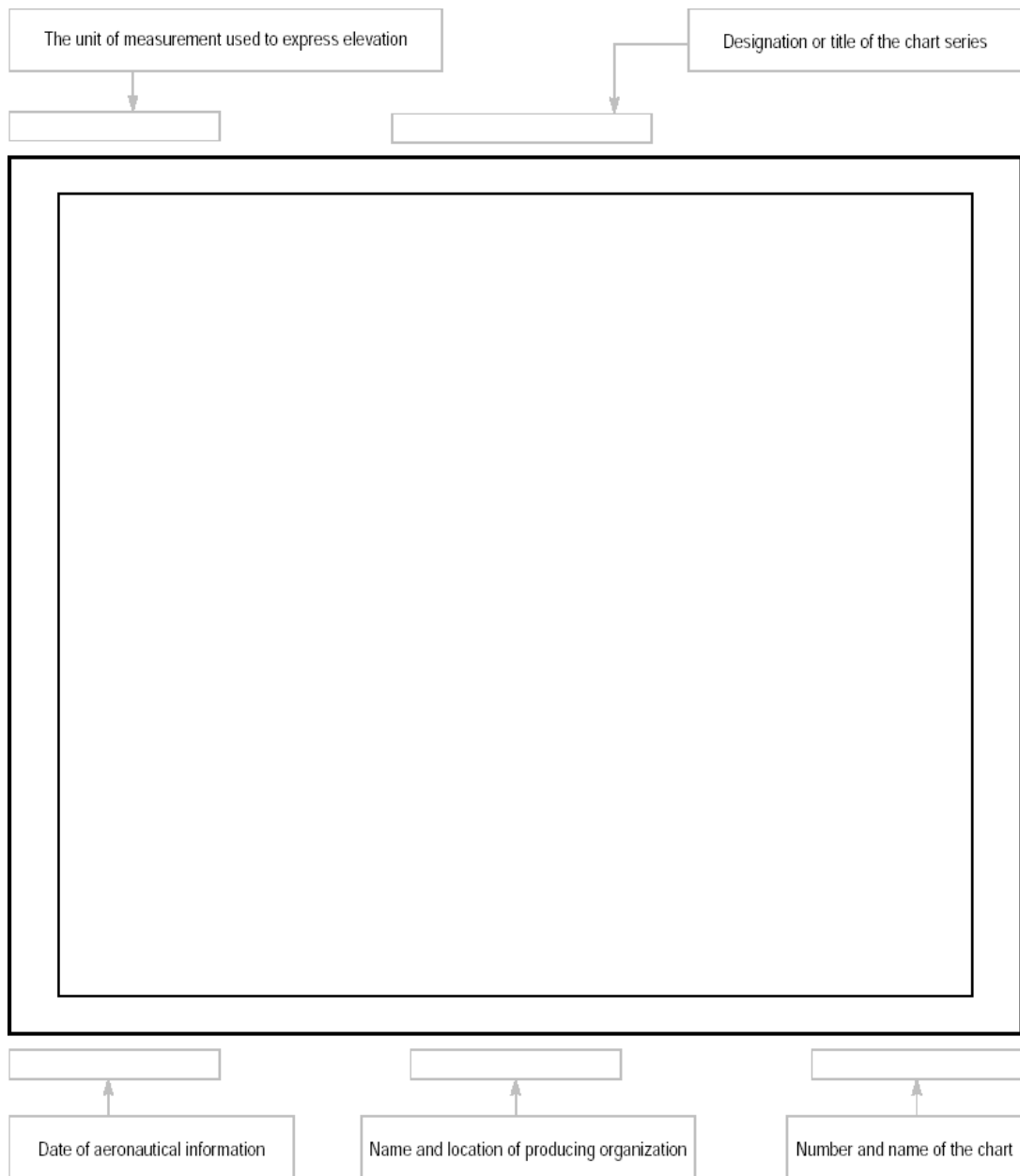
AERODROME ELEV 250 m
TRANSITION ALT 2150 m

APP 119.8

LINSTAR/Intl (EADL)






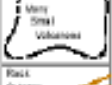


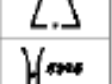

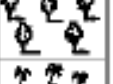

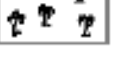


























APPENDIX 1. MARGINAL NOTE LAYOUT



SYMBOLS AND COLOURS

TOPOGRAPHY

| | | | | | | | | | | | | |
|---|----------------------------|---|--|----|------------------|--|----|--|---|---|-----------------------------|---------------------------------------|
| 1 | Contours |  | | 8 | Gravel |  | | | 12 | Highest elevation on sheet | Alternative 17456 | 17456 |
| 2 | Approximate contours |  | | 9 | Larvae or exerts | Alternative  | | | 13 | Spot elevation | .8977 .8975 | |
| 3 | Relief shown by hachures |  | | | | | 10 | Unusual land features appropriately labelled | Very Small Unsurveyed  Rock Outcrop  | | 14 | Spot elevation (of doubtful accuracy) |
| 4 | Bluff, cliff or escarpment |  | | 11 | Mountain pass |  | | | | | 15 | Coniferous trees |
| 5 | Lava flow |  | | | | | | 16 | Other trees |  | | |
| 6 | Sand dunes |  | | | | | | 17 | Palms |  | | |
| 7 | Sand area |  | | 18 | | Areas not surveyed for contour information or relief data incomplete | | Caution | | | | |

| HYDROGRAPHY | | | | | | | | | | | | |
|-------------|------------------------------------|--|--|----|--|--|----|---|--------------------------------------|--|--|--|
| 19 | Shore line (reliable) |  | | 30 | Abandoned canal Note — Dry canal having landmark value. |  | | | 38 | Reservoir | ■ Reservoir | |
| 20 | Shore line (unreliable) |  | | 31 | Lakes (perennial) | Alternative  | | | 39 | Dry lake bed | Alternative  | |
| 21 | Tidal flats |  | | | | | 32 | Lakes (non-perennial) | | | | Alternative  |
| 22 | Coral reefs and ledges |  | | 33 | Salt lake |  | | | | 41 | Shoals | |
| 23 | Large river (perennial) |  | | 34 | Salt pans (evaporator) |  | | 42 | Glaciers and ice caps |  | | |
| 24 | Small river (perennial) |  | | 35 | Swamp | Alternative  | | 43 | Danger line (2 m or one fathom line) |  | | |
| 25 | Rivers and streams (non-perennial) | Alternative  | | | | | 36 | | | Rice field | Alternative  | |
| 26 | Rivers and streams (unsurveyed) |  | | 37 | Spring, well or water hole | Alternative  | | | 45 | | | Rock awash |
| 27 | Rapids |  | | | | | 46 | Unusual water features appropriately labelled | | Alternative  | | |
| 28 | Falls |  | | | | | | | | | | |
| 29 | Canal |  | | | | | | | | | | |

CULTURE

BUILT-UP AREAS

| | | |
|----|--------------------|--|
| 47 | City or large town | |
| 48 | Town | |
| 49 | Village | |
| 50 | Buildings | |

HIGHWAYS AND ROADS

| | | |
|----|----------------|--|
| 57 | Dual highway | |
| 58 | Primary road | |
| 59 | Secondary road | |
| 60 | Trail | |
| 61 | Road bridge | |
| 62 | Road tunnel | |

MISCELLANEOUS (Cont.)

| | | |
|----|-----------------------|--|
| 65 | Pipeline | |
| 70 | Oil or gas field | |
| 71 | Tank farms | |
| 72 | Nuclear power station | |
| 73 | Coast guard station | |
| 74 | Lookout tower | |
| 75 | Mine | |
| 76 | Forest ranger station | |
| 77 | Race track or stadium | |
| 78 | Ruins | |
| 79 | Fort | |
| 80 | Church | |
| 81 | Mosque | |
| 82 | Pagoda | |
| 83 | Temple | |

RAILROADS

| | | |
|----|-------------------------------|--|
| 51 | Railroad (single track) | |
| 52 | Railroad (two or more tracks) | |
| 53 | Railroad (under construction) | |
| 54 | Railroad bridge | |
| 55 | Railroad tunnel | |
| 56 | Railroad station | |

MISCELLANEOUS

| | | |
|----|---|--|
| 63 | Boundaries (international) | |
| 64 | Outer boundaries | |
| 65 | Fence | |
| 66 | Telegraph or telephone line (when a landmark) | |
| 67 | Dam | |
| 68 | Ferry | |

AERODROMES

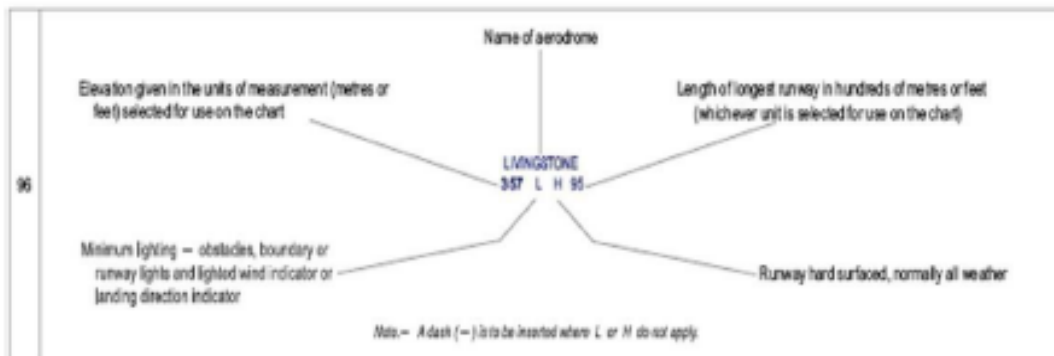
| | | | |
|----|----------|-------|--|
| 84 | Civil | Land | |
| 85 | Civil | Water | |
| 86 | Military | Land | |
| 87 | Military | Water | |

| | | | |
|----|---|-------|--|
| 88 | Joint civil and military | Land | |
| 89 | Joint civil and military | Water | |
| 90 | Emergency aerodrome or aerodrome with no facilities | | |
| 91 | Abandoned or closed aerodrome | | |

| | | |
|----|---|--|
| 92 | Sheltered anchorage | |
| 93 | Aerodrome for use on charts on which aerodrome classification is not required e.g. Enroute Charts | |
| 94 | Heliport Note.— Aerodrome for the exclusive use of helicopters | |

| | | |
|----|--|--|
| 95 | Note.— Where required by the function of the chart, the runway pattern of the aerodrome may be shown in lieu of the aerodrome symbol, for example: | |
|----|--|--|





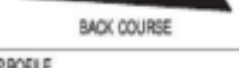




AERODROMES (Cont.)
AERODROME DATA IN ABBREVIATED FORM WHICH MAY BE
IN ASSOCIATION WITH AERODROME SYMBOLS
 (Reference: 16.9.2.2 and 17.9.2.2)
















AERODROME SYMBOLS FOR APPROACH CHARTS

| | | | | | |
|----|---|---|----|---|---|
| 97 | Aerodromes affecting the traffic pattern on the aerodrome on which the procedure is based |  | 98 | The aerodrome on which the procedure is based |  |
|----|---|---|----|---|---|

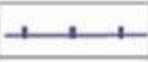



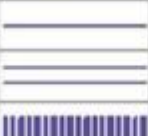





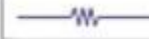


RADIO NAVIGATION AIDS*















































| | | | | | | |
|--|--|--|-----|--|---|---|
| 99 | Basic radio navigation aid symbol Note – This symbol may be used with or without a box to enclose the data. |  | 107 | Collocated VOR and TACAN radio navigation aids | VORTAC |  |
| 100 | Non-directional radio beacon | NDB | 108 | Instrument landing system | ILS | PLAN VIEW  |
| 101 | VHF omnidirectional radio range | VOR | 108 | | ILS | Electronic FRONT COURSE  |
| 102 | Distance measuring equipment | DME | 108 | | ILS | BACK COURSE  |
| 103 | Collocated VOR and DME radio navigation aids | VOR/DME | 108 | | ILS | PROFILE  |
| 104 | DME distance | Distance in kilometres (nautical miles) to DME → 15 km Identification of radio navigation aid → KAV | 108 | | ILS | Beak GLIDE PATH  |
| 105 | VOR radial | Radial bearing from, and identification of, VOR R 090 KAV | 109 | Radio marker beacon | Elliptical  | |
| 106 | UHF tactical air navigation aid | TACAN | 109 | Radio marker beacon | Bone Shape  | |
| Note – Marker beacon may be shown by outline, or stipple, or both. | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|-----|---|---------|---|-------|---|--------|---|
| 110 | Compass rose To be orientated on the chart in accordance with the alignment of the station (normally Magnetic North) |  | Compass rose to be used as appropriate in combination with the following symbols: | | | | | | | | |
| | | | <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>VOR</td> <td style="text-align: center;"></td> </tr> <tr> <td>VOR/DME</td> <td style="text-align: center;"></td> </tr> <tr> <td>TACAN</td> <td style="text-align: center;"></td> </tr> <tr> <td>VORTAC</td> <td style="text-align: center;"></td> </tr> </table> | VOR |  | VOR/DME |  | TACAN |  | VORTAC |  |
| VOR |  | | | | | | | | | | |
| VOR/DME |  | | | | | | | | | | |
| TACAN |  | | | | | | | | | | |
| VORTAC |  | | | | | | | | | | |
| Note – Additional points of compass may be added as required. | | | | | | | | | | | |





* Note – Guidance material on the presentation of radio navigation aid data is given in the Aeronautical Chart Manual (Doc 6697).

AIR TRAFFIC SERVICES

| | | | | | | | | | | | |
|-----|--|------------|--|-------------|---|--|--|-----|--------------------|---|---|
| 111 | Flight information region | FR |  | 117 | Air defence identification zone | ADIZ |  | | | | |
| 112 | Aerodrome traffic zone | ATZ |  | 118 | Advisory route | ADR | Alternative  | | | | |
| 113 | Control area Airway Controlled route | CTA AWY | Alternative  | | | | | 119 | Visual flight path | compulsory with a/ds communication requirement |  |
| | | | | | | | | | | compulsory, without a/ds communication requirement |  |
| 114 | Uncontrolled route | |  | recommended |  | | | | | | |
| 115 | Advisory airspace | ADA |  | 120 | Scale break (on ATS route) | Alternative  | | | | | |
| 116 | Control zone | CTR |  | | | |  | | | | |

| Significant Point Functionality | | | | | | | |
|--|-----------------------------|---|---|---|---|---|---|
| | REPORTING FLYBY/FLY-OVER | Significant point depiction for conventional navigation | | Significant point depiction for area navigation | | | |
| | | On request (NA) | Compulsory (NA) | On request fly-by | Compulsory fly-by | On request fly-over | Compulsory fly-over |
| 121 Basic Symbols with functionality | VFR reporting point |  |  |  |  |  |  |
| | Intersection INT |  |  |  |  |  |  |
| | VORTAC |  |  |  |  |  |  |
| | TACAN |  |  |  |  |  |  |
| | VOR |  |  |  |  |  |  |
| | VORDME |  |  |  |  |  |  |
| | NDB |  |  |  |  |  |  |
| | Waypoint WPT | Not used | Not used |  |  |  |  |

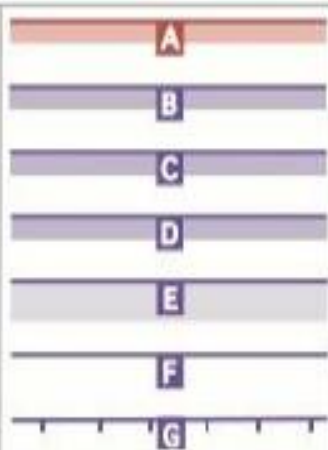


For details on use and meaning of these symbols, refer to paragraph 24

| | | | | | | | | | | | | |
|-----|--|-----|---|-----|-------------------------|-----|------------|--|-----|--------------------|-----|---|
| 122 | Change-over point To be superimposed on the appropriate route symbol at right angles to the route | OCP |  | 123 | ATS/MET reporting point | MPP | Compulsory |  | 124 | Final approach fix | FAF |  |
| | | | | | | | On request |  | | | | |



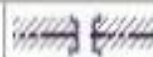
AIR TRAFFIC SERVICES (cont.)

| | | | | |
|-----|----------------------------------|------------------------------------|------------------|------------------|
| 125 | Procedure altitudes/light levels | Altitude/light level 'window' | 17 000 10 000 | FL 220 10 000 |
| | | 'At or above' altitude/light level | 7 000 | FL 070 |
| | | 'At or below' altitude/light level | 5 000 | FL 050 |
| | | 'At' altitude/light level | 3 000 | FL 030 |
| | | 'Recommended' altitude/light level | 5 000 | FL 050 |
| | | 'Expected' altitude/light level | Expect 5 000 | Expect FL 050 |








AIRSPACE CLASSIFICATIONS

| | | | | |
|-----|--------------------------|--|--|-------------|
| 126 | Airspace classifications |  | <p>Aeronautical data in abbreviated form to be used in association with airspace classification symbols:</p> | |
| | | <table border="1"> <tr> <td rowspan="2">127</td> <td rowspan="2">Alternative</td> <td> <p>TMA DONLON 119.1 C 200m AGL - FL 245</p> <p>Type Name or call sign Radius frequency(ies) Airspace classification Vertical limits</p> </td> </tr> <tr> <td>  </td> </tr> </table> | 127 | Alternative |
| 127 | Alternative | <p>TMA DONLON 119.1 C 200m AGL - FL 245</p> <p>Type Name or call sign Radius frequency(ies) Airspace classification Vertical limits</p> | | |
| | |  | | |



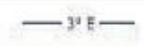
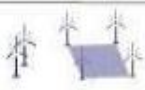

AIRSPACE RESTRICTIONS

| | | | | |
|-----|---|---|------------------------------|---|
| 128 | Restricted airspace (prohibited, restricted or danger area) |  | Common boundary of two areas |  |
| | Note.— The angle and density of rulings may be varied according to scale and the size, shape and orientation of the area. | | | |
| 129 | International boundary closed to passage of aircraft except through air corridor |  | | |

OBSTACLES

| | | | | | |
|-----|-------------------------|---|--|---|---|
| 130 | Obstacle |  | 134 | Exceptionally high obstacle (optional symbol) |  |
| 131 | Lighted obstacle |  | 135 | Exceptionally high obstacle - lighted (optional symbol) |  |
| 132 | Group obstacles |  | Note.— For obstacles having a height of the order of 300 m (1 000 ft) above terrain. | | |
| 133 | Lighted group obstacles |  | 136 | <p>Elevation of top (italics)  Height above specified datum (upright type in parentheses)</p> | |



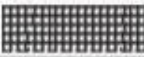





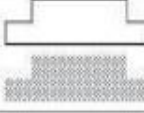








MISCELLANEOUS

| | | | | | |
|-----|--|---|-----|--|---|
| 137 | Prominent transmission line |  | 140 | Wind turbine — unlighted and lighted |  |
| 138 | Isogonic line or isogonal |  | 141 | Wind turbines — minor group and group in major area, lighted |  |
| 139 | Ocean station vessel (normal position) |  | | | |


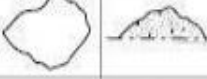




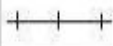
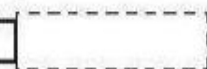
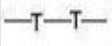
VISUAL AIDS

| | | | | | | | | | | | |
|-----|--|---|---|--------------|----------------------------|---|----------------------------|-----------------|------------------------------|---|--|
| 142 | Maree light <i>Note 2 — Characteristics are to be indicated as follows:</i> | Alt B F | Alemating Blue Fixed | F G Cp | Flashing Green Group | Occ R SEC | Occulting Red Sector | sec (U) W | Second Unwatched White |  | <i>Note 1 — Maree alternating lights are red and white unless otherwise indicated. Maree lights are white unless colours are stated.</i> |
| | | | | | | | | | | | |
| 143 | Aeronautical ground light |  |  | 144 | Lightship |  | | | | | |


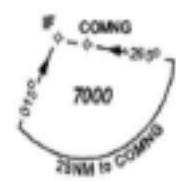
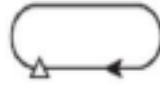

SYMBOLS FOR AERODROME/HELIPORT CHARTS

| | | | | | |
|-----|--|---|-----|--|---|
| 145 | Hard surface runway |  | 154 | Point light |  |
| 146 | Pierced steel plank or steel mesh runway |  | 155 | Obstacle light |  |
| 147 | Unpaved runway |  | 156 | Landing direction indicator (lighted) |  |
| 148 | Stopway SWY |  | 157 | Landing direction indicator (unlighted) |  |
| 149 | Taxiways and parking areas |  | 158 | Stop bar |  |
| 150 | Helicopter alighting area on an aerodrome |  | 159 | Runway-holding position <i>Note. — For application, see Annex 14, Volume I, 5.2.10.</i> |  |
| 151 | Aerodrome reference point ARP |  | 160 | Intermediate holding position <i>Note. — For application, see Annex 14, Volume I, 5.2.11.</i> |  |
| 152 | VOR check-point |  | 161 | Hot spot <i>Note. — Hot spot location to be circled.</i> |  |
| 153 | Runway visual range (RVR) observation site |  | | | |







SYMBOLS FOR AERODROME OBSTACLE CHARTS - TYPE A, B AND C

| | Plan | Profile | | Plan | Profile | |
|-----|-------------------------------------|---|-----------------------|------|------------------------------------|---|
| 162 | Tree or shrub |  | Identification number | 167 | Terrain penetrating obstacle plane |  |
| 163 | Pole, tower, spire, antenna, etc. |  | | 168 | Escarpment |  |
| 164 | Building or large structure |  | | 169 | Stopway SWY |  |
| 165 | Railroad |  | | 170 | Clearway CWY |  |
| 166 | Transmission line or overhead cable |  | | | | |

ADDITIONAL SYMBOLS FOR USE ON PAPER AND ELECTRONIC CHARTS

| PLAN VIEW | | Electronic |
|-----------|--|---|
| 171 | <p>Minimum sector or altitude Note—This symbol may be modified to reflect particular sector shapes.</p> <p>MSA</p> |  |
| 172 | <p>Terminal arrival altitude Note—This symbol may be modified to reflect particular TA shapes.</p> <p>TAA</p> |  |
| 173 | <p>Holding pattern</p> |  |
| 174 | <p>Missed approach track</p> |  |









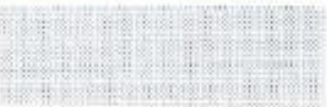



PROFILE

| | | |
|-----|---|---|
| 175 | <p>Runway</p> |  |
| 176 | <p>Radio navigation aid (type of aid and its use in the procedure to be annotated on top of the symbol)</p> |  |
| 177 | <p>Radio marker beacon (type of beacon to be annotated on top of the symbol)</p> |  |
| 178 | <p>Collocated radio navigation aid and marker beacon (type of aid to be annotated on top of the symbol)</p> |  |
| 179 | <p>DME fix (distance from DME and the fix use in the procedure to be annotated on top of the symbol)</p> |  |
| 180 | <p>Collocated DME fix and marker beacon (distance from DME and the type of beacon to be annotated on top of the symbol)</p> |  |

APPENDIX 3. COLOUR GUIDE

(REF 2.11.1)

CHART SYMBOLS

| | | | |
|---|------------------|-----------------|---|
| Culture, except highways and roads; outlines of large cities, grids and graticules; spot elevations; danger lines and off-shore rocks; names and lettering except for aeronautical and hydrographic features | | BLACK |  |
| Built-up areas of cities | | BLACK Stipple |  |
| Highways and roads | Optional colours | BLACK Half-tone |  |
| | | RED |  |
| Built-up areas for cities (alternative to black stipple) | | YELLOW |  |
| Contours and topographic features: Items 1 through 10 of Appendix 2 Hydrographic features: Items 30 through 41 of Appendix 2 | | BROWN |  |
| Shore lines, drainage, rivers, lakes, bathymetric contours and other hydrographic features including their names or description | | BLUE |  |
| Open water areas | | BLUE Half-tone |  |
| Salt lakes and salt pans | | BLUE Stipple |  |
| Large non-perennial rivers and non-perennial lakes | | BLUE Stipple |  |
| Aeronautical data, except for Enroute and Area Charts - ICAO, where different colours may be required. Both colours may be used on the same sheet but, where only one colour is used, dark blue is preferred. | Optional colours | MAGENTA |  |
| | | DARK BLUE |  |

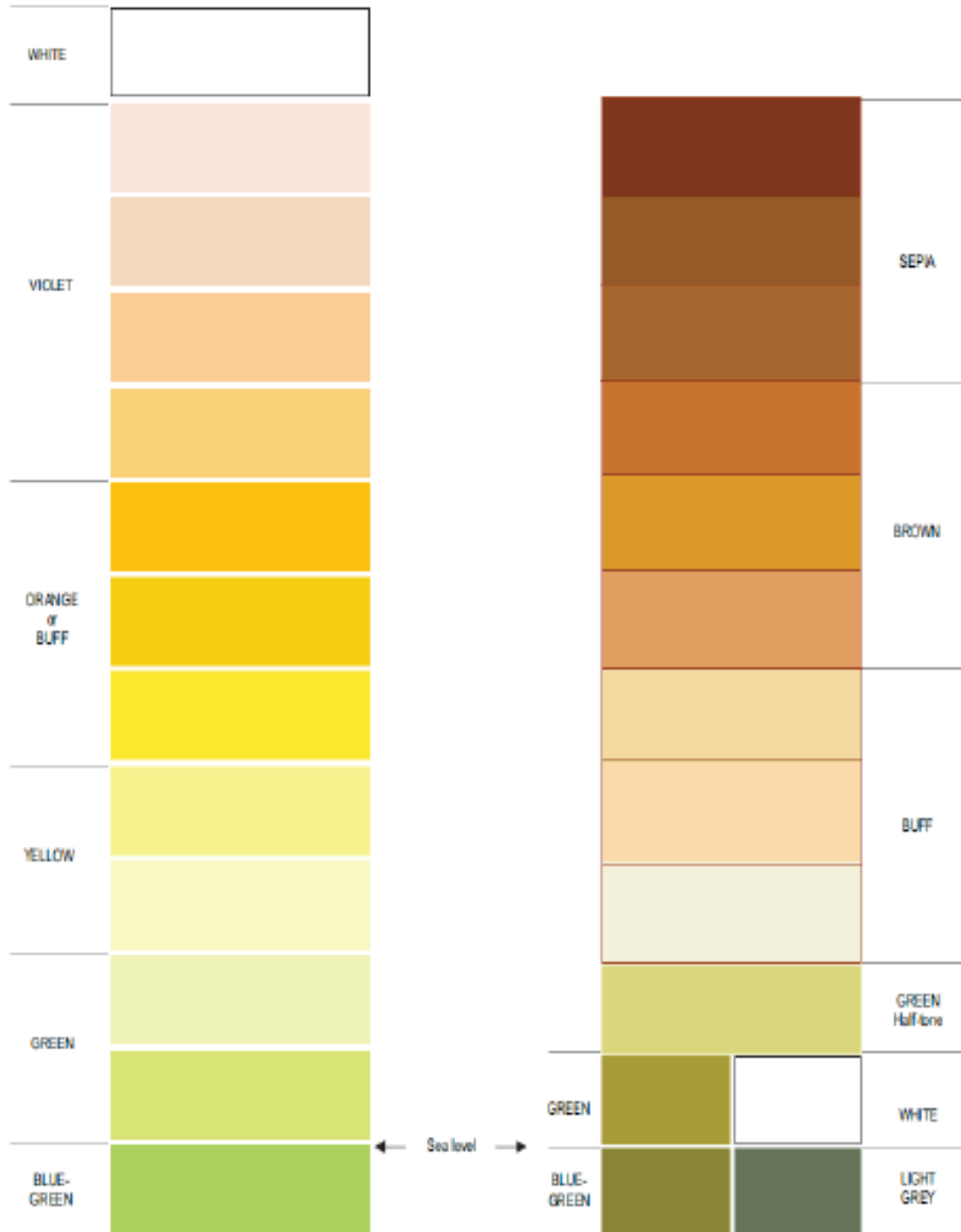
| | | | |
|--|------------------|-------------|---|
| Woods | | GREEN |  |
| Areas which have not been surveyed for contour information or relief data are incomplete | Optional colours | GOLDEN BUFF |  |
| | | WHITE |  |

HYPSONETRIC TINTS

| | | | | | |
|---|----------------|----------------------------------|------------------|--------------|---|
|  | WHITE | Tint for extreme elevations | Optional colours | SEPIA |  |
|  | VIOLET | | | | |
|  | ORANGE or BUFF | Tint for higher range elevations | | BROWN |  |
|  | YELLOW | Tint for middle range elevations | | BUFF |  |
|  | GREEN | Tint for lower range elevations | Optional colours | GREEN |  |
| | | | | WHITE |  |
|  | BLUE GREEN | Tint for areas below sea level | Optional colours | BLUE - GREEN |  |
| | | | | LIGHT GREY |  |

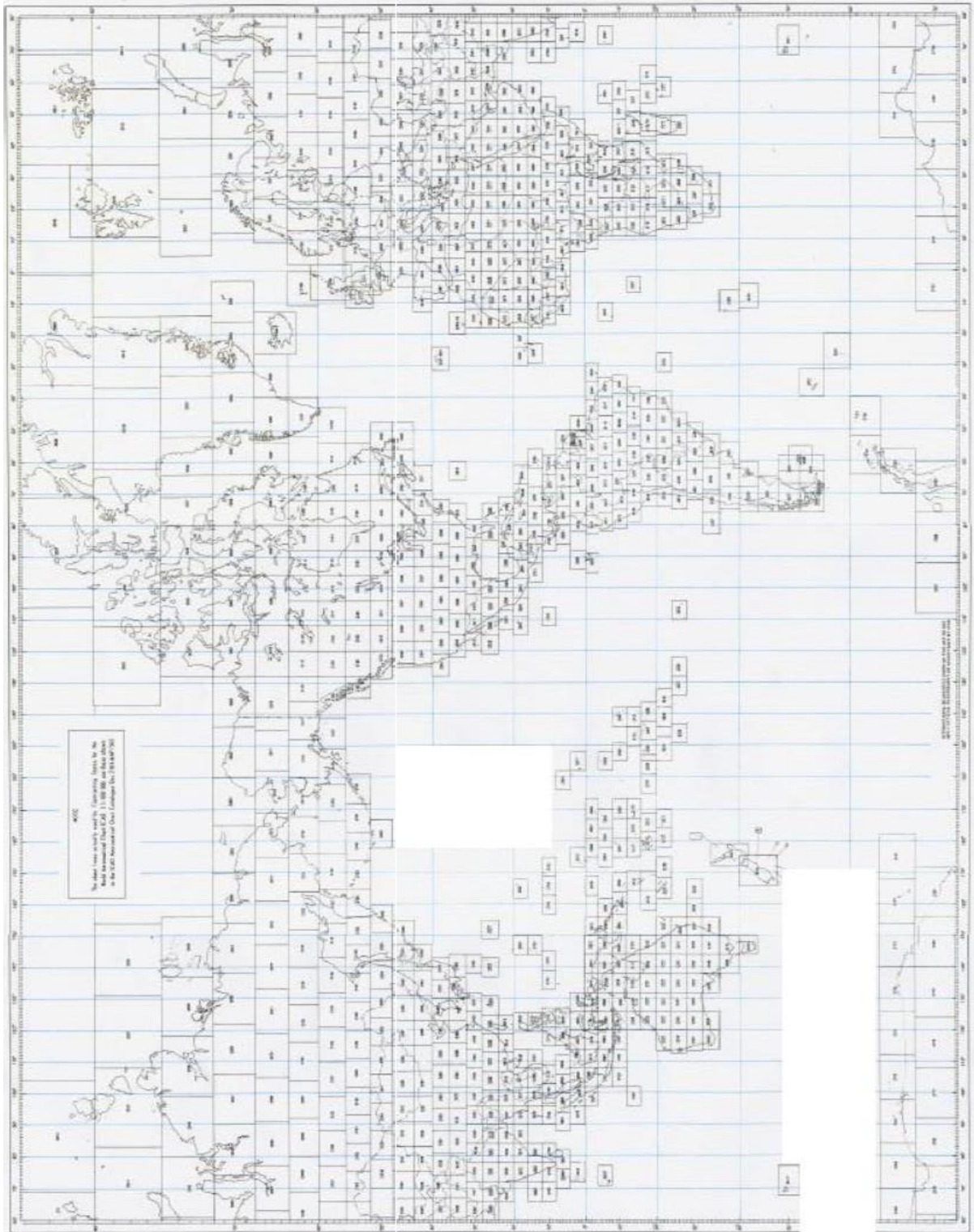
Note — Basic tints are identical to those specified for the International Map of the World

APPENDIX 4- HYPOMETRIC TINT GUIDE (Alternative systems, reference 2.12.2)



Note 1.— These tints are identical to those specified for the International Map of the World.

Note 2.— Elevations have not been associated with tints of other system in order to allow for flexibility in their selection.



SURVEY MAPS

AirportMap

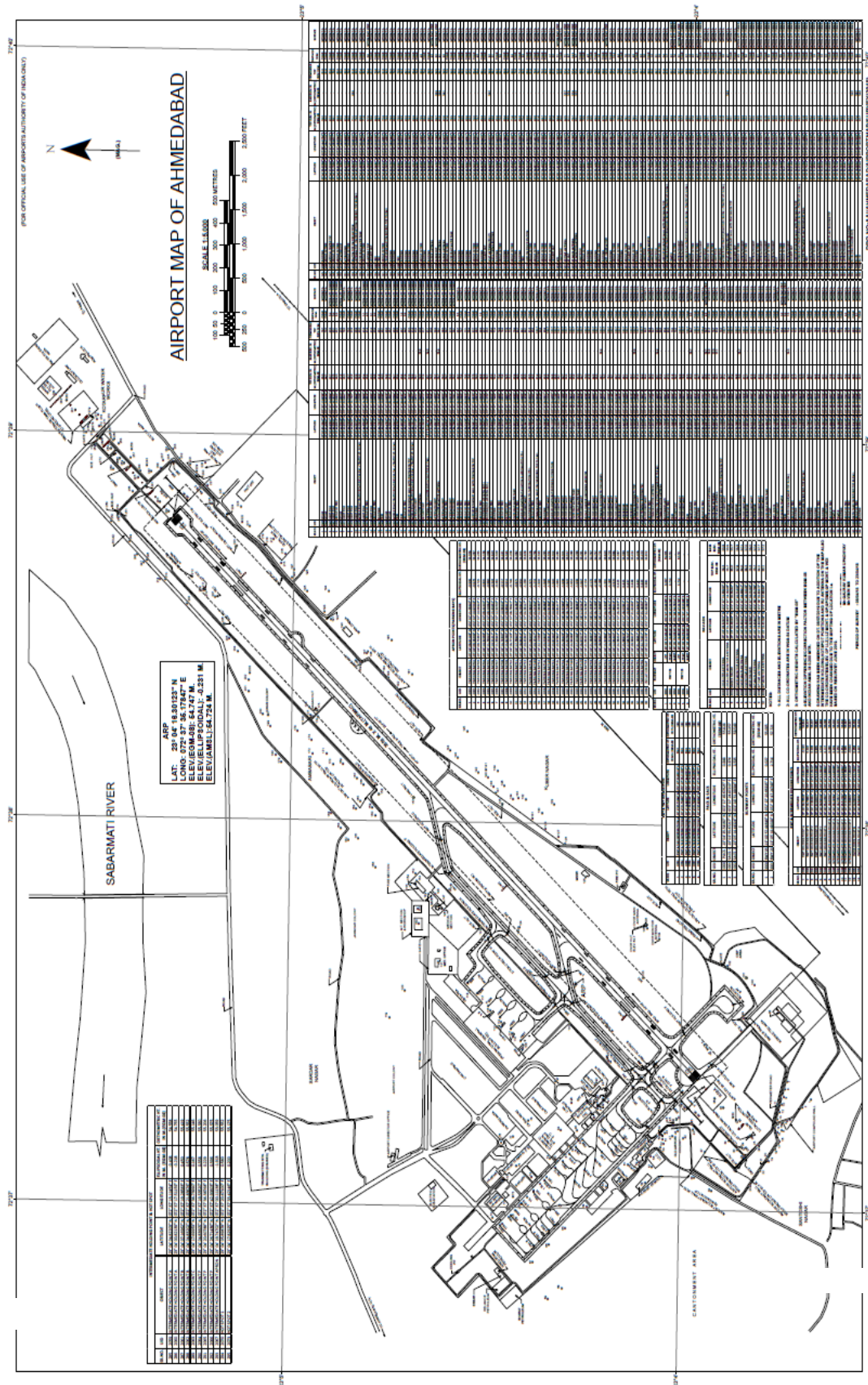


Fig. REF - 1

Approach Chart of Runway 05

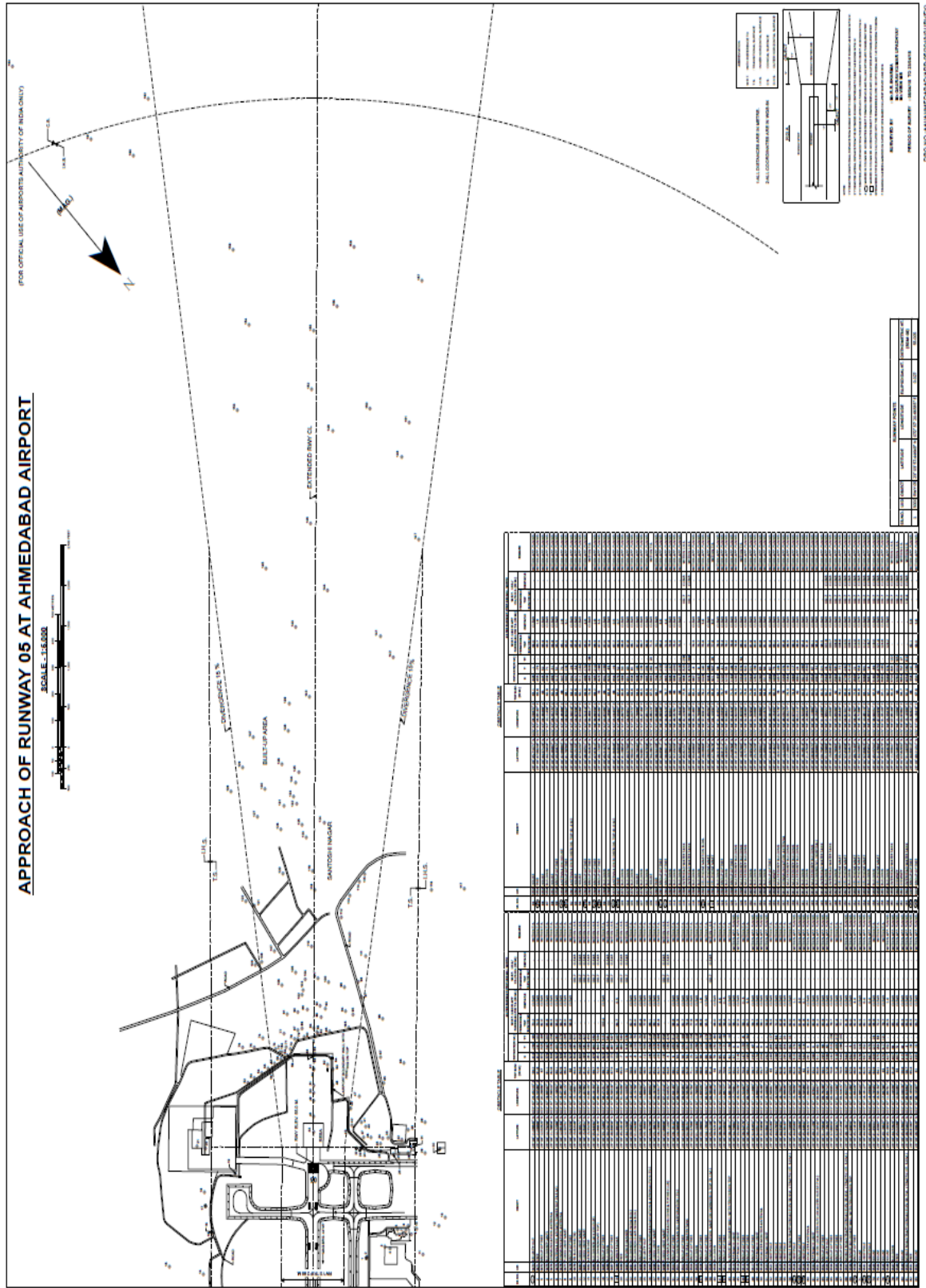


Fig. REF - 2

Approach Chart of Runway 23

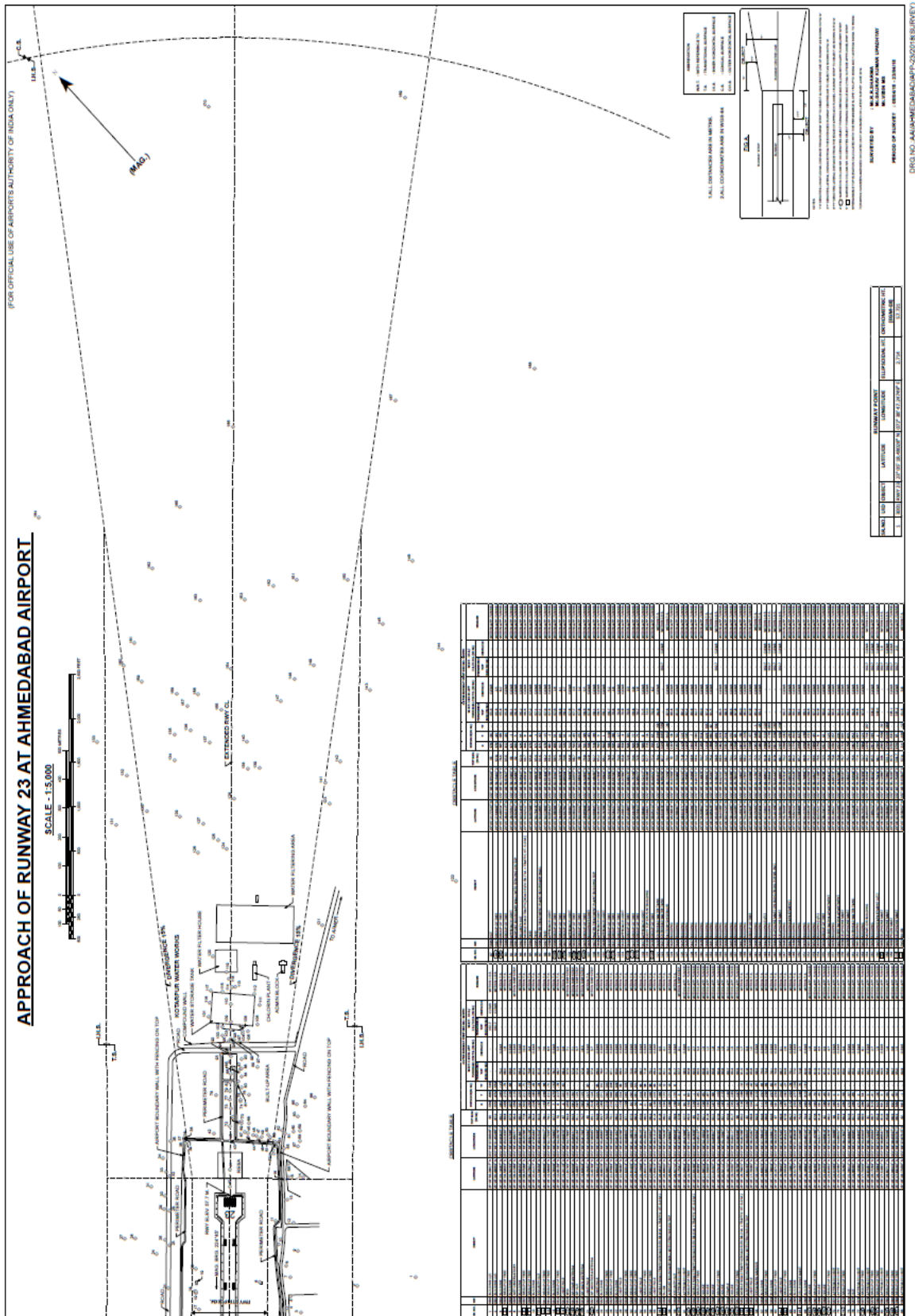


Fig. REF - 3

Vertical Significance Chart

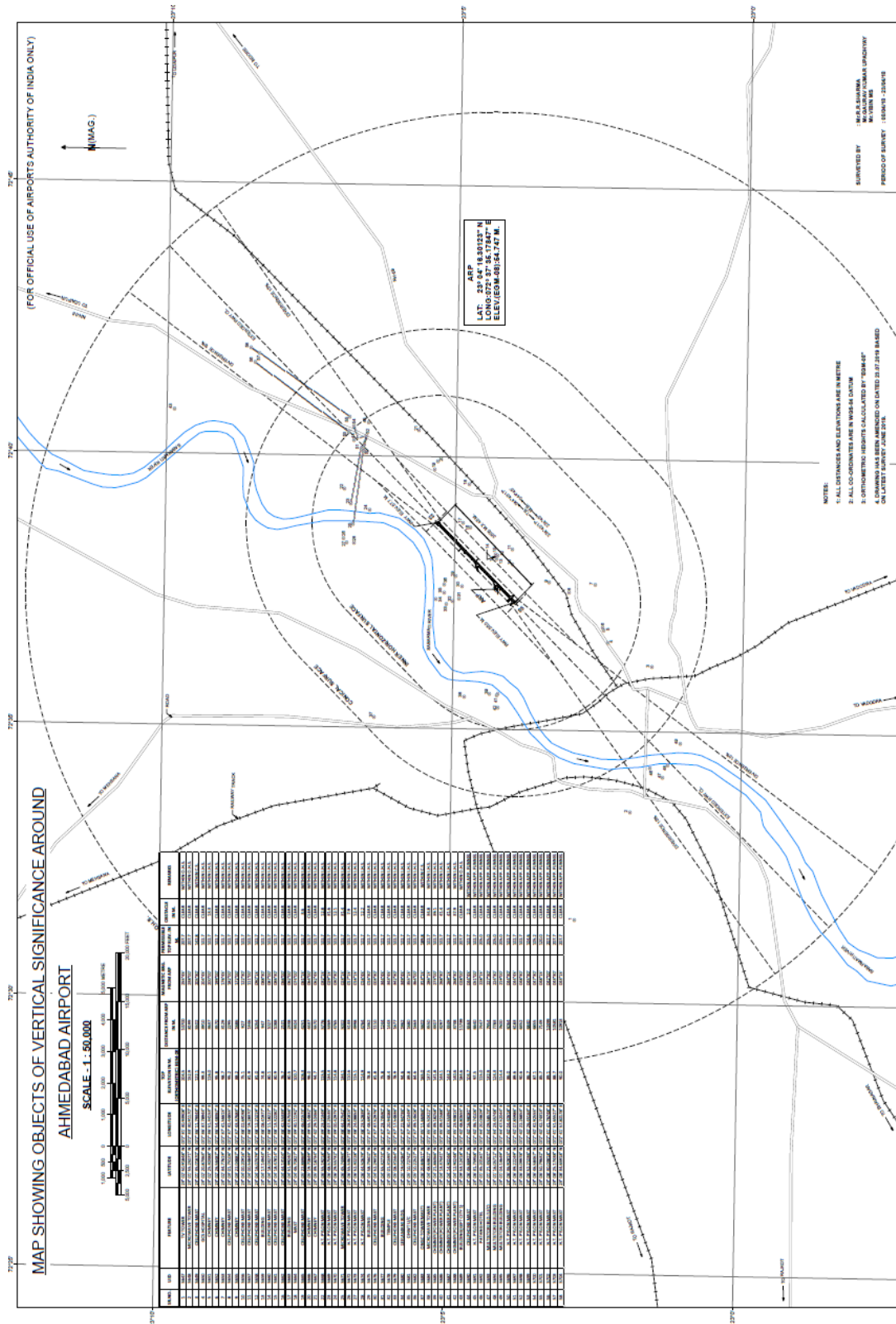


Fig. REF - 4

Obstacle free zone (OFZ)

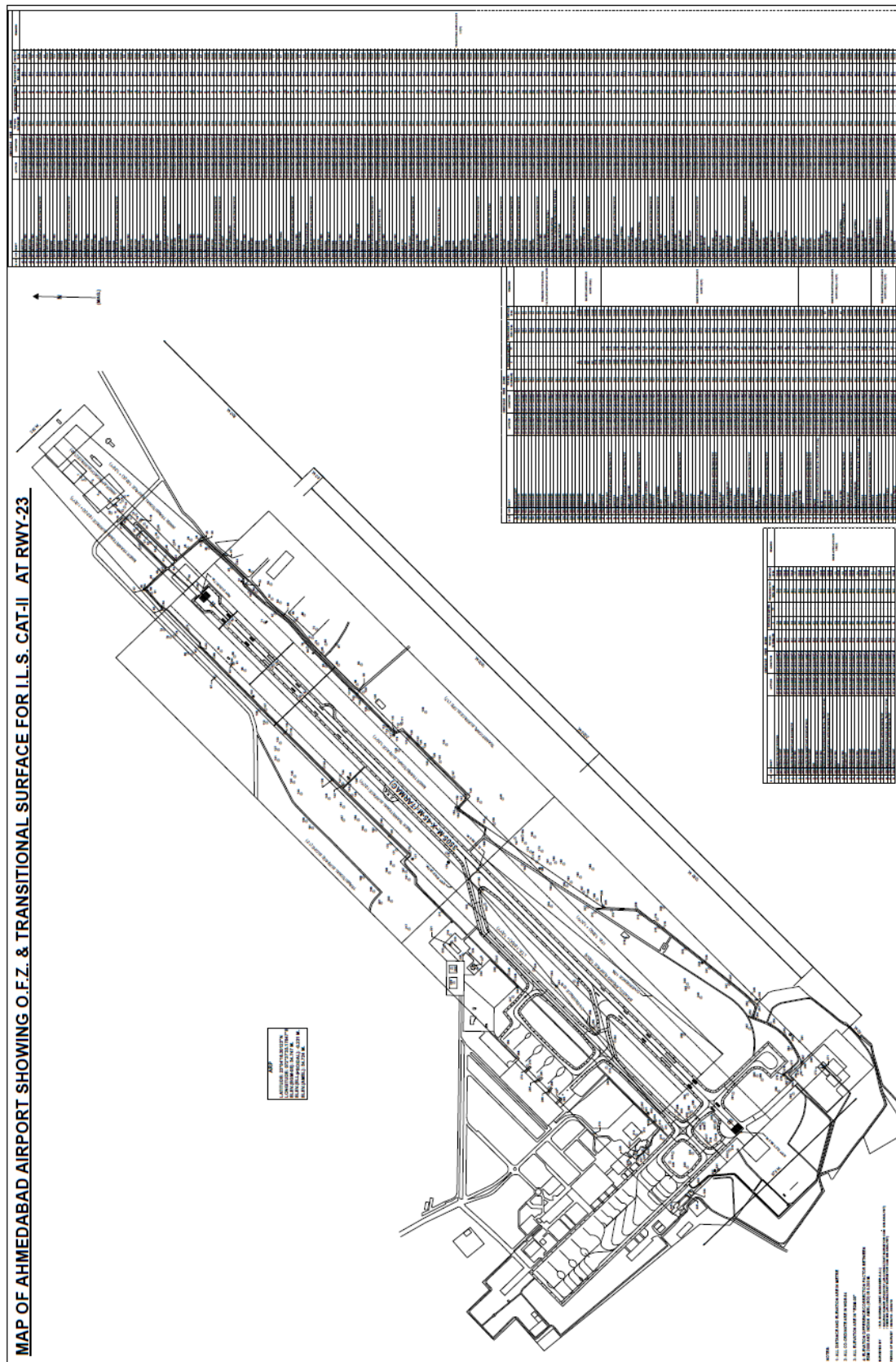


Fig. REF - 5

Contour Map

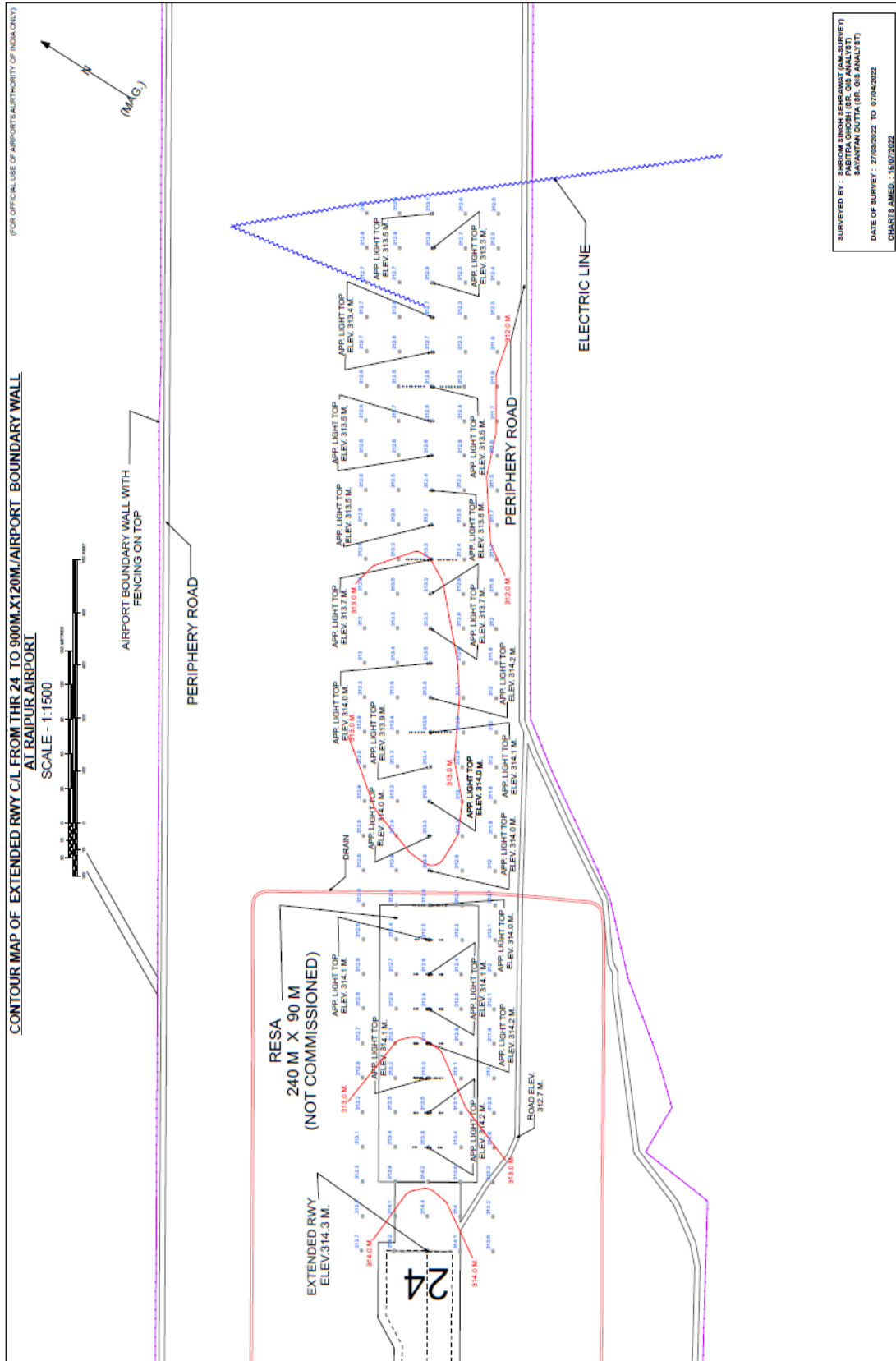


Fig. REF - 6