ICAO CIRCULAR

CIRCULAR 12—AN/10

DECEMBER 1949

AERODROME OBSTRUCTION CHARTS

Prepared in the Air Navigation Bureau
and published by authority of the Secretary General

INTERNATIONAL
CIVIL AVIATION
ORGANIZATION
MONTREAL • CANADA

This publication is issued in English, French and Spanish

Published in Montreal, Canada, by the International Civil Aviation Organization. Correspondence concerning publications should be addressed to the Secretary General of ICAO, International Aviation Building, 1080 University Street, Montreal, Canada.

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Price: 10 cents (Canadian currency) (Montreal)

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FOREWORD

The Operations Division (OPS) of the Air Navigation Commission, at its Third Session (see Final Report of the Session, Doc 6640-OPS/567, Page 167, Paragraph 8.1) recommended that,

"Since the application of operating limitations and instrument approach-to land procedures are directly dependent upon the provision of detailed information concerning obstacles in the vicinity of an aerodrome, the production of Aerodrome Obstruction Charts should be given the highest priority."

The instructions contained in this paper are being circulated to give an indication of the type of information that would be required for portrayal on obstruction charts and as an example of how one of ICAO's Contracting States is handling the survey problem.

The instructions are those issued by the Director, U.S. Coast and Geodetic Survey for the use of airport survey party personnel and are being circulated by permission of the U.S. Government.

The instructions were not intended for publication and general distribution and, consequently, the presentation is less formal and some of the material is not as meticulously selected as would be the case in a reference work or manual intended for publication.

The instructions consider only the field survey operations required for the preparation of Airport Obstruction Plans. The office process (such as compilation, drafting and reproduction) required for the preparation of these plans are not covered in the instructions.

The instructions have just been issued to field parties and are now being used for the first time; it is likely that field use will disclose desirable changes in details.

No Airport Obstruction Plan has as yet been published to comply with these instructions. The charts included in this paper are reduced copies of two typical examples of the current type of U.S. Obstruction Chart. In future, the original scale of 1:12,000 will continue to be used where there are no obstructions beyond the sheet limits at this scale, and the non-existence of obstructions will be indicated by notes; otherwise, it will be necessary to publish the plans at some scale smaller than 1:12,000.

It should be understood that the specifications given in Paragraphs 1.3.1 to 1.3.5 and 4.1 and illustrated in Plates 1 and 2 may not necessarily conform with the Standards and Recommended Practices that may be promulgated eventually in an AGA Annex to the Convention on Civil Aviation.

AERODROME OBSTRUCTION CHARTS

INSTRUCTION FOR OBSTRUCTION PLAN SURVEYS

1.- GENERAL DISCUSSION

1.1 Purpose of Obstruction Plans. Obstruction Plans of airports are published by this Bureau for the use of the Civil Aeronautics Administration and the Air Carriers in computing take-off loads permitted under existing air transport regulations.

1.2 Type of survey. Each Obstruction Plan survey will be designated in the project instructions as either a Type I or a Type II survey. The type of a survey determines only its extent and the definition of an obstruction in certain areas of that survey. The quality, accuracy, and other requirements of all surveys are the same, regardless of type.

1.3 Extent of survey. Each Type I survey will cover an area of about 85 square miles, and each Type II survey an area of about 68 square miles (Plate 1). More specifically, the limits of each survey are formed by the periphery of a Conical Section (C) (1.3.5), and the boundaries of two Instrument Approach Areas (A) (1.3.1), one at each end of the instrument runway, which extend beyond the Conical Section. Within these over-all limits, each survey must determine the position and elevation (above mean sea level) of all natural and cultural obstructions (4.1). Each survey must also determine the mean sea level elevation of the airport, the length and azimuth of each runway, and the horizontal positions of a sufficient number of ground stations to control a radial plot of the area.

1.3.1 Instrument Approach Area. Each survey area contains two Instrument Approach Areas (A), one at each end of the instrument runway.

Each Instrument Approach Area is symmetrically located with respect to the instrument runway centerline extended, and extends from the runway end outward for 50,000 feet measured horizontally along the centerline extended. Each Instrument Approach Area consists of an inner rectangular section, abutting the runway end, and of an outer isosceles trapezoidal section, abutting the outer end of the rectangular section. The rectangular section is 3,100 feet in width (1,550 feet on each side of the runway centerline extended), and 6,217 feet in length, its sides terminating where they intersect the sides of the trapezoidal section. The sides of the isosceles trapezoidal section are the extensions of lines originating at the center of the end of the runway, and flaring outward at an angle of 14° on each side of the runway centerline extended (Plate 1).

1.3.2 Noninstrument Approach Area. Each survey area contains one Noninstrument Approach Area (N) at each end of each noninstrument runway. Noninstrument Approach Areas are exactly similar in all respects and dimensions to Instrument Approach Areas, except that Noninstrument Approach Areas are located at the ends of noninstrument runways, and extend outward for a total of only 10,000 feet from the runway end.

1.3.3 Runway Area. The Runway Area (R) encloses all of the runways. For a single-runway, the Runway Area is rectangular in shape. Its length is the length of the runway, and its width is 3,100 feet (1,550 feet on each side of the runway centerline). For a system of runways, such as usually encountered at an airport, the limits of the Runway Area are the outermost limits of the overlapping, single-runway areas (Plate 1).

1.3.4 Horizontal Area. The Horizontal Area (H) is circular in shape, with its center at the mid-point of the instrument runway. Its radius is 13,000 feet for a Type I survey, and 10,000 feet for a Type II survey. (Dimension a, Plate 1). The Instrument Approach, Noninstrument Approach, and Runway Areas are excluded from the Horizontal Area.

1.3.5 Conical Section. The Conical Section is concentric with the Horizontal Area, and extends radially outward (Dimension b, Plate 1) beyond the circumference of the Horizontal Area 7,000 feet for a Type I survey and 5,000 feet for a Type II survey. The Instrument Approach and Noninstrument Approach Areas are excluded from the Conical Section.

1.4 Data furnished to survey party. The following listed data, if available, are furnished to the field party prior to the survey:

1) Aerial Photographs;

2) Horizontal and vertical control data;

3) Airport plans;

4) Planimetric and topographic maps of the area;

5) Approach and Landing Charts.

1.5 Types of field operations. Obstructions surveys will ordinarily consist of the following operations:

1) Horizontal control survey;

2) Leveling;

3) Selection of obstructions;

4) Determination of position and elevation of obstructions;

5) Field computations.

1.6 Obstruction plans of other organizations. The data on obstruction plans prepared by other organizations shall not be accepted. Obstruction plans of other organizations, however, may be used for planning the operations of a new survey.

2.- HORIZONTAL CONTROL SURVEYS

2.1 Local control scheme. A local horizontal control scheme shall be established at each airport unless (a) the project instructions specifically state that such control is not required, or (b) such control has been established during a previous survey (2.1.4). The local control scheme is used for the following purposes:

1) To control the radial plot;

2) To serve as a base for locating obstructions by intersection methods;

3) To determine the lengths and azimuths of the runways;

4) To correlate the maps and plans used in the survey;

5) To facilitate future revision surveys.

2.1.1 Selection of local control stations. An ideal selection of local control stations includes main scheme stations consisting of the airport control tower, the airport beacon, and stations located at the ends of each runway; and supplementary stations located at approximately regular intervals at, or beyond, the outermost obstructions of the survey area. Supplementary stations will normally consist of such elevated objects as building finials, chimneys, radio masts, and tanks that are visible from the main scheme stations. Main scheme ground stations, such as those at the ends of the runway, are usually designated by letters of the alphabet. A control layout diagram shall be prepared on one of the following: (1) an airport plan, (2) the landing chart, or (3) in the field record book, and submitted with the completed survey data.

2.1.2 Identification of control stations. Each control station shall be identified on an aerial photograph with an accuracy of plus or minus 0.15 mm. Where the photograph is 1:12,000 scale, this tolerance is equivalent to about 6 feet on the ground. Each selected control station shall be designated on the photograph by its assigned letter of the alphabet or appropriate descriptive title. Federal control stations of third-order accuracy or better shall be enclosed by an inked triangle, and all other control stations by an inked square. All control stations shall be identified on the photographs in accordance with Photogrammetry Instructions No. 22.

2.1.3 Development of control scheme. The control scheme may be developed from the base line by either triangulation or traverse or by a combination of the two. The two ends of the base line must always be occupied, and as many as practicable of the other main scheme stations shall also be occupied. All unoccupied main scheme stations should either be intersected from at least three other stations, or intersected from two stations with the length of one unknown side of the triangle taped. Supplementary stations should be intersected from three main scheme stations. Usually it is not practicable to occupy the supplementary stations. A single direction should be observed to a supplementary station in any large part of the survey area where it is not practicable to locate a station by complete observations. It should be remembered that some data are usually better than none at all; such a direction serves to strengthen a radial plot in one direction.

2.1.4 Use of previously established control. If a control scheme has been established during a previous obstruction survey, its stations may be used for base lines, or for other purposes, during a new survey provided (a) a sufficient number of the original stations can be positively recovered to make its use practicable, and (b) a line, other than the base line of the original scheme is taped, and checks the original survey length by 1:2,000 or better.

2.2 Control scheme base line. The base line from which the local control scheme is developed shall be laid out between two control stations at the opposite ends of a runway, wherever practicable. The base line shall be selected so as to obtain the best practicable intersection angles on the other main scheme stations. The base line shall be double-taped with an agreement between the two tapings of 1 part in 5,000 or better. The taping shall be along the surface of the runway and shall be corrected to the horizontal if the slope of the runway is greater than 10 feet in 1,000 feet.

2.3 Measurement of angles. All control scheme angles shall be measured by the direction method. The same initial station (generally an airport beacon or the control tower) shall be used from each occupied station, wherever practicable. One direct reading and one reverse reading of each angle shall be made and both verniers shall be recorded for each pointing. All angle observations shall be recorded in "Horizontal Angle Observations", Form 250.

2.4 Accuracy requirements. The best of the angles at an intersected station shall seldom be less than 12°. The computed sides of the triangles formed by the main scheme stations shall check within 1 part in 4,000; those for the supplemental stations shall check within 1 part in 2,000. At least one computed side of one of the triangles formed by the main scheme stations shall be taped and shall check the computed length by 1 part in 4,000.

2.5 Azimuth observations. Observations shall be made so that the azimuth can be determined for one line of the local control scheme (preferably the base line) by one of the following methods: (1) solar observations; (2) polaris observations; or (3) an adequate and self-checking azimuth connection to geodetic datum (2.7).

2.5.1 Solar observations. The solar observations shall consist of two sets of four pointings each on the sun. Detailed instructions for solar azimuth observations are contained in Photogrammetry Instructions No. 19. The observations shall be tested graphically for accuracy and repeated if necessary to obtain a satisfactory set of readings.

2.5.2 Polaris observations. Detailed instructions for making polaris observations are contained in Photogrammetry Instructions No. 4.

2.6 Lengths and azimuths of runways. A control station shall always be established at each end of each runway to provide the runway/

azimuth and the length. For this purpose, the end of the runway shall be considered as the end of the rectangle bounding the usable area for which the runway has full width (2.6.1). Spur traverses may be required to establish such control stations since it is not always practicable otherwise to establish stations at the ends or on the edges of the runways. A spur traverse shall be double-taped. A sketch shall be made in the field records to illustrate clearly the relationship between the physical end of the runway and the control station.

2.6.1 Definition of the length of a runway. The length of a runway is the total usable surfaced length for which the runway has full width. Thus, if the ends of a runway are rounded, its length is the maximum length of the rectangular area that has full width.

2.6.2 Runway numbers. Runway numbers that are painted on the runways shall be shown in approximately correct relationship to the runway ends on sketches in the field records. A separate sketch shall be made for each runway end. The sketch shall be dated, and shall include the line, if any, under the runway number, and an arrow orienting the sketch with respect to true north. If no numbers are painted on the runways at the time of the survey, that fact shall be noted in the field records, and the sketches may be omitted. Where the painted runway numbers, as they appear on the runways at the date of the survey, are clearly legible on a photograph, the sketch may also be omitted. In this case, a note in the field records shall state the number of the photograph on which the runway numbers are correctly shown.

2.6.3 Runway widths. The width of each runway shall be taped. If the runway is irregular, the field records shall state that the mean width is furnished.

2.7 Connection to Federal triangulation network. The local control scheme shall be connected to one or more stations of the Federal control network by triangulation or traverse methods of surveying wherever it is practicable.

2.8 Use of horizontal control of other organizations. Occasionally it may be possible to recover and identify existing control of which this office has no record. Such control should be used for strengthening the radial plot if:

1) There is a scarcity of existing control in the area;

2) The control is of third-order accuracy or better;

3) State plane coordinates or geographic positions can be furnished the Washington Office.

2.9 Recovery report. Form 526 shall be submitted for all control stations of this Bureau that are searched for, occupied, or identified on the photographs. Descriptions headed "Not Previously Described" shall be submitted on Form 526 for all stations of this Bureau that are recovered and that have not been previously described.

3.- LEVELING

3.1 Datum. All leveling shall be based on mean-sea-level datum--the datum of all U.S. Coast and Geodetic Survey bench marks.

3.2 Use of bench marks of other organizations. A conveniently situated bench mark of another organization may be accepted and used, provided all three of the following requirements are satisfied:

1) The elevation was determined by running a closed loop;

2) The elevation is referred to mean-sea-level datum;

3) It is evident to the chief of party that the elevation is of third-order accuracy or better. (The evaluation of the accuracy of such an elevation might obviously require more time than a new determination.)

3.3 Control leveling. Control leveling is the first of the three types of leveling performed in airport obstruction surveys. It is used where it is necessary to establish a bench mark at the airport. The bench mark should be a recoverable permanent object such as a corner of a concrete step at the administration building, but need not be monumented or marked. A description of the bench mark shall be recorded in the level record for future recovery.

3.3.1 Control leveling accuracy requirements. The control level line shall be either double run or else run as a closed loop. The closing error in the levels shall not exceed 0.05 foot times the square root of the length of the level line in statute miles--the generally accepted requirement for leveling of third-order accuracy.

3.3.2 Control leveling precautions. The following precautions should be observed to meet the closure requirements:

1) Limit the length of the sights so that the smallest rod divisions are always clearly visible;

2) Read and record the rod values to 0.001 foot;

3) Use the plumbing level on the rod for all sights;

4) Make each foresight distance approximately equal to the backsight distance;

5) Keep the level instrument in adjustment at all times;

6) Use a steel turning pin driven to a firm bearing in the ground where a suitable natural object is not available for a turning point.

3.4 Field leveling. Field leveling is the second of the three types of leveling performed in airport obstruction surveys. Elevations determined on the landing area during field leveling include:

1) The official airport elevation;

2) The ends of the runways;

3) The intersections of the runways;

4) Runway profile points;

5) Temporary recoverable bench marks.

3.4.1 Field leveling accuracy requirements. Field leveling shall be run in closed loops. Each loop shall start and close on either bench marks of third-order accuracy or better, or start and close on temporary recoverable bench marks established during the control leveling procedure. The closing error of field leveling shall not exceed 0.2 foot.

3.4.2 Horizontal position of field leveling station. The horizontal position of each field leveling station (except temporary recoverable bench marks) should be determined by one of the following methods: (1) identifying the image of the station on an aerial photograph; (2) indicating the position on a large scale map or chart; or (3) tying the station to the local control scheme with field measurements. The position shall be identified with an accuracy of 0.6 mm. on a 1:12,000 scale photograph, which is equivalent to about 25 feet on the ground.

3.4.3 Official airport elevation. The official airport elevation is the elevation of the highest part of the usable landing area. This elevation may be on any part of the airport designated by the airport authorities as a landing area and is not necessarily on a runway.

3.4.4 Runway elevations. Each elevation that pertains to a runway shall be determined at the centerline of the runway.

3.4.5 Profiles of runways. A sufficient number of elevations shall be determined by field leveling between runway ends and/or intersections so that a reasonably accurate profile of each runway can be drawn. These elevations shall be at intervals not greater than 600 feet and also at all apparent changes in runway grades. The positions of the profile points may be determined by any convenient method that will assure a position accuracy of 25 feet, such as with stadia or by spacing the profile points opposite runway lights; but the accuracy requirements are such that taping is usually not warranted. The positions of the profile points shall be indicated to the Washington Office by plotting them on a photograph or airport plan or by showing them on a sketch.

3.4.6 Temporary recoverable bench marks. Temporary recoverable bench marks should be established during field leveling at convenient locations on the field for later use in leveling to obstructions or to base line stations.

3.5 Obstruction leveling. Obstruction leveling is the third of three types of leveling performed in airport obstruction surveys. Obstruction leveling is used to furnish the ground elevations that are used in determining the elevations of the tops of obstructions. It may be accomplished either by spirit leveling methods or by stadia-trigonometric methods. The accuracy may be somewhat less than that required for control leveling and field leveling.

3.5.1 Obstruction leveling accuracy requirements. Obstruction leveling shall be run in closed loops. Loop closures shall in no case exceed one-half the elevation tolerances noted in 5.1, or 2 feet, whichever is least. Each loop shall start and close, where practicable, on a third-order bench mark, or on a temporary recoverable bench mark established during control leveling or field leveling. Care shall be exercised, where a series of loops for area coverage is required, to guard against building up a cumulative error in excess of the above requirements.

3.5.2 Use of spot elevations. Elevations published on topographic maps at road intersections or at spots that are indicated on the map by a black cross may be used for starting and closing a leveling loop to obstructions in the Horizontal Area or Conical Section or more than 10,000 feet from a runway end in Approach Areas. A loop for determining obstruction elevations in any of these areas may also start and close on an elevation that was established trigonometrically from stations of the Horizontal Control Survey. The probable error of the final elevation of an obstruction shall not exceed the tolerances noted in 5.1 regardless of the methods used.

3.6 Leveling records. All leveling shall be recorded in the standard "Wye Leveling Record Book", Form No. 634. Each foresight reading shall be entered on a line of the record book separate from the line of the backsight reading.

4.- SELECTION OF OBSTRUCTIONS

4.1 Definition of obstruction. The definition of an obstruction depends on the type of the survey and on the part of the area in which the obstruction is located. An obstruction is defined as follows for each of the survey areas:

4.1.1 Instrument Approach Area:

a) For a Type I survey an obstruction is any object that extends above a 100:1½ glide angle (0° 52' vertical angle) from an origin at the elevation of the runway end but located 200 feet off the runway end on the runway centerline extended (Plate 2). Objects that are within 200 feet of the Runway Area and extend above the elevation of the runway end, are also obstructions;

b) For a Type II survey the definition is the same as for a Type I survey, except that the glide angle is 50:1 (1° 09' vertical angle).

4.1.2 Noninstrument Approach Area. An obstruction is any object that extends above whichever of the following is the lower: (a) a 50:1 glide angle from the origin described in (a) above, or (b) a horizontal plane 150 feet above the official airport elevation;

4.1.3 Runway Area. An obstruction is any object that extends appreciably above the elevation of the nearest runway;

4.1.4 Horizontal Area. An obstruction is any object that extends above a horizontal plane 150 feet above the official airport elevation;

4.1.5 Conical Section. An obstruction is any object that extends above a 20:1 slope measured upward from the horizontal plane described above, and outward radially from the circumference of the Horizontal Area.

4.2 Detection of obstructions from ends of runways. The obstructions that are in the Approach Area and are visible from the airport may frequently be detected from the ends of the runways by use of the theodolite or transit. A vertical angle of 0° 52' (equivalent to the 100:1½ glide angle) or of 1° 09' (equivalent to the 50:1 glide angle), whichever is applicable, is set on the instrument and the horizon within the Approach Areas is swept for possible obstructions. The instrument must be in adjustment, and allowance must be made for the height of the instrument and the displacement of the instrument from the origin of the glide angle (4.1). These allowances may be eliminated, if the terrain permits setting the theodolite or transit off the runway end so that the telescope is in the glide angle.

4.3 Detection of obstructions by other methods. The following suggestions will aid in the detection of obstructions in the Approach Areas but not visible from the ends of runways; or in other parts of the survey area:

1) A stereoscopic study of the photographs or a study of the contours on a topographic map may aid in finding areas where obstructions may exist;

2) Vertical angle observations that are made from the tops of structures of known elevations on or near the field can be used with approximate distances scaled from photographs or maps for obtaining test elevations for objects believed to be obstructions. The test elevation will not be accepted as the final elevation of the obstruction;

3) A line of levels may be run to a suspected obstruction or obstructed area;

4) Test barometric elevations may be run as in (3), but will not be accepted as a basis for the final elevation of the obstruction.

4.3.1 Detection of obstructions in the Runway Area. Obstructions in the Runway Area are not rigidly defined. An adequate selection of obstructions in this area will depend upon the judgment of the chief of party. Representative structures on the airport property, such as the administrative building, typical hangars, the control tower, and the airport beacon should be included in the selection, even though they are some distance outside the runway area and/or are not considered actual obstructions.

4.4 Obstructed areas. An obstructed area is a part of the airport survey area where the numerous obstructions make it more practicable to determine the positions and elevations of only a few representative and critical obstructions, rather than attempt to designate each and every obstruction. Examples of obstructed areas are: a congested industrial area, a mountain, and a wooded area. Paragraphs 4.4.1 and 4.4.2 outline general criteria for guidance in the delineation of an obstructed area.

4.4.1 Determination of an obstructed area. It must be decided whether the character of the obstructions can be most vividly indicated on a plan by showing the individual obstructions or by showing an obstructed area. If it is decided to use the obstructed-area designation, then the critical and typical obstructions must be selected and the area must be outlined on a photograph or map. Elevated land that forms an obstruction of considerable area shall be treated as an obstructed area.

4.4.2 Use of topographic maps in delineating obstructed areas. It is not necessary to determine the elevations of as many obstructions as usual if the area is covered by recent topographic maps of good quality. All critical elevations must be obtained by the airport obstruction survey, but if the topographic map coverage has been proved to be of reliable accuracy by comparison with other parts of the airport survey, then the obstructed areas may be delineated on the topographic maps.

4.5 Selection of obstructions. After all the probable obstructions or obstructed areas in the various parts of the survey have been found a selection of those obstructions which are to be shown on the Obstruction Plan must be made. Good judgment and careful consideration are required in this selection. A sufficient number of points must be selected to represent accurately on the Obstruction Plan the nature and distribution of the obstructions in the survey area. To this end the typical and critical obstructions in each vicinity should be selected, but the total number of obstructions finally chosen should be kept to the minimum which will adequately represent the survey area on the Obstruction Plan.

4.5.1 Additional elevations. In the Approach Areas some elevations are required in addition to the elevations of the obstructions. These additional elevations are: (a) one or two elevations on hills, mountains, or ridges at or near the intersection of the 100:1½ or the 50:1 glide angle with the mountainside or hillside in addition to the highest or critical elevations, and (b) an elevation on the runway centerline extended at its intersection with each frequently traveled road and with each railroad where the road or railroad is within 3,000 feet of the runway end. The location of each elevation point must be obtained. The road or railroad throughout that part of its extent that falls in the Approach Area and within 3,000 feet of the runway end must also be denoted on a photograph or map.

4.5.2 Ground elevations at obstructions. The elevation of the ground shall be determined at a sufficient number of obstructions in the Approach Areas to indicate the high points of the terrain.

4.5.3 Special methods suggested. The determination of an elevation on the side of a wooded mountain or hill at the intersection with the 100:1½ or 50:1 glide angle may be a difficult field problem. One solution consists of setting on the hillside a target that can be located by theodolite observations from the airport. Another solution consists of occupying a station on the hillside with a theodolite and obtaining a position by resection on objects previously located.

5.- DETERMINATION OF ELEVATION AND LOCATION OF OBSTRUCTIONS

5.1 Accuracy requirements for elevation and location of an obstruction. The horizontal and vertical accuracy requirements for obstructions vary with location. Elevation tolerances are shown in the following table:

Obstruction Location	Distance from Runway End	Elevation Tolerance
Approach Areas	0 - 5,000 Ft.	1.5 Ft.
	5,000 - 10,000	3.0
	10,000 - 15,000	4.5
	15,000 - 20,000	6.0
	20,000 - 25,000	7.5
	25,000 - 30,000	9.0
	30,000 - 35,000	10.5
	35,000 - 40,000	12.0
	40,000 - 45,000	13.5
	45,000 - 50,000	15.0
Runway Area	-----------	1.5
Horizontal Area	-----------	10.0
Conical Section	-----------	15.0

Obstructions that are not to be used as control stations shall be located with the following horizontal accuracy:

Distance in Feet from Mid-Point of Instrument Runway	Tolerance on Ground	Approximate Tolerance on Map or Photograph at 1:12,000	at 1:31,680
0 to 20,000	25 Feet	0.6 mm.	0.25 mm.
20,000 to 50,000	50 Feet	1.3 mm.	0.50 mm.

5.2 Methods for determining position and elevation of an obstruction. Any survey method may be used in determining the elevation and location of an obstruction, provided the results meet the previously mentioned accuracy requirements. Two methods now in common practice are (1) the base line method and (2) the direct method.

5.2.1 The base line method. The base line method is usually preferred for the location of objects that are inaccessible or difficult to identify on photographs. Horizontal and vertical angles are observed on the obstruction from both ends of a measured line. The elevations of the ends of the base are determined either by field leveling or by obstruction leveling. The base line is usually tied to the local control scheme by ground survey methods or it may be identified on a photograph for location by the radial plot. The elevation and the location of the obstruction are both obtained by this method. Elevations computed from the two ends of the base line should always agree within one-half the elevation tolerance limits stated in Paragraph 5.1 or 2 feet, whichever is least. Horizontal angle intersections at an obstruction should never be less than 10°. A temporary base line established for this method should not be longer than necessary to give the required angles of intersection. The base line should always be double-taped, except where a check value has been computed for it in the control scheme. Horizontal angles shall be recorded both with the telescope normal (direct, D) and inverted (reverse, R), and likewise, vertical angles shall be recorded both with the telescope normal (vertical circle left, CL) and inverted (vertical circle right, CR).

5.2.2 The direct method. Levels are run to the obstruction and its height above the instrument is determined either by (1) observing a vertical angle and measuring the distance from the instrument to the obstruction, or (2) by measuring it directly, if practicable. Vertical angle observations shall consist of readings with the telescope both in normal position (vertical circle left, CL) and inverted (vertical circle right, CR). The distance shall be determined by double taping or by stadia observations. To guard against making blunders in stadia observations, the three horizontal cross hairs shall be read and all readings shall be recorded. Stadia distances shall be reduced to horizontal distances wherever the correction is large enough to affect appreciably the determination of the height of the object.

5.2.3 Location of obstructions. The horizontal location of each obstruction shall be determined by either (a) identification on a photograph, or (b) identification on a map, or (c) instrument methods. The accuracy of the location shall conform to the horizontal tolerances noted in 5.1. All obstructions should be shown on a photograph or map to aid in determining an adequate density and distribution. An obstruction that has been located by instrument methods need be only approximately identified on the photograph or map and shall be shown in colored pencil only. The feature should be labeled, however, so that it will not be mistaken for a point that has been positively identified on the photograph or map.

6.- FIELD COMPUTATIONS

6.1 Computations required. Generally only those field computations should be made that are required to ensure that the field work meets the accuracy requirements of these instructions. The field computations shall include:

1) Elevations obtained by leveling;

2) Means of vertical and horizontal angle readings;

3) Local control triangles;

4) Elevations of obstructions.

6.2 Checking and initialing. The following operations shall be checked by a second person and initialed: the level records; the determination of the mean of the vertical and horizontal angle readings; and the transcribing of data from record book to computation form.

6.3 Rejection of observations. After completing the necessary check computations, any field work that does not meet the accuracy requirements of these instructions shall be rejected, and repeated until satisfactory results are obtained. Rejected observations or computations shall be lightly marked over with a large "R" and cross-referenced to the page showing the accepted work.

6.4 Summary report. A summary report shall be prepared for each survey. The report shall contain any useful information that cannot be shown conveniently in the other records. Changes that are proposed or construction underway at the airport, such as new runways or hangars, changes in lighting, etc., shall be noted in the summary report. Any peculiar problems or conditions encountered during the survey shall also be described, such as unusual methods employed, discrepancies found in data and their solutions, etc.

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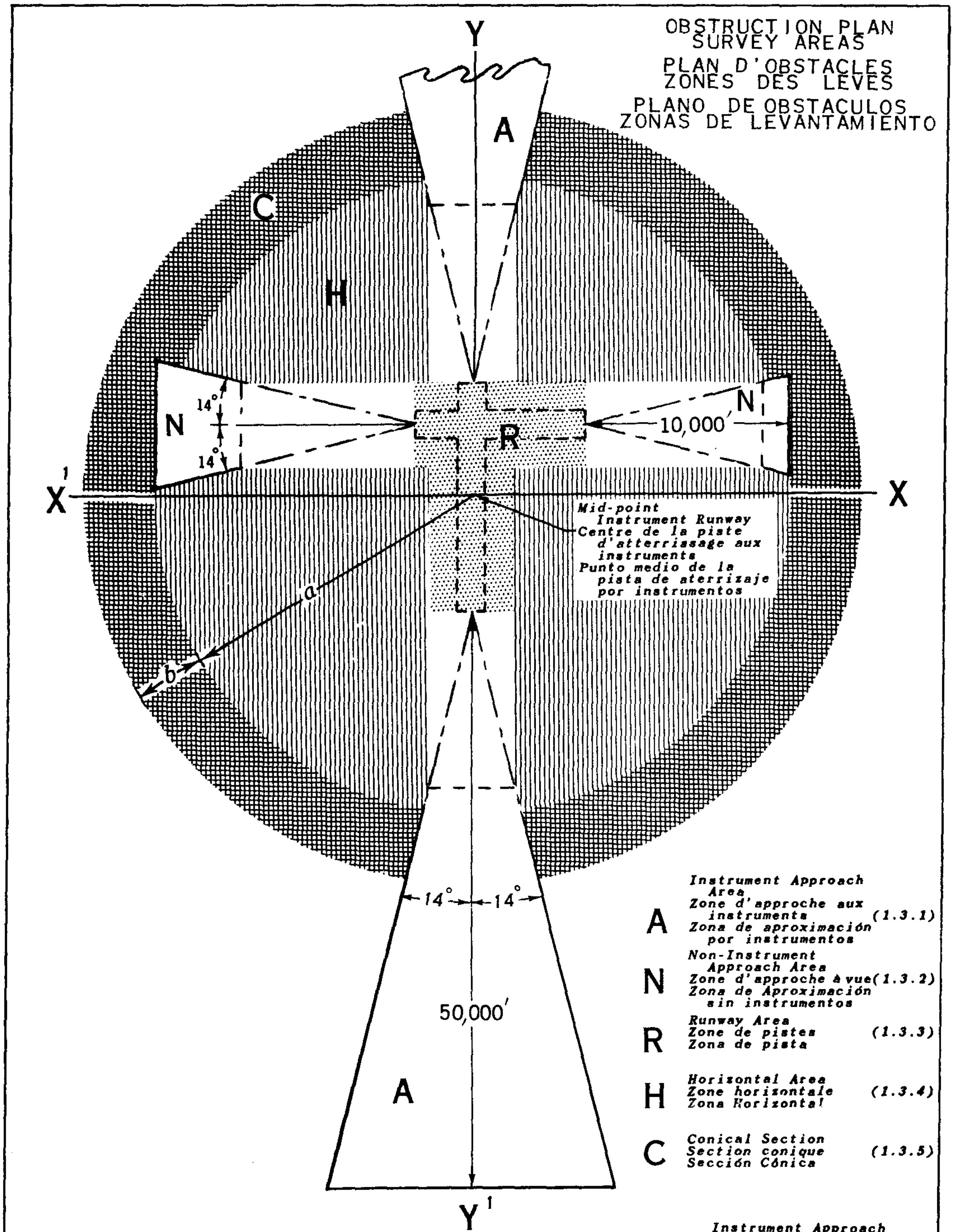

Survey Type / Type de leve / Levantamiento Tipo	a	b	Instrument Approach Glide Angle / Approche aux instruments Angle de descente / Angulo de planeo de Aproximación por Instrumentos
I	13,000'	7,000'	100 : 1½
II	10,000'	5,000'	50 : 1

M-2662-12(2)

PLATE
PLANCHE 1
LAMINA

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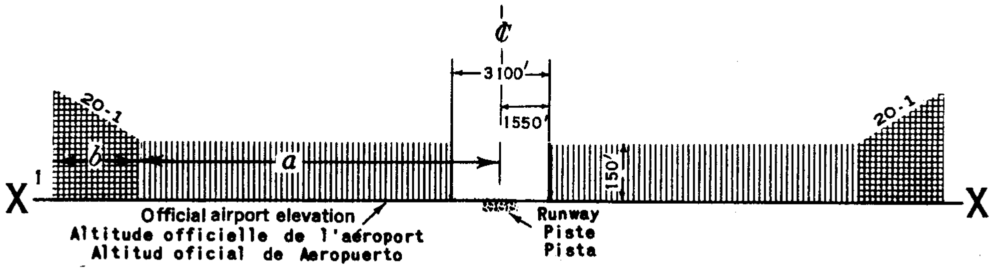
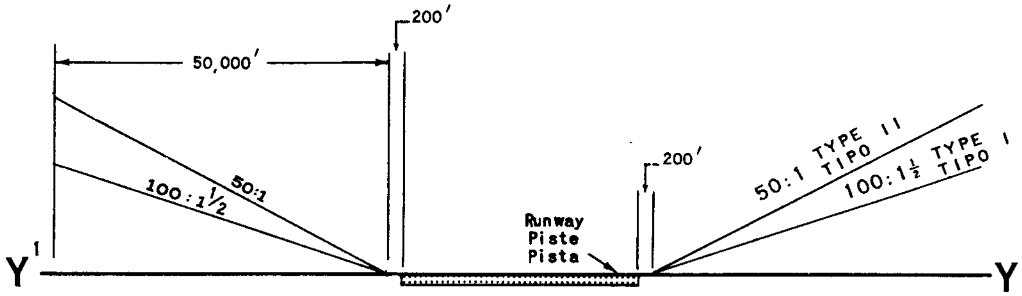
OBSTRUCTION PLAN
VERTICAL SECTIONS

PLAN D'OBSTACLES
SECTIONS VERTICALES

PLANO DE OBSTACULOS
SECCIONES VERTICALES



SECTION
SECCION X'-X



SECTION
SECCION Y'-Y

M-2662-12(2)

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The attached reduction copies of Obstruction Plans produced by the U.S.A. are followed by the French and Spanish translations of the general notes, terms and abbreviations appearing on these plans.

Les reproductions ci-jointes, à échelle réduite, de plans d'obstacles publiés par les Etats-Unis sont accompagnées des traductions française et espagnole des notes générales, des termes et des abréviations figurant sur ces plans.

Los ejemplares adjuntos (en escala mas reducida) de los Planos de obstaculos publicados por los E.U.A., van acompanados de las versiones espanola y francesa de las notas generales, términos y abreviaturas que aparecen en ellos.

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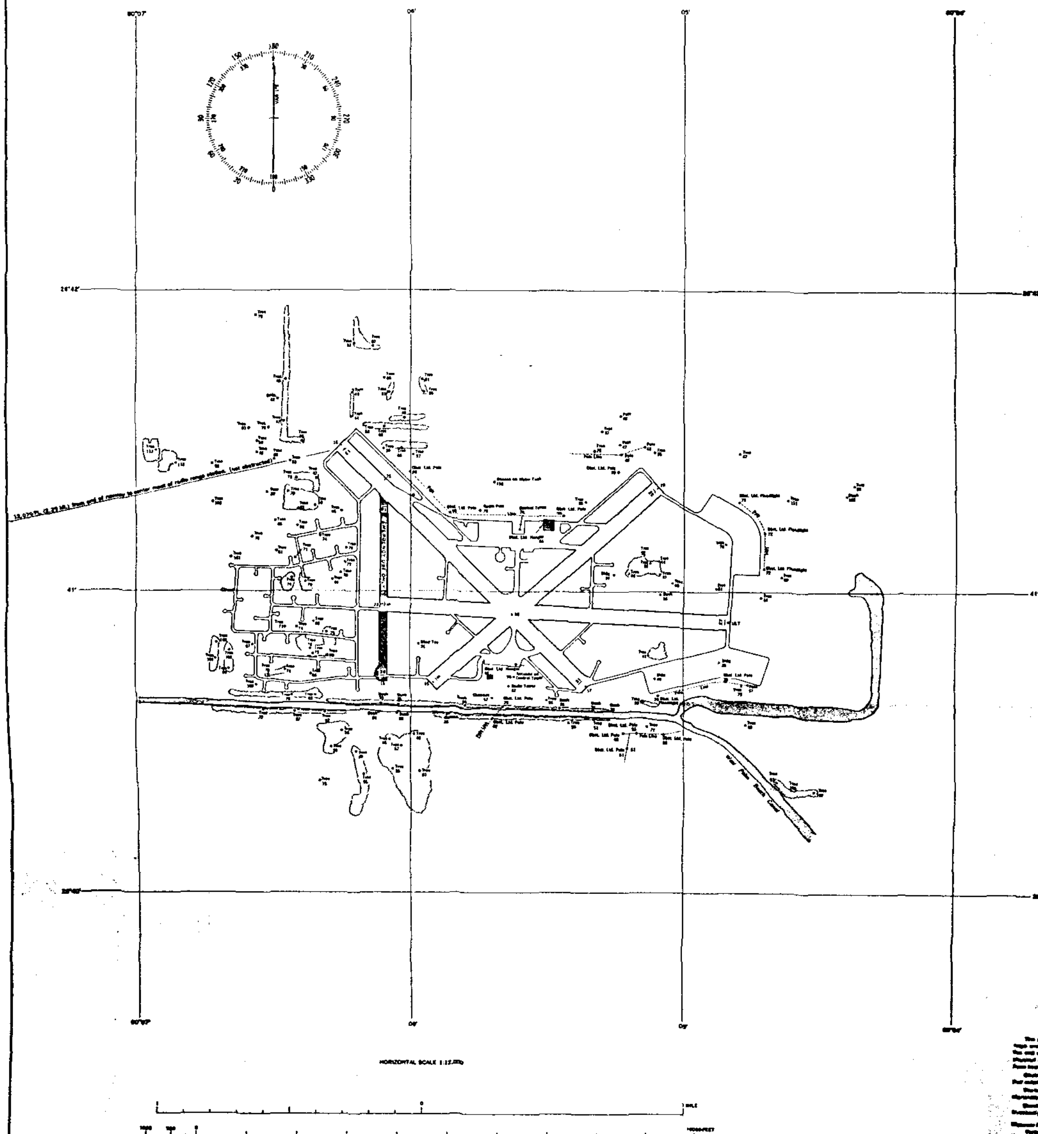

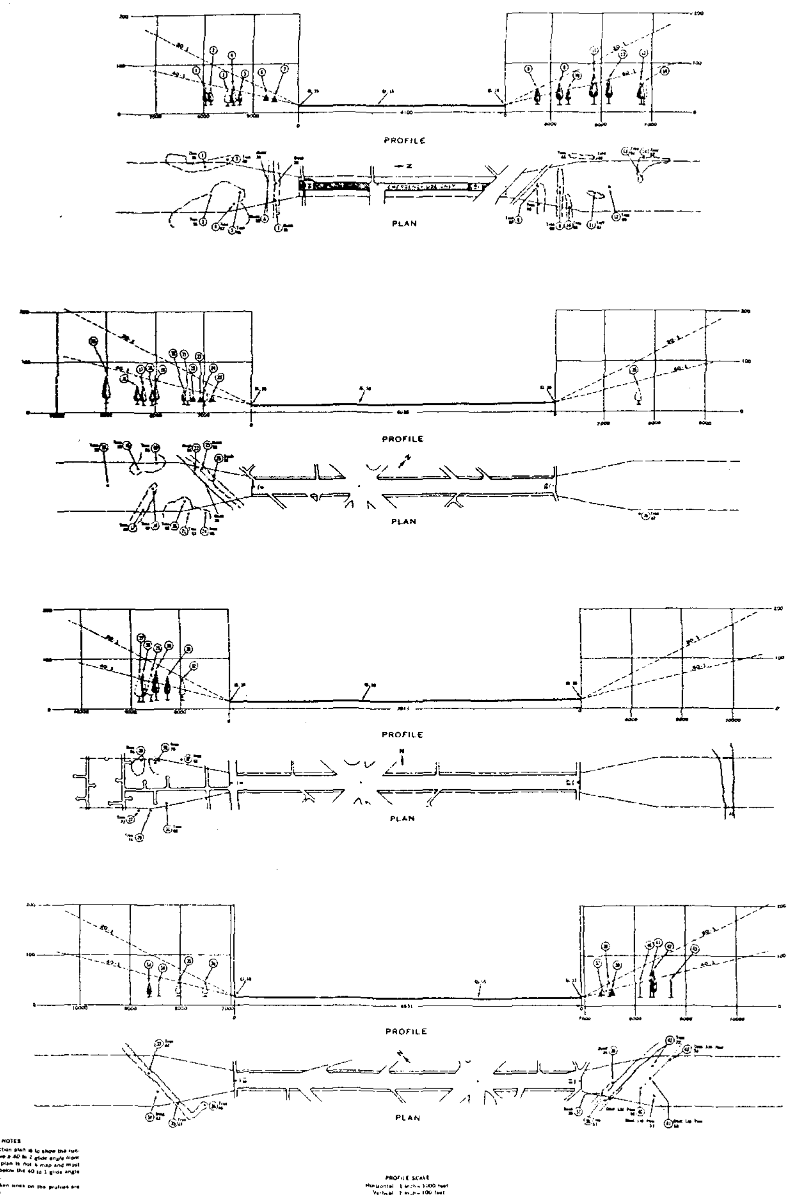

GENERAL NOTES

[illegible] of the obstruction plan is to show the run[illegible] and the obstructions above a 40 to 1 glide angle from [illegible] runways. This plan is not a map and most [illegible] features below the 40 to 1 glide angle [illegible]ionally omitted.

[illegible] shown by broken lines on the profiles are [illegible] approach zones.

[illegible] point of the usable landing area is shown by a [illegible] considered the official elevation of the airport.

[illegible] are in feet above mean sea level and were de[illegible] methods to give the following accuracies:

[illegible]	Elevation tolerance
[illegible]	1 Foot
[illegible]	3 Feet
[illegible]	5 Feet

[illegible]

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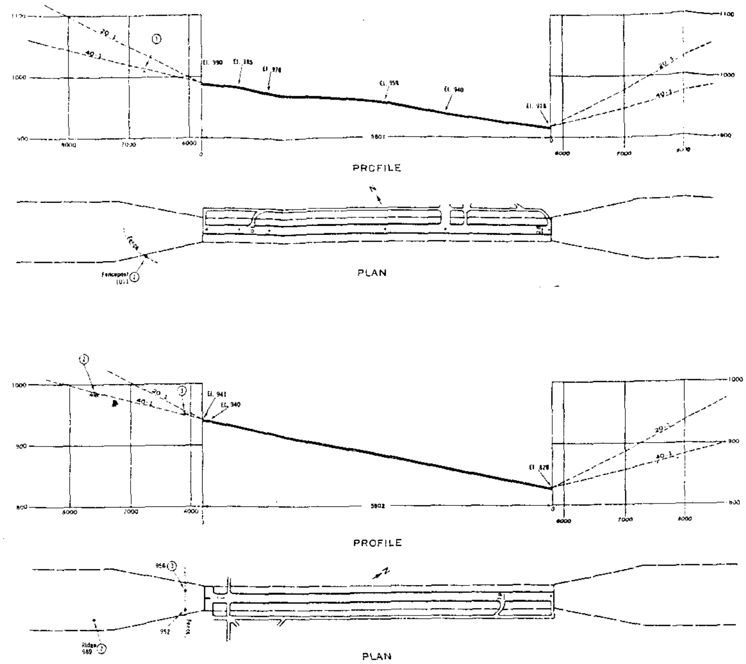
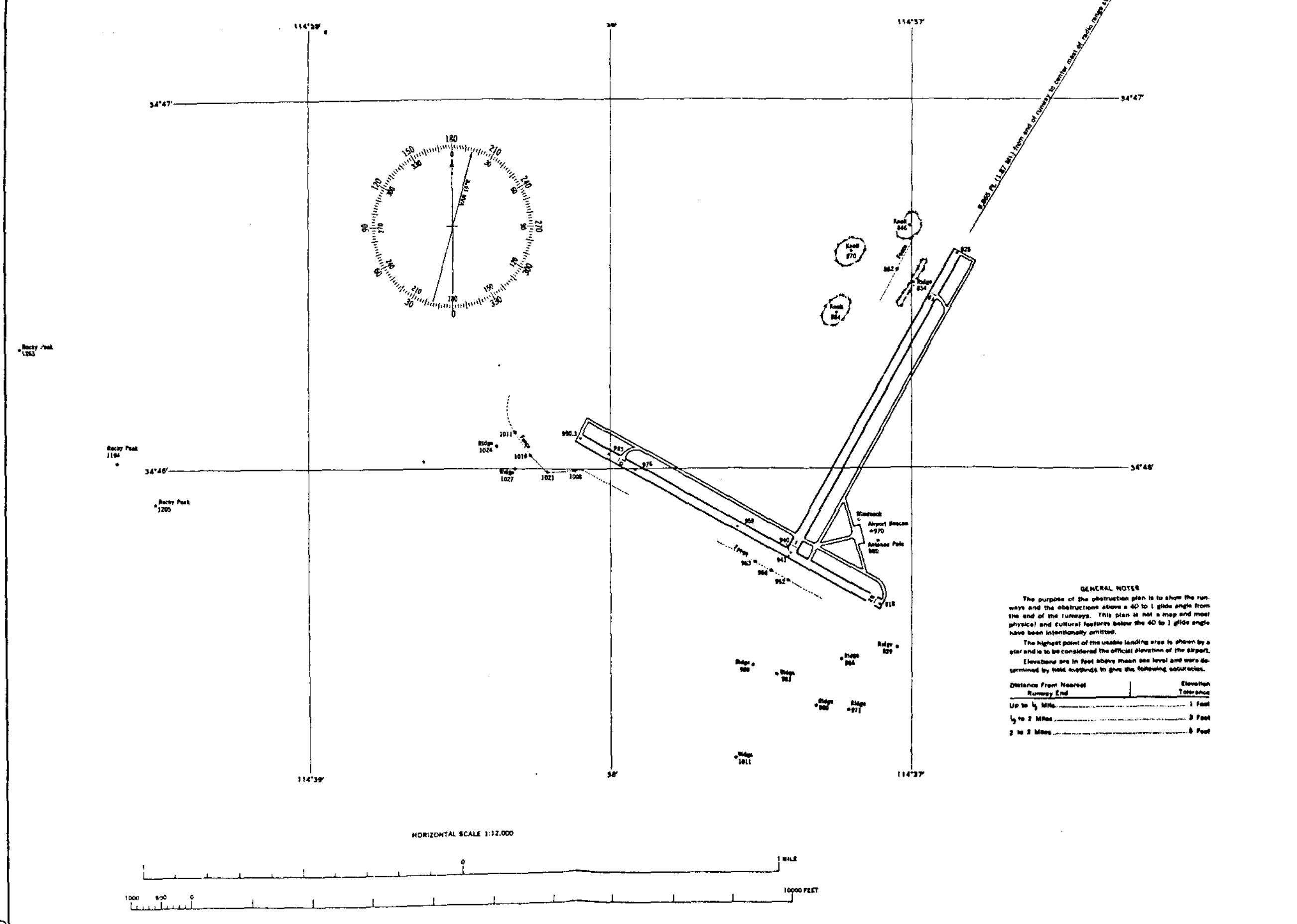
AIRPORT OBSTRUCTION PLAN AND PROFILE
NEEDLES AIRPORT, NEEDLES, CALIF.



GENERAL NOTES

Obstructions shown by broken lines on the profiles are just outside the approach zones. Elevations are in feet above mean sea level.

Horizontal scale 1 inch=1000 feet.
Vertical scale 1 inch=100 feet.



GENERAL NOTES

The purpose of the obstruction plan is to show the runways and the obstructions above a 40 to 1 glide angle from the end of the runways. This plan is not a map and most physical and cultural features below the 40 to 1 glide angle have been intentionally omitted.

The highest point of the usable landing area is shown by a star and is to be considered the official elevation of the airport.

Elevations are in feet above mean sea level and were determined by field methods to give the following accuracies.

Distance From Nearest Runway End	Elevation Tolerance
Up to ½ Mile	1 Foot
½ to 2 Miles	3 Feet
2 to 3 Miles	5 Feet

Surveyed and compiled by the Coast and Geodetic Survey
U. S. Department of Commerce according to specifications
by the Civil Aeronautics Administration
Field Surveys— January 1948
Published— April 1948

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PALM BEACH INTERNATIONAL AIRPORT
WEST PALM BEACH, FLA.
OP-449

GENERAL NOTES

The purpose of the obstruction plan is to show the runways and the obstructions above a 40 to 1 glide angle from the end of the runways. This plan is not a map and most physical and cultural features below the 40 to 1 glide angle have been intentionally omitted.

Obstructions shown by broken lines on the profiles are just outside the approach zones.

The highest point of the usable landing area is shown by a star and is to be considered the official elevation of the airport.

Elevations are in feet above the mean sea level and were determined by field methods to give the following accuracies.

Distance From Nearest Runway End	Elevation Tolerance
Up to 1/2 mile	1 foot
1/2 to 2 miles	3 feet
2 to 3 miles	5 feet

NOTES GENERALES

Les plans d'obstacles sont destinés à représenter les pistes et les obstacles dont l'angle de pente, mesuré à partir de l'extrémité des pistes, est supérieur à 1/40. Ce plan n'est pas une carte, la plupart des détails topographiques dont l'angle de pente, mesuré à partir de l'extrémité des pistes, est inférieur à 1/40 ont été omis intentionnellement.

Les obstacles indiqués en tirets sur les profils sont situés juste en dehors des zones d'approche.

Le point le plus élevé de la partie utilisable de l'aire d'atterrissage est indiqué par une étoile et son altitude doit être considérée comme étant l'altitude officielle de l'aérodrome.

Les hauteurs sont exprimées en pieds et se rapportent au niveau moyen de la mer. Elles ont été déterminées par des procédés topographiques avec la précision suivante:

Distance de l'extrémité de piste la plus proche	Tolérance d'altitude
Jusqu'à 1/2 mille	1 pied
de 1/2 à 2 milles	3 pieds
de 2 à 3 milles	5 pieds

NOTAS GENERALES

El objeto del plano de obstáculos es mostrar las pistas y los obstáculos por encima de un ángulo de planeo de 40 a 1, desde el extremo de las pistas. Este plano no es un mapa y la mayor parte de las características físicas y artificiales que están por debajo del ángulo de planeo de 40 a 1 han sido omitidas intencionalmente.

Los obstáculos indicados en los perfiles con líneas de trazos se hallan situados justamente fuera de las zonas de aproximación.

El punto más alto del área de aterrizaje utilizable está indicado con una estrella y debe considerarse como la altitud official del aeropuerto.

Las cotas están expresadas en pies sobre el nivel medio del mar y fueron determinadas empleando procedimientos de campo para dar los grados de precisión siguientes:

Distancia desde el extremo más próximo de la pista	Tolerancia de cota
Hasta 1/2 milla	1 pie
de 1/2 a 2 millas	3 pies
de 2 a 3 millas	5 pies

NEEDLES AIRPORT
NEEDLES, CALIF.
OP-543

GENERAL NOTES

The purpose of the obstruction plan is to show the runways and the obstructions above a 40 to 1 glide angle from the end of the runways. This plan is not a map and most physical and cultural features below the 40 to 1 glide angle have been intentionally omitted.

The highest point of the usable landing area is shown by a star and is to be considered the official elevation of the airport.

Elevations are in feet above mean sea level and were determined by field methods to give the following accuracies.

Distance From Nearest Runway End	Elevation Tolerance
Up to 1/2 mile	1 foot
1/2 to 2 miles	3 feet
2 to 3 miles	5 feet

NOTES GENERALES

Les plans d'obstacles sont destinés à représenter les pistes et les obstacles dont l'angle de pente, mesuré à partir de l'extrémité des pistes, est supérieur à 1/40. Ce plan n'est pas une carte, la plupart des détails topographiques dont l'angle de pente, mesuré à partir de l'extrémité des pistes, est inférieur à 1/40 ont été omis intentionnellement.

Le point le plus élevé de la partie utilisable de l'aire d'atterrissage est indiqué par une étoile et son altitude doit être considérée comme étant l'altitude officielle de l'aéroport.

Les hauteurs sont exprimées en pieds et se rapportent au niveau moyen de la mer. Elles ont été déterminées par des procédés topographiques avec la précision suivante:

Distance de l'extrémité de piste la plus proche	Tolérance d'altitude
Jusqu'à 1/2 mille	1 pied
de 1/2 à 2 milles	3 pieds
de 2 à 3 milles	5 pieds

NOTAS GENERALES

El objeto del plano de obstáculos es mostrar las pistas y los obstáculos por encima de un ángulo de planeo de 40 a 1, desde el extremo de las pistas. Este plano no es un mapa y la mayoría de las características físicas y artificiales que están por debajo del ángulo de planeo de 40 a 1 han sido omitidas intencionalmente.

El punto más alto del área de aterrizaje utilizable está indicado con una estrella y debe considerarse como la altitud oficial del aeropuerto.

Las cotas altimétricas están expresadas en pies sobre el nivel medio del mar y fueron determinadas empleando procedimientos de campo para dar los siguientes grados de precisión:

Distancia desde el extremo más próximo de la pista	Tolerancia de cota
Hasta 1/2 milla	1 pie
de 1/2 a 2 millas	3 pies
de 2 a 3 millas	5 pies

G E N E R A L N O T E S

Obstructions shown by broken lines on the profiles are just outside the approach zones. Elevations are in feet above mean sea level.

Horizontal scale 1 inch = 1000 feet
Vertical scale 1 inch = 100 feet

N O T E S G E N E R A L E S

Les obstacles indiqués en tirets sur les profils sont situés juste en dehors des zones d'approche. Les hauteurs sont exprimées en pieds et se rapportent au niveau moyen de la mer.

Echelle horizontale 1 pouce = 1000 pieds
Echelle verticale 1 pouce = 100 pieds

N O T A S G E N E R A L E S

Los obstáculos indicados en los perfiles con líneas de trazos se hallan situados justamente fuera de las zonas de aproximación. Las cotas están indicadas en pies sobre el nivel medio del mar.

Escala horizontal 1 pulgada = 1000 pies
Escala vertical 1 pulgada = 100 pies

Terms and Abbreviations appearing on these Obstruction Plans	Termes et abréviations figurant sur les plans d'obstacles	Glosario de términos y abreviaturas empleados en estos mapas de obstáculos
El. Elevation	Alt. Altitude	Cota
Radio range station	Radiophare d'alignement	Radiofaro direccional
Ridge	Crête	Cerro
Knoll	Butte	Montículo
Fence	Clôture	Cerca
Rocky peak	Sommet rocailleux	Pico rocoso
Windsock	Manche à vent	Manga - Veleta (manga indicadora del viento)
Airport beacon	Phare d'aéroport	Faro del aeropuerto
Antenna pole	Mât d'antenne	Poste de antena
Tree	Arbre	Arbol
Obst. Ltd. Pole Obstruction lighted pole	Mât avec f. d'obst. Mât avec feu d'obstacle	Mástil con luz de obstáculo
Beacon on water tank	Phare sur château d'eau	Faro en el depósito de agua
Stack/Chimney	Cheminée	Chimenea
Obst. Ltd. Floodlight Obstruction lighted floodlight	Réflecteur avec f. d'obst. Réflecteur avec feu d'obstacle	Proyector de iluminación de obstáculo
Radio pole	Mât de radio	Poste de radio
Control tower	Tour de contrôle	Torre de mando
Obst. Ltd. Hangar Obstruction lighted hangar	Hangar avec f. d'obst. Hangar avec feux d'obstacle	Hangar con luz de obstáculo
Bldg. Building	Bt. Batiment	Edificio
Antenna on control tower	Antenne sur la tour de contrôle	Antena sobre torre de mando
Radio tower	Pylône de radio	Torre de radio
Bush	Fourré	Arbusto
Pole line	Rangée de poteaux	Linea de postes