THE

WAVIONIX

PROCEDURES DESIGNER

VERSION 5

USER'S
MANUAL
JANUARY 1999

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INSTALLATION

After installing Autocad version 12, insert the **Wavionix Procedure Designer** disk into your CD-ROM drive; change to the appropriate drive and double click on "install". Follow the on screen prompts.

Autocad set-up

At the Autocad command prompt, type "MENU". Load the appropriate menu, "WPD5V14" or "WPD5MAP" depending on the version of Autocad you are using. These menus should now be in the sub directory "WPD5" of the main directory (C:\WPD5). This menu incorporates the Autocad utilities and the **Wavionix Procedure Designer**. Always start a new drawing with the **Wavionix** template 1WPD5.DWT. If this template is not in the Autocad template directory it can be found in the WPD5 directory. The 1wpd5 template has certain Autocad system variables changed. These changes are needed for efficient procedures design for example, the standard Autocad has 0 degrees in the easterly direction and angles are calculated in an anticlockwise direction, which is exactly opposite to what is required for aviation navigation
The system variables changed are: -

ANGBASE	NORTH	LUPREC	4
ANGDIR	1	MENUECHO	0
APERTURE	10	OSMODE	0
AUNITS	0	PICKBOX	6
AUPREC	4	SKPOLY	1
CMDECHO	1	SNAPMODE	0
COORDS	1	UNITMODE	0
EXPERT	0	FILEDIA	1
LUNITS	2		

The **Wavionix** Startup command can be used at **any time** in a future drawing session to set up the above system variables.

Tablet

Refer to the Autocad manual for set-up and use of a digitiser. The **Wavionix** Tabwpd command can be used to facilitate digitiser configuration.

Bonus Menu

If at any stage you would like to access the Autocad R14 bonus menu, type "bonusmenu" at the Autocad command prompt.

The final part of the set-up is not an actual change but a realisation by the user that the drawing units in the actual procedure design drawings are in **meters** and that all routes and tracks should be drawn in true direction not magnetic. All calculations done by the **Wavionix Procedure Designer** are on the assumption that all distances drawn are in **meters** unless otherwise specified.

GENERAL

Manual Lay-out

Items that are new to version five of the **Wavionix Procedures Designer** are denoted with a version five symbol.

V5

Wavionix commands can be accessed from the **Wavionix** toolbars and the drop down **Wavionix** menu. The heading for each command explanation in this manual has the toolbar access symbol on the left and the position of the command, in descending order, in the **Wavionix** drop down menu on the right. This can be seen in the following example of the heading of the Points to a File command.

POINTS TO A FILE   TOOLS

+→F   FILE

V5   POINTS->FILE

Text............................
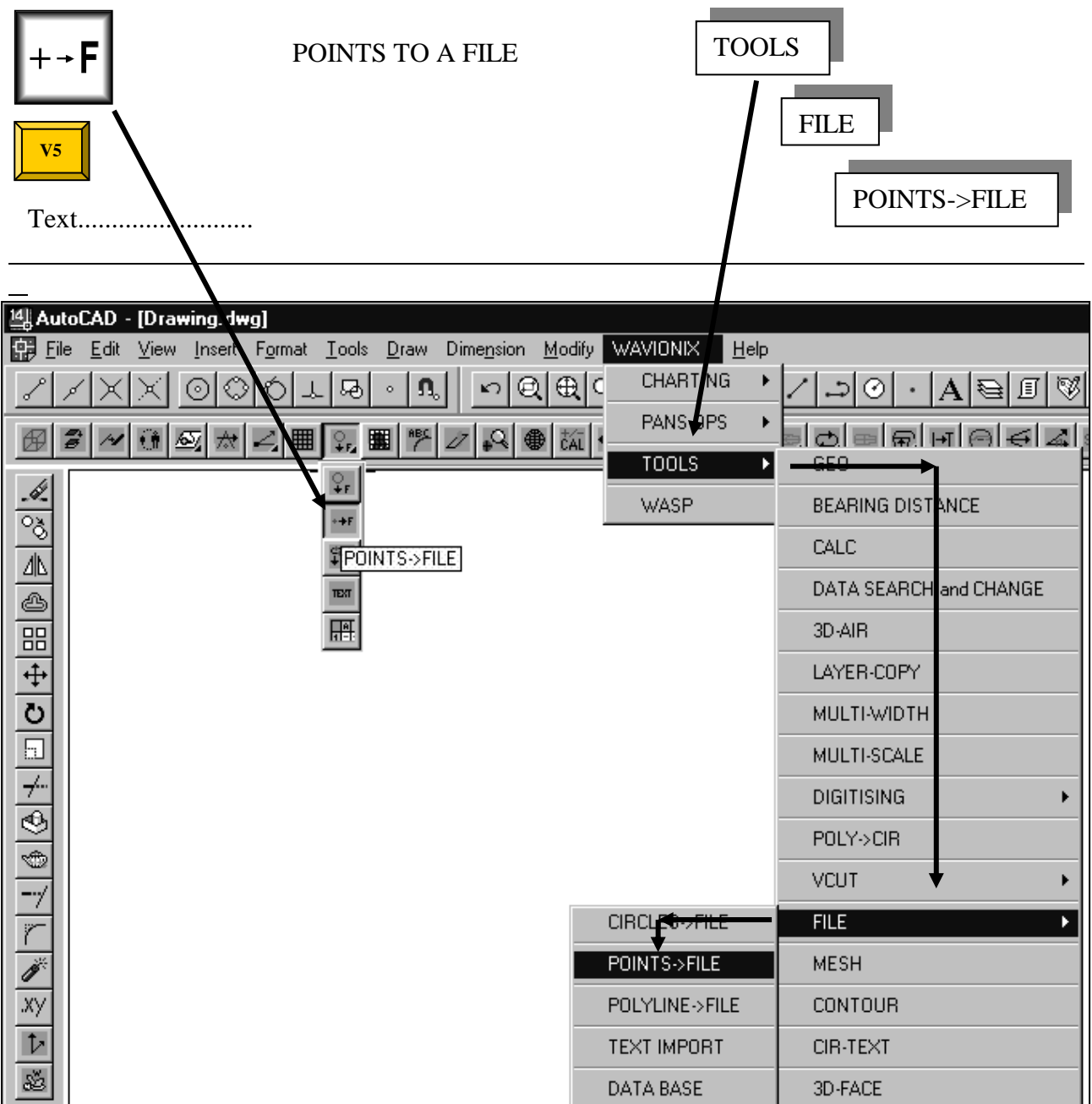
Dialogue Boxes

   Extensive use is made of dialogue boxes throughout the **Wavionix Procedures Designer**. Values can be entered manually in the boxes provided or if possible a button can be pushed to obtain the value from the computer graphics screen. Construction parameters can be checked prior to pushing the OK button. If the program is later reactivated in the same drawing session the previous values and configuration is available. The dialogue box can be moved to any position on the screen by picking the title of the dialogue box and dragging it to the new position. Note that the appearance of the dialogue boxes could vary slightly from what is shown in this manual depending on the graphics platform used.
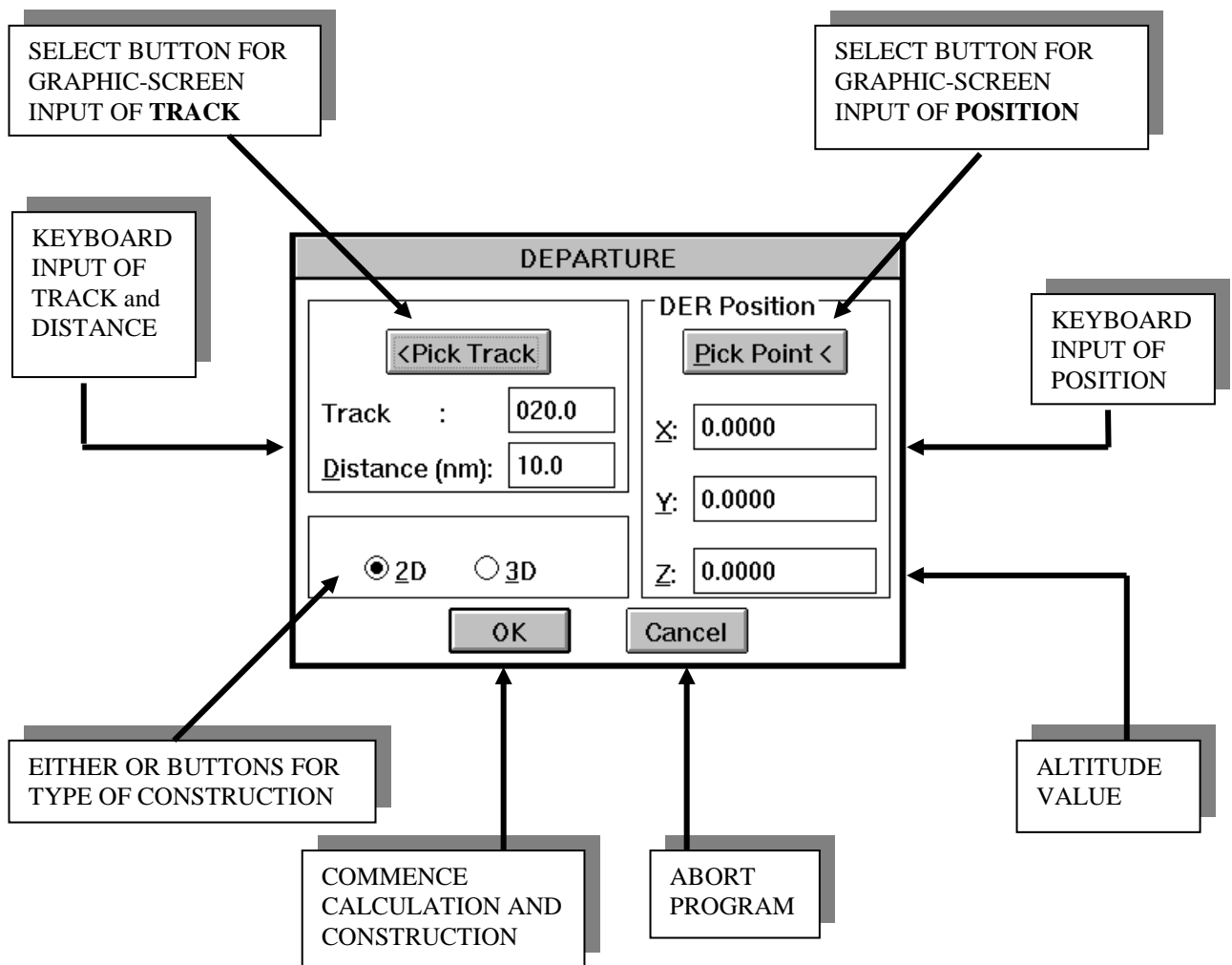
New Autocad users

   Users that are unfamiliar with Autocad would be advised to read the Autocad users manual in regards to the following Autocad commands.

DRAWING ENTITIES	**ACTION COMMANDS**	**EDIT COMMANDS**	**INQUIRY COMMANDS**
Line	Snap	Change	Distance
Polyline	Zoom	Modify	Angle
Arc	Scale	Pedit	List
Circle	Rotate	Edit text	ID
Point	Offset	Explode	
Dtext	Move	Layer	
Blocks	Mirror	Undo	
	Copy	Erase	
	Extend		
	Trim		

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Microsoft and Windows are the registered trademarks of Microsoft Corporation.

PROCEDURES DESIGN PROGRAMS
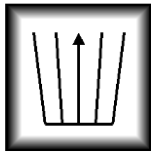
PANS-OPS

RADIALS AND TRACKS VOR, NDB

RADIAL

This program will draw the various navigational aid tolerances for a VOR and an NDB.

The dialogue box for the Radial program is divided into three sections Navigational Aid, Type of Tolerance, and 2D/3D Construction.

In the Navigational Aid section select the type of aid either a VOR or an NDB. The position of the navigational aid can be entered either as X and Y values or the user can obtain a position from the graphics screen, by selecting the >Pick Position< button. In the Type of Tolerance section select the tolerance required. Refer to ICAO Doc. 8168 to determine which tolerance to use in a specific situation. In the appropriate boxes, enter the outbound Radial/Track in degrees and Starting Distance and Finish Distance in nautical miles. Selecting >Pick Track< enables you to pick any two points from the graphics screen to determine the angle of the track. Selecting >Pick Distance< enables you to determine the Starting Distance or Finishing Distance by picking a point away from the facility.

RADIAL OUTPUT (AREA SPLAY)
2-DIMENSIONS

The output in the two dimensional (2D) construction are lines and so can be erased, extended and trimmed as needed. Three-dimensional construction is only available when drawing an Area Splay tolerance (i.e. primary and secondary areas).

When 3D is selected, the dialogue box enables you to edit three other input edit boxes. The aircraft Starting Altitude and the Primary minimum obstacle clearance (MOC) determine the initial placement of the obstacle protection surfaces in three-dimensional space. These protection surfaces can be given a longitudinal slope in the direction of the track if required. The longitudinal slope of the surfaces can be either positive or negative depending on the whether the percentage Altitude Change is positive or negative (i.e. the aircraft is climbing or descending).

AREA SPLAY
3-DIMENSIONAL

STARTING
ALTITUDE   PRIMARY
MOC

OBSTACLE
PROTECTION
SURFACES ·

ALTITUDE
CHANGE

PENETRATING
OBSTACLE
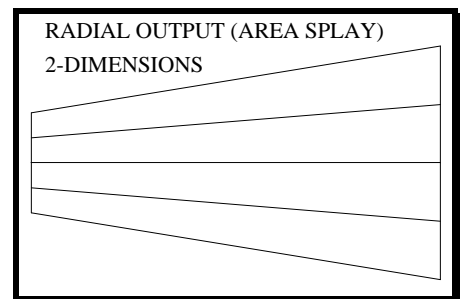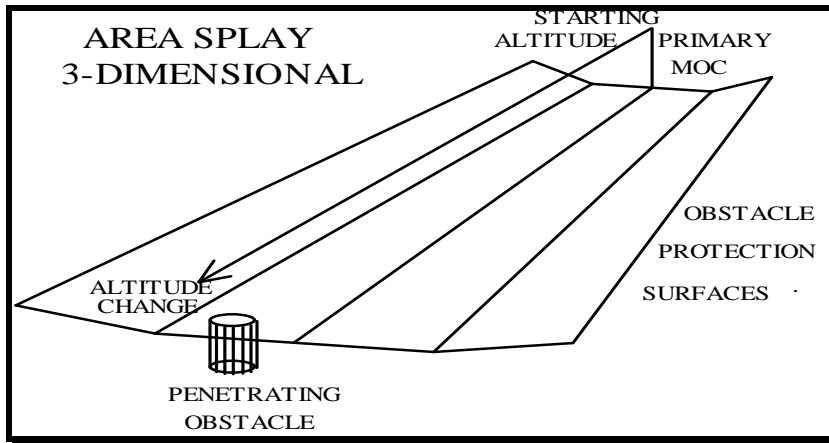
The subsequent three-dimensional construction is comprised of 3-dimensional surfaces and a 3-dimensional centre line. The centreline represents not just the aircraft's track but also its altitude and the minimum obstacle clearance. Obstacle penetration of the 3-dimensional surfaces can be checked with an Autocad "shade" or "hide" command.
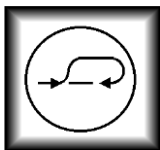
VISUAL CIRCLING

PANS-OPS

VISUAL CIR

This program will calculate a circle representing the visual circling protection area, for any category of aircraft.
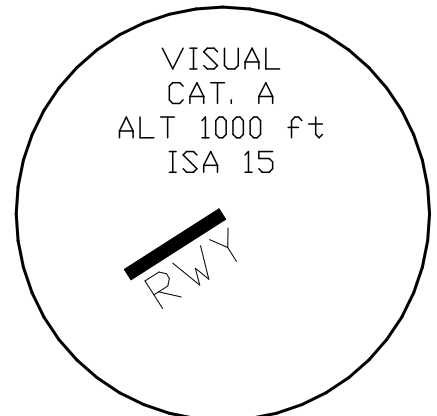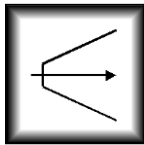

VISUAL CIRCLING

Threshold Position

Pick Point<

X :   9085.8

Y :   14824.2

Altitude (ft)   1000

ISA   (deg)   15

OK   Cancel

Aircraft
Category

◉ A
○ B
○ C
○ D
○ E

Input the co-ordinates of the threshold or pick a point from the graphics screen. Select the Aircraft Category by clicking on the appropriate button, only one category can be selected at a time. Enter the Altitude in feet and the ISA value in degrees, from the keyboard. The Altitude and ISA value determine the true airspeed, and so define the visual circling radius. Refer to ICAO Doc. 8168 Chapter 8 for the placement and use of the visual circling protection areas.

The parameters used in the construction of the visual circling protection area are written on a new layer "VCTEXT", for referral at a later date.

The values for the radius of the visual circling area vary slightly with the results as tabulated on ICAO Doc. 8168 Chapter 8 page 3.63. This is because of the different units being used i.e. knots, feet, meters and the conversion between them with-in the program.

VISUAL
CAT. A
ALT 1000 ft
ISA 15
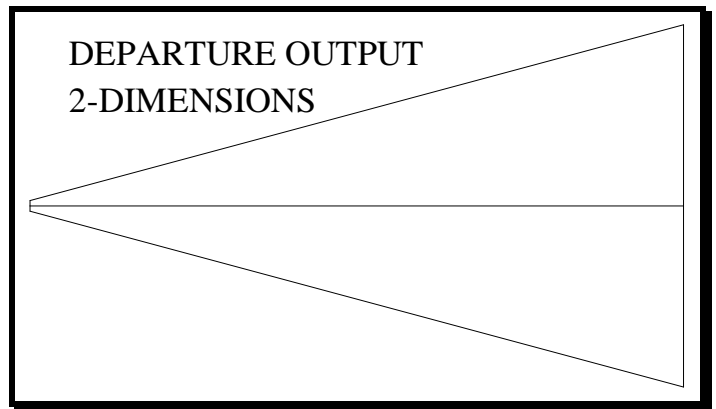
RWY

DEPARTURE PROTECTION AREA

PANS-OPS

DEPARTURE

The departure program will draw in two or three dimensions the departure obstacle protection area for a departure. Two-dimensional drawings are easier to trim and attach to navigational aid tolerances or turning areas. However three dimensions are extremely useful in checking a large selection of obstacles for protection surface penetration.

Using the dialogue box, the position of the Departure end of the runway (DER) can be entered either as X, Y and Z values or the user can pick a point from the graphics screen. The Z value represents the altitude of the departure end of the runway (DER) and is only needed in three-dimensional construction. The outbound Track can be entered along with the required Distance in nautical miles. Selecting Pick Track enables the user to pick two points on the graphics screen (not necessarily the actual track) to determine the track/angle.

The output in the two dimensional (2D) construction is a series of lines and so can be erased, extended and trimmed as needed.

If a 3D departure is required a further dialogue box, 3-Dimensional Construction, is activated. The MOC Change is the minimum obstacle clearance variance with distance and can not be reduced below the default value of 0.8%.

The Procedure Design Gradient is the required percentage climb-out gradient of the departure. The resulting three dimensional construction is comprised of 3-dimensional surfaces and a 3-dimensional centre line. The centreline represents the aircraft's climb-out profile. The 5m DER crossing height is automatically added to the **Z** value (height) of the DER position. Obstacle penetration of the 3-dimensional surfaces can be checked with an Autocad "shade" or "hide" command.

HOLDING PATTERN - RACE TRACK

PANS-OPS
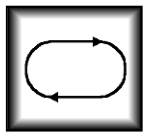
HOLD

RACE TRACK
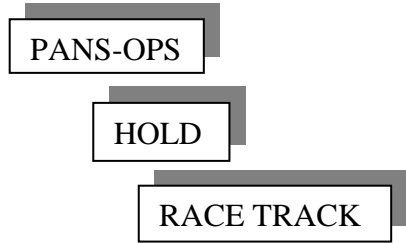
This program will draw a holding pattern **template** at any altitude and speed. Refer to ICAO Doc. 8168 and Doc. 9371 (Template Manual), for a detailed description on the use of templates to establish obstacle protection areas for holding patterns.

RACE TRACK TEMPLATE

Calculation Parameters

IAS   (kts)   `210`

Altitude   (ft)   `10000`

ISA   (deg)   `15`

Time   (min)   `1`

Insertion Point

Pick Point <

X: `0.00`

Y: `0.00`

Orientation

In-bound Track: `150`   <Pick Track

Turns   ○ Left   ⦿ Right

OK   Cancel

The Calculation Parameters section of the dialogue box determines the size of the subsequent holding template. The point where the template is placed in the drawing is decided by the values in the Insertion Point section. These grid values can be entered manually or a point can be picked from the graphics screen, by selecting the Pick Point button. The Orientation section establishes the alignment of the template. The in-bound track (not radial) to the holding position can be entered manually or any two points from the graphic screen can be picked, by selecting the Pick Track button. The two Turns buttons Left and Right allow the construction of either a left-hand or a right-hand holding pattern.

Selecting the OK button causes the program to calculate the wind value based on the formulas in ICAO Doc. 8168. Once the ICAO wind value is obtained a further dialogue box titled WIND is displayed, showing the calculated results. The wind value in knots can be changed if a statistical wind value is available. Entering ↵ RETURN will cause the program to recalculate the km/h value, while the OK button will cause the wind value in Kt's to be used in the template calculations.

WIND

The ICAO Calculated Wind is

`66.7`   Kts   123.6   Km/h

OK

IAS 210 kts
TAS 251 kts
ALT 10000 ft
1.00 min
ISA 15
WIND 66.7 kts
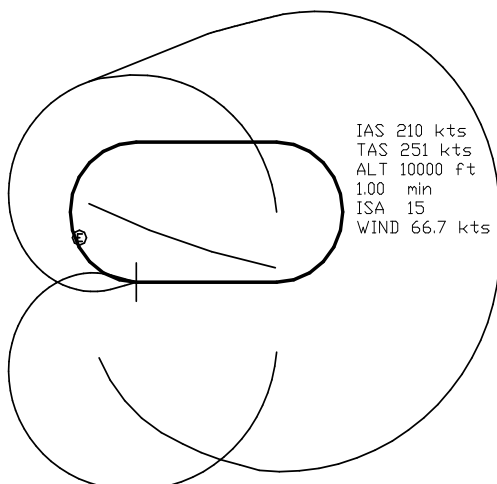
Arcs drawn by the program are a succession of minute straight lines. This enables the user to snap to the exact points on the template. The constants used or calculated by the program are written on a new layer "HTEXT" for reference at a later date.

The template can be copied a number of times and placed at various positions around the holding fix tolerance area. Portions of the template can be rotated, trimmed and positioned accordingly to determine protection of various entry procedures. A polyline can be drawn, on a separate layer, around the entire possibility area and so establish the obstacle protection area for the holding pattern.

PANS-OPS

V5
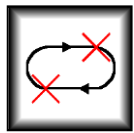
VOR/DME RACE TRACK HOLDING
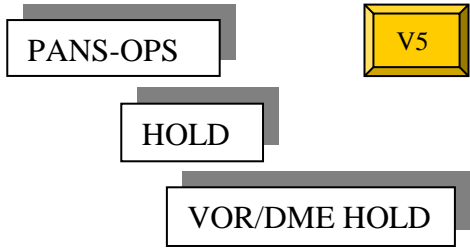
HOLD

VOR/DME HOLD

This program will construct the obstacle protection areas for a VOR/DME holding pattern.

The Calculation Parameters section of the dialogue box determines the size of the subsequent holding protection area. Either a standard ICAO or United Kingdom statistical wind can be selected.

The position of the VOR/DME facility can be entered manually or a point can be picked from the graphics screen. The Z co-ordinate value is the altitude in meters of the VOR/DME facility above mean sea level and combined with the aircraft altitude in feet is used in the computation of the DME tolerance.

The required entry sectors can also be constructed by selecting the appropriate entry in the Draw Entry Areas section. If no radial is entered in the radial box for a Reciprocal Entry, the program will calculate the required entry radial. If the entered radial is incorrect the program will return an error warning and change the entry radial.

ERROR

The direct entry radial is to close or to far from the inbound holding radial changing the radial to 101

OK

The Orientation section of this program determines the position and orientation of the resulting holding pattern

ERROR

Out-bound DME Distance is too close. Increasing it to 7.0 (nm)

OK
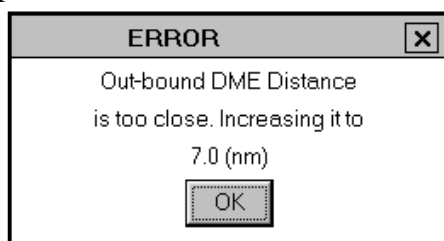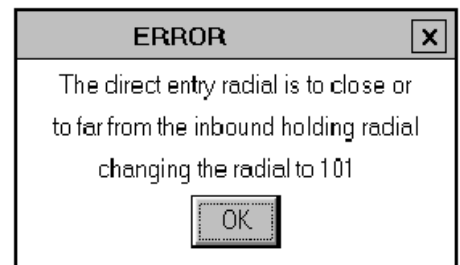
The DME orientation section establishes the distance of the holding pattern from the VOR/DME station. If either of the distances are to close or within the DME over-head then the program will return an error and change the DME distances

The Draw in section allows the resulting construction to be drawn in two or three dimensions.
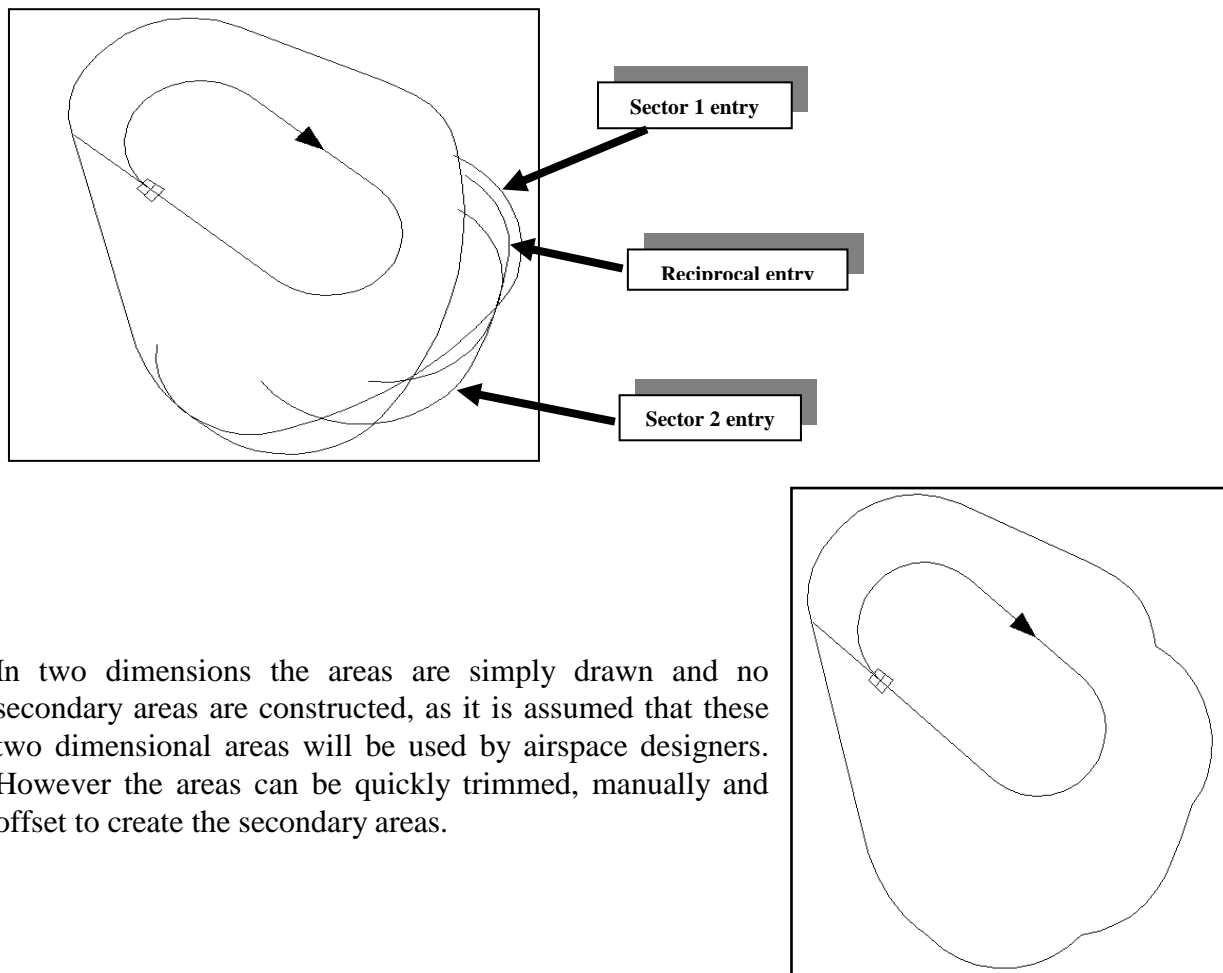
In two dimensions the areas are simply drawn and no secondary areas are constructed, as it is assumed that these two dimensional areas will be used by airspace designers. However the areas can be quickly trimmed, manually and offset to create the secondary areas.

   In three dimensions the entire area is constructed at the aircraft altitude minus the entered Minimum Obstacle Clearance (MOC). The secondary areas are also determined and constructed at the correct altitudes

PANS-OPS

HOLD

PROC-TURN
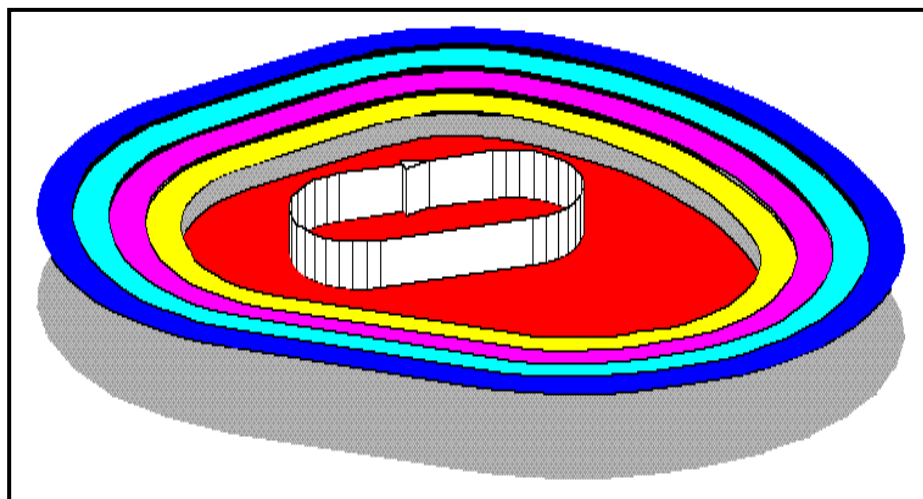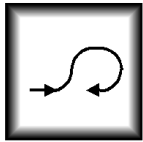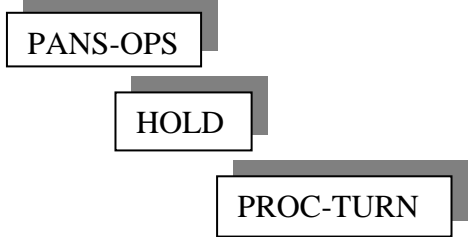
PROCEDURE TURN

The obstacle protection area **template** for a procedure turn is drawn using this command.

PROCEDURE TURN TEMPLATE

Calculation Parameters

IAS   (kts)   250

Altitude   (ft)   10000

ISA   (deg)   15

Time   (min)   1.25

Insertion Point

Pick Point <

X: 0.00

Y: 0.00

Orientation

In-bound Track :   090   <Pick Track

Major Turn   ○ Left   ● Right

OK   Cancel

The Procedure Turn Template dialogue box is the same as that used by the Race Track holding pattern program. Refer to that program, for an explanation of the use of the Procedure Turn Template dialogue box.

Selecting the OK button causes the program to display the Wind dialogue box; an explanation of this dialogue box is also detailed in the Racetrack holding pattern section.

WIND

The ICAO Calculated Wind is

66.7   Kts   123.5   Km/h

OK

PROCEDURE TURN
IAS 250 kts
TAS 299 kts
ALT 10000 ft
1.25 min
ISA + 15
WIND 66.7 kts
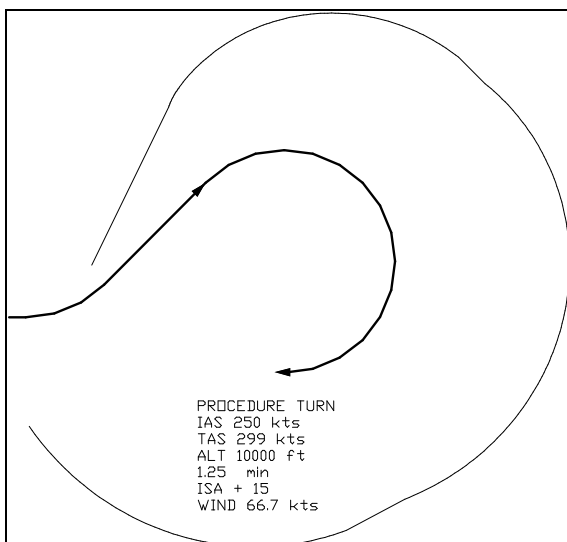
Once the wind value has been obtained the program will calculate and draw the obstacle protection template. All lines are polylines and the text, for future reference, is written on the Layer "PTEXT".

BASE TURN

PANS-OPS

HOLD

BASE-TURN

This program will draw a base turn **template** at any altitude and speed. Refer to ICAO Doc. 8168 and Doc. 9371 (Template Manual), for a detailed description on the use of templates to establish obstacle protection areas for base turns.

BASE TURN TEMPLATE

Calculation Parameters

IAS (kts)	185
Altitude (ft)	5000
ISA (deg)	15
Off-Set Entry Angle (deg)	30

Navigational Aid

⊙ VOR   ○ VOR/DME   ○ NDB   ○ NDB/DME

Position

‹Pick Position

X	:	0.0
Y	:	0.0
Z (Altitude M):		0.0

Limit Turn

⊙ Time   Mins   1
○ DME   NM

Orientation

In-bound Track : 270   ‹Pick Track

Major Turn   ○ Left   ⊙ Right

OK   Cancel

The Calculation Parameters section of the dialogue box establishes the size of the base turn template. The Off-Set Entry Angle is used in the construction of the and usually has a standard value of 30 degrees.

The overhead facility is can be a VOR, a VOR/DME, an NDB or an NDB/DME as selected in the Navigational Aid section. The position of the facility, which is the insertion point of the base turn, can be entered manually or a point can be picked from the graphics screen. Obviously if the grid co-ordinates of the position are entered they must be in meters. The Z co-ordinate value is the altitude in meters of the navigational aid above mean sea level and combined with the aircraft altitude in feet determines the over-head tolerance of the facility.

Base turns can be limited, in the Limit Turn section, by either a time in minutes or a DME distance in nautical miles. Limiting the base turn by a DME distance is only available if a VOR/DME or an NDB/DME is selected as the facility in the navigational section.

The Orientation section establishes the alignment of the template. The in-bound track (not radial) to the facility can be entered manually or any two points from the graphic screen can be picked, by selecting the Pick Track button. The Major Turn buttons, Left and Right, allow the construction of either a left-hand or a right-hand base turn procedure.

Selecting the OK button causes the program to calculate the wind value based on the formulas in ICAO Doc. 8168. Once the ICAO wind value is obtained a further dialogue box titled WIND is displayed, showing the calculated results.

The wind value in knots (inside the box) can be changed if a statistical wind value is available. Entering ↵ RETURN will cause the program to recalculate the km/h value, while the OK button will cause the wind value in Kt's to be used in the template calculations.

```
┌─────────────────────────────┐
│            WIND             │
├─────────────────────────────┤
│   The ICAO Calculated Wind is  │
│   ┌──────┐                   │
│   │ 66.7 │  Kts    123.6  Km/h │
│   └──────┘                   │
│          ┌──────┐            │
│          │  OK  │            │
│          └──────┘            │
└─────────────────────────────┘
```

In the following base turn construction diagram the area designations have been added later for clarification.

NAV-AID VOR
IAS 185 kts
TAS 208 kts
ALT 6000 ft
OUTBOUND 2.0 min.
ISA + 15
WIND 58.8 kts
ANGLE 22°
ENTRY ANGLE 30.0°

PRIMARY AREA
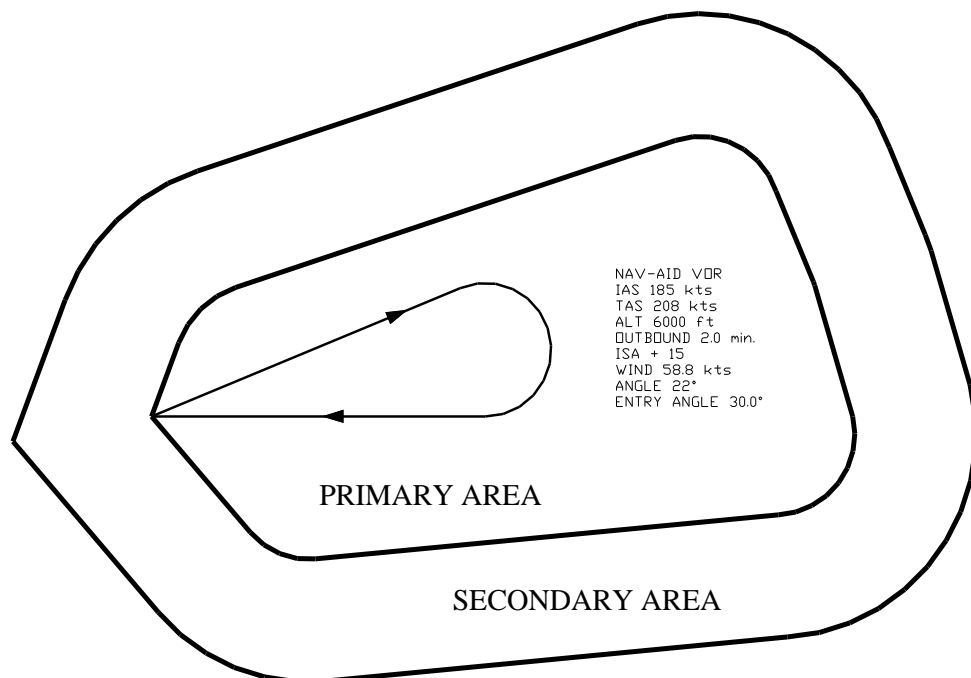
SECONDARY AREA

The constants used or calculated by the program are written on a new layer "BTEXT" for reference at a later date. The constructed primary and secondary areas are drawn as polylines, the secondary area being 4600 m from the primary area
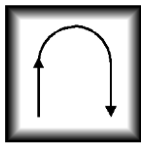
NOMINAL TURN

PANS-OPS

TURN

NOMINAL

The nominal track that an aircraft follows while making a turn is important in determining the succeeding track or radial to be followed. It is also useful in airspace utilisation and establishing whether a procedure will infringe noise abatement areas.

NOMINAL TURN CONSTRUCTION

Calculation Parameters

IAS	(kts)	210
Altitude	(ft)	10000
ISA	(deg)	15
Bank angle (deg)		15

Start Point

Pick Point <

X: 0.00

Y: 0.00

☒ Departure (IAS + 10%)

Orientation

Radial/Track: 150   <Pick Track

Direction of turn   ⦿ Left   ◯ Right

OK   Cancel

In the Calculation Parameters section enter the Indicated Air Speed (IAS), Altitude, International Standard Atmosphere (ISA) and the Bank angle. The Start Point section allows the picking of the start point of the turn, by selecting the Pick Point< button, or entering the position in co-ordinates in the boxes provided. Selecting Departure, as is shown in the diagram, adds 10% to the Indicated Air Speed (IAS). In the Orientation section the track prior to the turn can be either entered in the Radial/Track box or the <Pick Track button can be selected. If the <Pick Track button is selected the program reverts to the graphics screen and any two points can be selected. The angle of the two points is calculated and the program returns to the dialogue box. Finally the direction of the turn can be selected, either left or right.

Once the OK button is selected the program draws a single circle representing a 360° turn and writes the parameters used on a new layer "TNTEXT". Draw lines, for the in and out bound tracks, snapping to the tangent of the circle. Use the Autocad "trim" command to trim the unwanted portion of the circle to complete the nominal track.

TRIM IF NEEDED   TRIM IF NEEDED

NOMINAL-TURN
IAS 210 kts
DEP +10% 231 kts
TAS 276 kts
ALT 10000 ft
BANK 15 deg
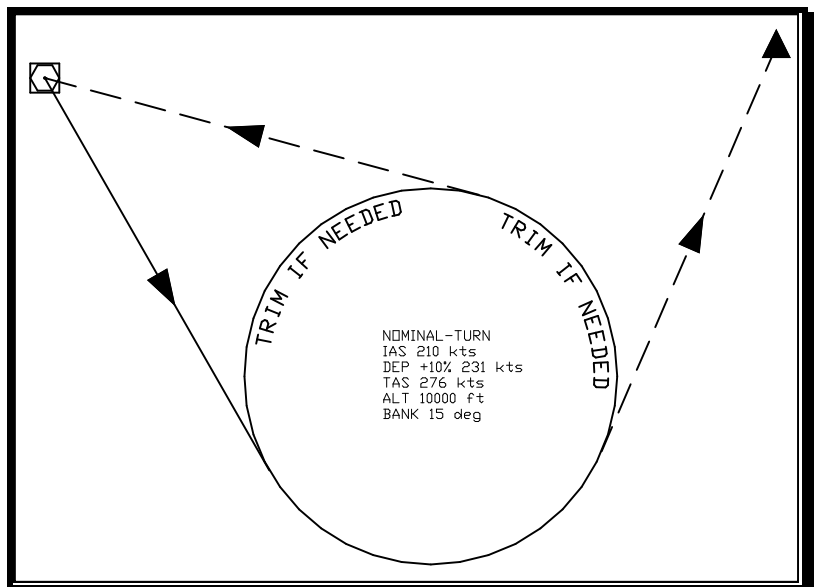
TURN PROTECTION AREA

PANS-OPS

TURN

AREA

The turn protection area wind spirals are drawn with this program.

In the Calculation Parameters section enter the Indicated Air Speed (IAS), Altitude, International Standard Atmosphere (ISA), Bank angle and Wind. For information, the default values for ISA, Bank angle and Wind are the usual values used in procedure design.

If the procedure is a departure, mark the Departure box as is shown in the diagram. This will automatically add the standard 10% of the speed to the IAS prior to calculation of the True Air Speed (TAS).

In the Orientation section the track prior to the turn can be either entered in the Track box or the <Pick Track button can be selected. If the <Pick Track button is selected the program reverts to the graphics screen and any two points can be selected. The angle of the two points is calculated and the program returns to the dialogue box. Finally the direction of the turn can be selected, either left or right. When OK is selected the program will ask for start points of the wind spiral. As many wind spirals as required can be drawn, until ↵ RETURN is entered. Once the wind spirals are drawn the Autocad "Line" command can be used to then connect the arcs with a line from their tangents (use the snap "Tan"). Use the Autocad "Trim" command to trim the unwanted portions of the wind spirals. In Autocad 14 snap to end points to obtain the tangent point The parameters used in the calculation of the wind spirals are written on a new layer "TATEXT" for reference at a later date.

BASIC CONSTRUCTION AREA

TURN AREA
IAS 210 kts
TAS 232 kts
ALT 5000 ft
BANK 15 deg
WIND 30 kts

OBSTACLE
PROTECTION
AREA

FINISHED CONSTRUCTION AREA

OBSTACLE
PROTECTION
AREA

TURN AREA
IAS 210 kts
TAS 232 kts
ALT 5000 ft
BANK 15 deg
WIND 30 kts
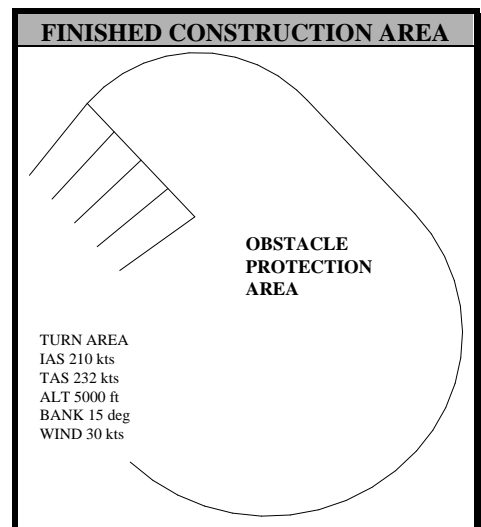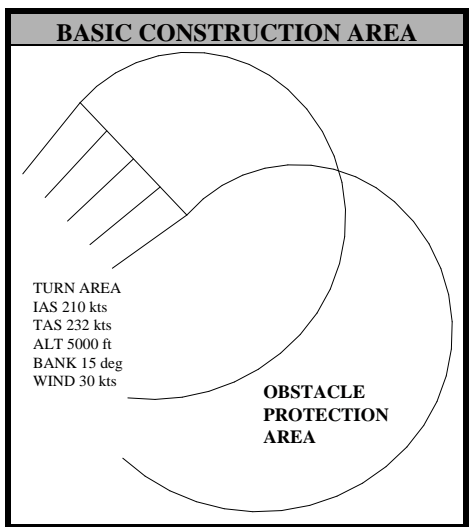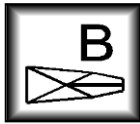
ILS BASIC SURFACE

This program draws in three dimensions the ILS basic protection area

The threshold (THR) position can be entered manually in the boxes provided or the pick point button can be used to pick a point from the screen. The Z value of the threshold position is the threshold elevation and is used primarily in three-dimensional construction. All grid references (X Y Z) must be in metres. The inbound track, in degrees, to the threshold can be entered manually or the <Pick Track button can be selected. The <Pick Track button enables any two points to be picked from the graphics screen and from these points the inbound track established. Finally the Basic ILS protection surfaces can be drawn in either two or three dimensions by selecting the appropriate button

TWO DIMENSIONS

THREE DIMENSIONS
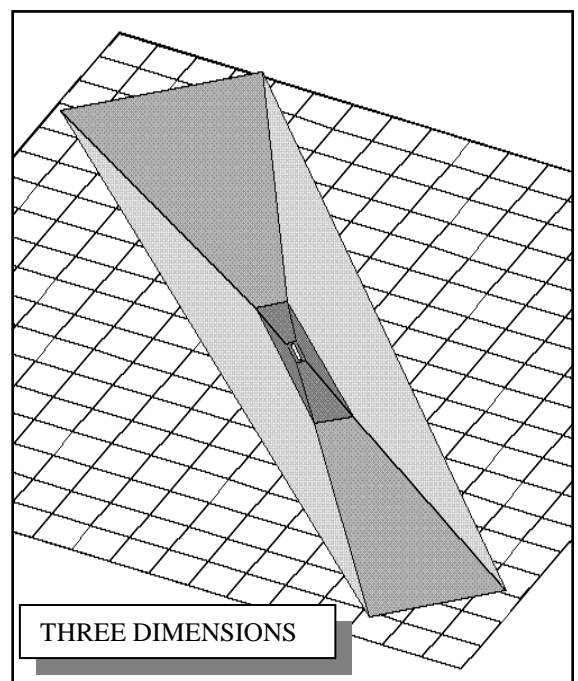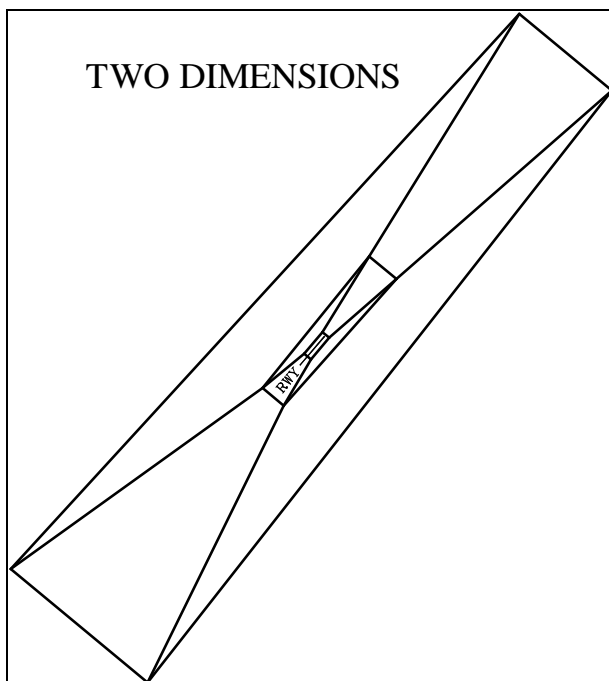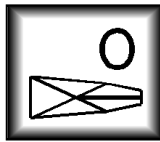
ILS OBSTACLE ASSESSMENT SURFACES

PANS-OPS

ILS

OAS

This program in conjunction with the values in ICAO Doc. 8168 Attachment I to Part III (green pages) enables the construction of the ILS obstacle assessment surfaces at any contour value.

OBSTACLE ASSESSMENT SURFACES (OAS)

Information

Glide path angle (deg) :	3.0	M/A climbout (%) :	2.5
LLZ to THR distance (m):	3600	ILS Category :	I

THR Position

Pick Point <

X: 0.0

Y: 0.0

Z: Elevation (m) 0.0

Calculation data

ILS Inbound Track

138.0   <Pick Track

OAS Contour Elevation (m)

300.0

Constants (ICAO Doc.8168 Vol. II Part III Attch I)

	A	B	C
W	0.028500		-8.01
X	0.028466	0.187680	-17.20
Y	0.024733	0.216946	-22.21
Z	-0.025000		-22.50

Draw

○ 2D

◉ 3D

OK   Cancel

The values in the information section of the dialogue box are for reference only and do not necessarily relate to the values in the constants box.

The Threshold Position can be entered manually in the boxes provided or the pick point button can be used to pick a point from the graphics screen. If the point picked is a three-dimensional point i.e. the point has a height value (Z value), the height value will also be returned and entered in the Z: Elevation box. The Elevation of the threshold can also be entered manually in the appropriate box.

In the calculation data section the inbound track, in degrees, to the threshold can be entered manually or automatically determined by picking any two points from the graphic screen. This mode is achieved by clicking on the <Pick Track button.

The obstacle assessment surfaces (OAS) are slopping surfaces that extend out from the runway footprint to any altitude. The OAS Contour Elevation box allows the determination of this altitude in meters. Obviously the lower the elevation the smaller the OAS area, however be advised that reduction of the OAS contour elevation below 300m requires specific justification.

Determination of the obstacle assessment surfaces requires the manual inputting of the constants, in ICAO Doc. 8168 Vol. II Part III Attch. I, into the Constants section. The computer does not automatically enter these constants

   The resulting obstacle assessment surfaces can be drawn either in two dimensions or three dimensions depending on the button clicked in the Draw section. In two dimensions the drawn entities are lines and can be trimmed or extended as needed. While in three dimensions the entities are three-dimensional surfaces and can be effectively used to determine penetration of obstacles (three-dimensional circles).

   Once construction of the obstacle assessment surfaces is completed the values entered in the information section and the Constants section are tabulated and written on a new layer "OASTEXT", to enable the checking and reference of the values used at a later date. This layer can be 'frozen' if not needed.

TWO DIMENSIONS

Glide path angle 3.0°
LLZ–>THR distance 3600m
Missed approach climbout 2.5%

	A	B	C
W	0.0285		−8.01
X	0.028466	0.18768	−17.2
Y	0.024733	0.216946	−22.21
Z	−0.025		−22.5

RWY

THREE DIMENSIONS

CRM
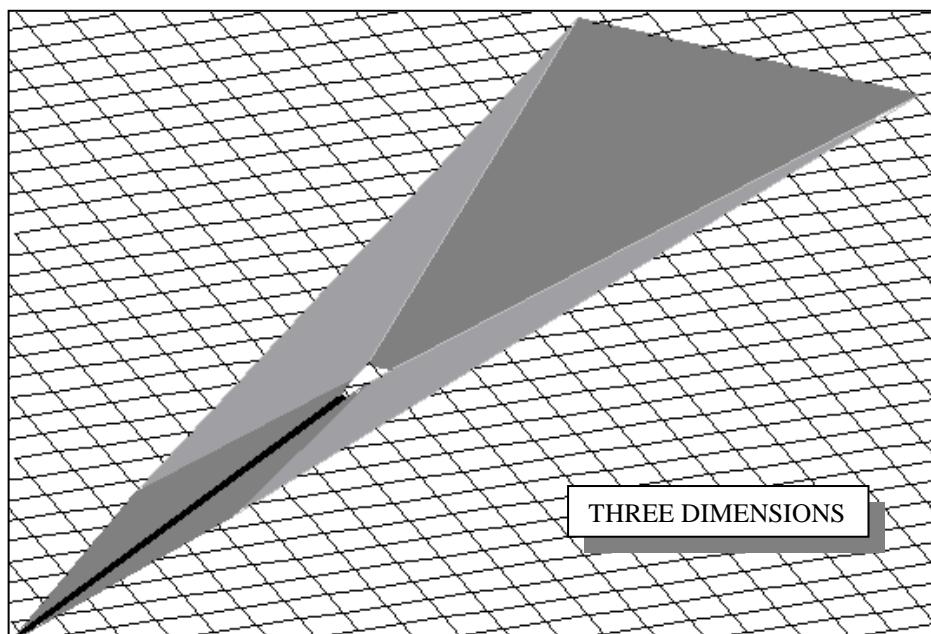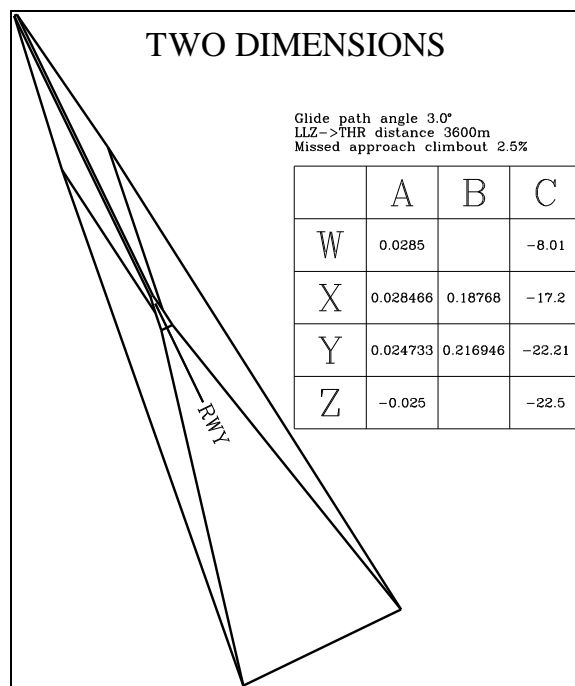
COLLISION RISK MODEL INTERFACE

PANS-OPS

ILS

CRM
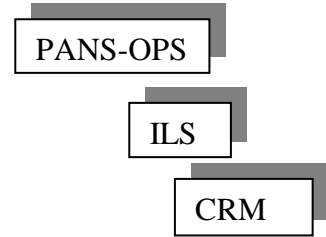
This program automates the creation or importation of a Collision Risk Model (CRM) obstacle file.

The first dialogue box determines whether a new obstacle file will be created or an old obstacle file is to be imported into a drawing. Next the program will ask for a file name for either creation or importation. It is important that when creating a CRM *.obs file that it is placed in the same directory as the CRM executable files (*.exe), otherwise the ICAO CRM program will not work.

COLLISION RISK MODEL (CRM)

Obstacle File

Create   Import

Cancel
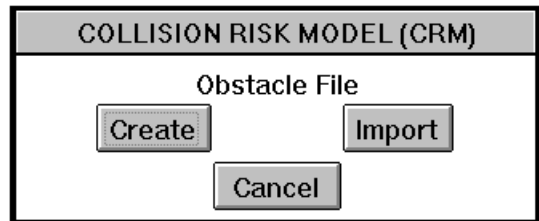
The following description of the CRM interface program is divided into two sections CRM Obstacle File Creation and CRM Obstacle File Importation.

CRM Obstacle File Creation

The creation portion of the CRM interface consists of 4 pages, these pages basically follow the familiar format of the CRM request form detailed in ICAO Doc. 9274-AN/904. Throughout this description items that start with a number square in brackets (i.e. [02]) refer directly to this form and an explanation of these items is detailed in the above document. Only differences and omissions to the ICAO format will be explained in this manual.
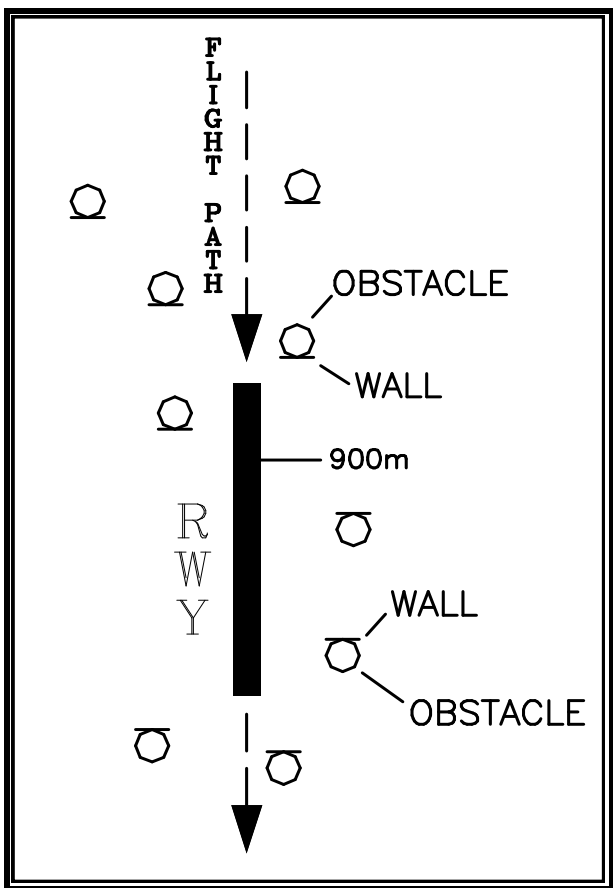
The question on Page 1, "Draw obstacle walls (for confirmation)?" is related to the way that obstacles are represented. For this program to work efficiently obstacles **must** be represented in the usual manner, as 3-dimensional circles. Where the radius of the circle represents the position tolerance and the elevation of the circle (Z value) is the elevation of the obstacle. Unfortunately the ICAO CRM computer program only allows the input of obstacle walls or points and does not accept circles as a representation of an obstacle. An obstacle point would not include the position tolerance, so the obstacle must be represented as a wall. To allow for the obstacle position tolerance the length of the wall must correspond to the diameter of the obstacle circle.

To ensure the inclusion of the worst possible obstacle position the obstacle wall is placed at the tangent point on the circle closest to the 900m point on the runway and at right angles to the flight path. This covers the worst possible case for the approach and missed approach. Obviously this whole process is carried out automatically by the **Wavionix** program. However if you wish to see conformation of this process select 'Yes' to the question, "Draw obstacle walls (for confirmation)?" and the obstacle walls that are written in the CRM obstacle file will also be placed in the drawing.

```
┌─────────────────────────────────────────────────────────┐
│           Create a CRM Obstacle File (page1)             │
├─────────────────────────────────────────────────────────┤
│  ┌──────────────────────────────┐   ┌─────────────────┐  │
│  │ Draw obstacle walls (for     │   │   DATA FILE     │  │
│  │ confirmation)?               │   │   ┌─────────┐   │  │
│  │   ● Yes      ○ No            │   │   │  LOAD   │   │  │
│  └──────────────────────────────┘   └───└─────────┘───┘  │
│  ┌─ Administrative Data ──────────────────────────────┐  │
│  │ [02] User Reference:  WAVIONIX                      │  │
│  │ [03] Title        :  Remember everything in METERS │  │
│  └────────────────────────────────────────────────────┘  │
│  ┌─ Ground Data ──────────────────────────────────────┐  │
│  │ [07] ILS glide path angle      (degrees)    3.00   │  │
│  │ [08] ILS reference datum height (meters)    15.0   │  │
│  │ [10] LLZ course width at THR   (meters)      210   │  │
│  │ [12] Distance FAP to THR       (meters)    10807   │  │
│  │                                          Y    N    │  │
│  │ [13] Standard termination of Precision   ●    ○    │  │
│  │      segment                                       │  │
│  │    If NO then:                                     │  │
│  │ a) Termination point before THR          ●    ○    │  │
│  │ b) Distance termination point to THR (meters) 1852│  │
│  └────────────────────────────────────────────────────┘  │
│       ┌──────────┐              ┌──────────┐              │
│       │   Next   │              │  Cancel  │              │
│       └──────────┘              └──────────┘              │
└─────────────────────────────────────────────────────────┘
```

If the CRM interface creation pages (1-4) have been previously completed and saved, this data can be loaded with the Data File Load button.

It is expected that the user will use the PC version of the CRM included with the **Wavionix Procedures Designer**. For this reason items [01] *ICAO reference*, [04] *Requestor*, [05] *Address*, and [06] *Person to contact*, of the CRM request form have been omitted, as they are no longer relevant.

The distance between the ILS localizer antenna and the runway threshold item [09] is omitted because the value is calculated automatically after the position of the threshold and localizer antenna is given on page 4.

Item [11] is obtained on page 4 along with the threshold grid position and so is omitted at this point. Selecting the Next button will move on to the next page of the Create a CRM obstacle file.

Create a CRM Obstacle File (page 2)

Aeroplane Data

	Y	N
[14] Standard dimensions	●	○

If NO specify:

a) Distance between the flight paths of
the wheels and the GP antenna   (meters)   `6.0`

b) Wing semispan   (meters)   `30.0`

	Y	N
[15] Standard missed approach climb gradient	●	○

If NO then specify climb gradient (per cent)   `2.5`

Requested case

[16] ILS approach category

- ⦿ Category I
- ○ Category II
- ○ Category I (radio altimeter only)
- ○ Category II (autopilot only)

[Next]   [Cancel]   [Previous]

Page 2 follows on from page 1, with the standard CRM request form questions. Selecting the Previous button will return to the previous page, in this case page 1.

Page 3 follows on from page 2, with the standard CRM request form questions.

Create a CRM Obstacle File (page 3)

Requested Case (cont.)

[17] Select choice of OCA or OCH

- ⦿ OCA (above mean sea level)
- ○ OCH (above THR)

[18] Select unit of measurement for OCA/H

- ⦿ Meters
- ○ Feet

[19]

Speed Category	Risk for specified OCA/H requested? If YES then OCA/H		Minimum acceptable OCA/H requested?
	Y N	meters	Y N
A	○ ●	`61`	● ○
B	○ ●	`61`	● ○
C	○ ●	`61`	● ○
D	○ ●	`61`	● ○

[Next]   [Cancel]   [Previous]

On Page 4, item [21] *language* is omitted and set to English, the standard language used throughout the **Wavionix Procedures Designer**.

Item [22] *Total number of obstacles* is automatically calculated by the program and so does not need to be imputed by the user.

Obstacles, the threshold position and the localizer position in a drawing are already in a grid co-ordinate system and so items [23], [25] and [26] are irrelevant.

The threshold position and the Localizer position can be entered manually or the 'Pick Point' button can be selected to pick a position from the graphics screen. If the threshold position picked has an elevation, it is automatically entered in item [24] part (e) otherwise the elevation can be entered manually.

Once all the data for the CRM obstacle file has been entered, it can be saved as a Wavionix CRM data file by selecting the Data File Save button. This avoids having to enter all the information once again for a minor change (i.e. ILS CAT. II).

When the Select Obstacles button is selected the dialogue box closes and the program reverts to the graphics screen. Three-dimensional circles can be selected either singly or a window can be used to select a group of circles. Any entities selected that are not circles will be filtered out. The maximum number of obstacle circles that can be selected is 2800. The program will also try to find any text written in the centre of the circle, if any text is found it will be used as the name of the obstacle in the created obstacle file.

CRM Program and usage

The use of the ICAO CRM program is comprehensively detailed in ICAO Doc. 9274-AN/904. However a short description is given here of the ICAO CRM PC version included with the **Wavionix Procedures Designer.**

Once the obstacle file has been written and placed in the **same** directory as the CRM executable files, change to that directory and type "CRM *filename* (no extension)".

An example using a created obstacle file name of "wpd". obs", which has been saved in the CRM directory.

In DOS enter at the C:\> prompt *cd crm*
then at the C:\CRM> prompt enter *crm wpd*

In Windows 95/NT use the run function in the start menu and in the open box enter
*C:\CRM>crm wpd*

The CRM sort routine program will now print the following lines: -

     1 file(s) copied

    Stop-program terminated

     1 file(s) copied

    Stop-program terminated

    Stop-program terminated

    Stop-program terminated

     1 file(s) copied

This could take some time depending on the number of obstacles and the speed of your computer. If the program stalls run the program once more. Once the program is finished, there will be two new files in the CRM directory. These files will have the same name as the obstacle file but with an extension of ' *. prt ' and ' *. rsk ' (example wpd.prt wpd.rsk). These files can be read with any word processing program. The use and interpretation of these files is detailed in ICAO Doc. 9274-AN/904 but basically the last page of the file '*.rsk ' is the summary of the calculations.

CRM Results: Warnings and Errors

Within the results of the ICAO CRM program, **warnings** may appear stating that the obstacle wall constructed is not perpendicular to the approach track. This comes about due to an inherent deficiency with the ICAO CRM program. The CRM obstacle file will not accept decimal places for X and Y co-ordinates.

10m OBSTACLE POSITION TOLERANCE
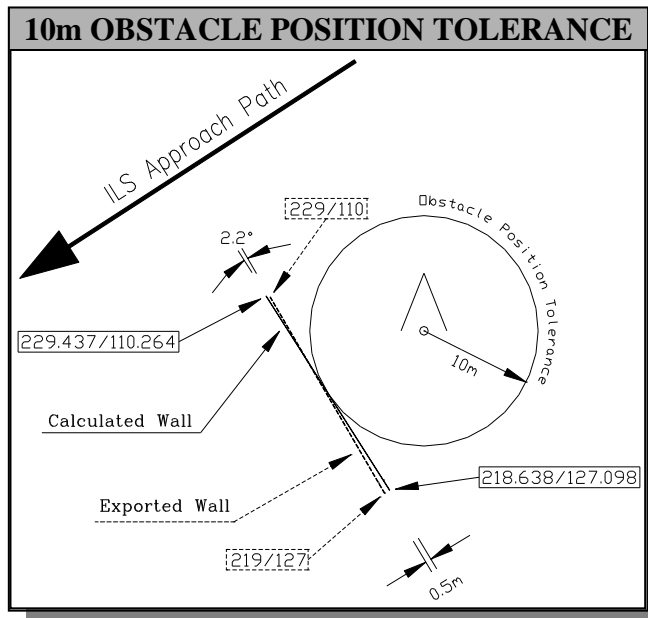
The Wavionix system calculates an obstacle wall exactly perpendicular to the approach track. However the Wavionix system must export the positions of the ends of the walls in the reduced whole meter accuracy required by the ICAO CRM program. Because of this reduction of accuracy in the ICAO CRM program, when very small walls are created and entered into the CRM obstacle file they are not always exactly perpendicular to the approach track. This does not cause a significant problem though, as the amounts involved are minimal.

If however, the circular position tolerance of an obstacle is reduced below 5m the ICAO CRM program will determine that the angular difference between the approach path and the wall is too large and return an **error**. When an error is returned the ICAO CRM program will stop and not return the required results.

3m OBSTACLE POSITION TOLERANCE
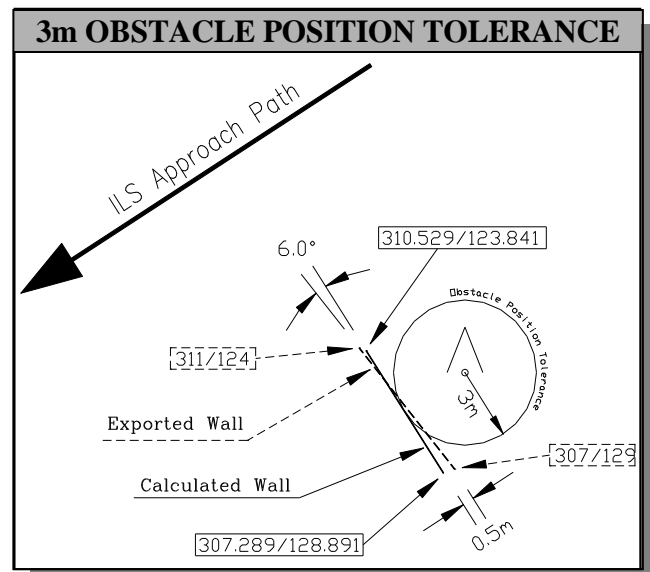
This problem is solved by, the Wavionix CRM interface program, placing a spike at the outer extremities of the position tolerance circle.

CRM Obstacle File Importation

Once the file to be imported is selected the CRM interface program will display the CRM Import File - Obstacle Output dialogue box. Obstacles in the standard CRM obstacle file can be imported into a drawing either as three dimensional circles or points by selecting the appropriate button in the Obstacles: section. The radius of the circle or the size of the point can be changed as required. The Layer box can be used to determine the layer on which the obstacles will be drawn.

Two text values are included in the standard CRM obstacle file for each obstacle; these are Ident and Description. This text can be written on different layers, to enable the viewing or printing of one value without the other. The layer for the text values can be changed in the Text section Layer boxes. In the same section entering a new value in the Height box can change the size of the text.

The threshold position can be entered manually in the X and Y boxes or the Pick Point< button can be selected to select a position from the graphics screen.

The bearing of the localizer to the threshold can be entered manually in the box provided or using the <Pick Bearing button, any two points from the graphics screen can be selected to determine the bearing.

Selecting the OK button erases the dialogue box and the program commences insertion. The threshold and localizer positions are marked with a circle and labelled.

If the bearing from the localizer to the threshold does not agree with the value given in the dialogue box, an alert box is displayed showing the value obtained from the CRM obstacle file and from which section of the file it was obtained. The program will continue to place the obstacles in relationship to the value given in the CRM Import File - Obstacle Output dialogue box.
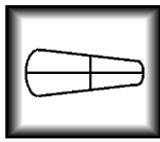
OVER-HEAD TOLERANCE OF A VOR, NDB

PANS-OPS

OH-TOL

The over-head navigational aid tolerance of a VOR or NDB is drawn with this command. The insertion point is the mid-point of the centre line.


Pick the position of the navigational aid from the graphics screen with the Pick Point< button or enter it manually in the boxes provided. The Z value of the position is the elevation of the navigational aid and is used in calculating the tolerance area. All grid references (X Y Z) must be in metres. The type of navigational aid can be selected, either a VOR or an NDB. When a VOR is selected the Inbound *TRACK* will change to Inbound *RADIAL*.

The <Pick Track/Radial button enables the picking of any two points from the graphics screen to determine the track or radial. When picking a VOR radial ensure that the first point picked represents the navigational aid and vice versa for an NDB track. This slight inconsistency is due to the fundamental definition of a radial and a track not the program, which simply determines the angle from the first point picked to the second point. The Aircraft Altitude box establishes the maximum height of the navigational aid tolerance cone. In the following diagram, the Wavionix program drew the tolerance lines and the navigational aid symbol was added later for clarification.
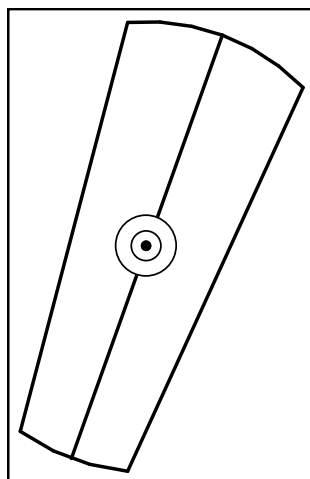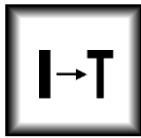
PANS-OPS

INDICATED AIR SPEED TO TRUE AIR SPEED

IAS to TAS

This program converts Indicated Air Speed (IAS) to True Air Speed (TAS). It also calculates three, six and fifteen seconds flying distance.

In the boxes provided enter the Indicated Air Speed (IAS), Altitude, and International Standard Atmosphere (ISA). The Wind and time boxes are for non-standard times and winds. These boxes can be filled or left blank as required.

When the OK button is selected the program will display the dialogue box TAS RESULTS. The distance values are in metres and are automatically calculated for 3, 6 and 15 seconds with 10 and 30 Kt's of wind. The values in square brackets [ ] are the commonly used values in procedure design and correspond to the abbreviations in normal brackets ( ) i.e. LTP SOC d etc...

Any other flying time with a different wind value can be calculated by entering the desired values in the initial dialogue box

SEC   MINIMUM OBSTACLE CLEARANCE IN THE
                                      SECONDARY AREA

PANS-OPS

SEC
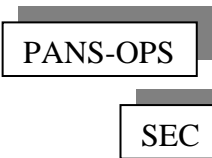
The calculation of obstacle infringement in the secondary area is easily done with three-dimensional surfaces and an Autocad "hide" or "shade" command. However sometimes it is of value to calculate the exact minimum obstacle clearance in the secondary area. This program will do that and write the result under the obstacle if required.

Fill in the appropriate dialogue boxes and either select the obstacle position from the graphics screen or enter the X and Y co-ordinates. When the Calculate button is pressed the program will ask for the selection of the line representing the inner-edge of the secondary area. This is the edge closest to the primary area. Next the program will request the line representing the outer-edge of the secondary area. It should be noted that the program only accepts polylines or lines to represent the inner and outer edges of the secondary area. This means that, to use this program the protection areas will have to be drawn in two dimensions, when using the Radial program. When the area splay protection areas are drawn in three dimensions, using the Radial program, the resulting entities are three-dimensional surfaces and not accepted by the SEC program.

Once these selections are completed the program will calculate the secondary MOC. This value will be written under the obstacle if the Write Text box is ticked, as in the dialogue box diagram. The program then returns to the dialogue box and enters the calculated result; this allows multiple values to be calculated.
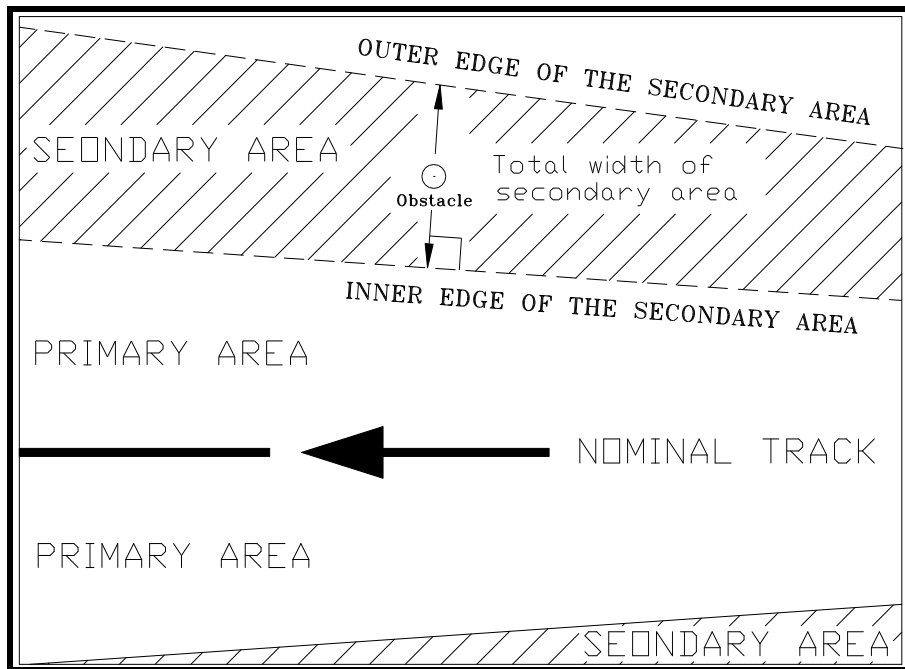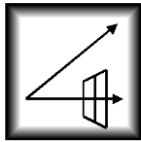
DME TOLERANCE AND SLANT RANGE

The ICAO navigational tolerance of a DME can be calculated with this program.

DME DISTANCE

◉ Ground   ○ Aircraft

DME Tolerance

Ground Distance (NM):   `10`

DME Tolerance (Pilot Distance): 0.38 nm   693.5

Slant range

Aircraft Altitude (FT) :   `8000`

DME Station Altitude (FT) :   `0.0`

Pilot Read-out : 10.09 nm   18679.8 m

SLANT tolerance   : 0.09 nm   161.2 m

QUIT   CALCULATE

Enter the respective values in the boxes. Then select the calculate button and the calculated results will appear.

Selecting Aircraft at the top of the dialogue box will change the first box in the DME tolerance section from Ground Distance to Pilot Read-out (read-out of the cockpit instrument) and enables the determination of specific DME readings for aircraft at specific altitudes above the DME station. The calculated results in the Slant range section will change from Pilot Read-out to Ground Distance. Obviously selecting Ground returns the layout of the dialogue box to that shown in the diagram.

Note that the tolerance of the DME is always calculated using the distance from the DME antenna to the aircraft receiver.

The slant range tolerance is the difference between the ground distance and the equivalent ground distance at the specified altitude. This value should be included in the fix tolerance extents in the direction of the DME station.

10000ft

PILOT

10nm

READ-OUT

SLANT
TOLERANCE

GROUND DISTANCE   10nm

EQUIVALENT

GROUND DISTANCE
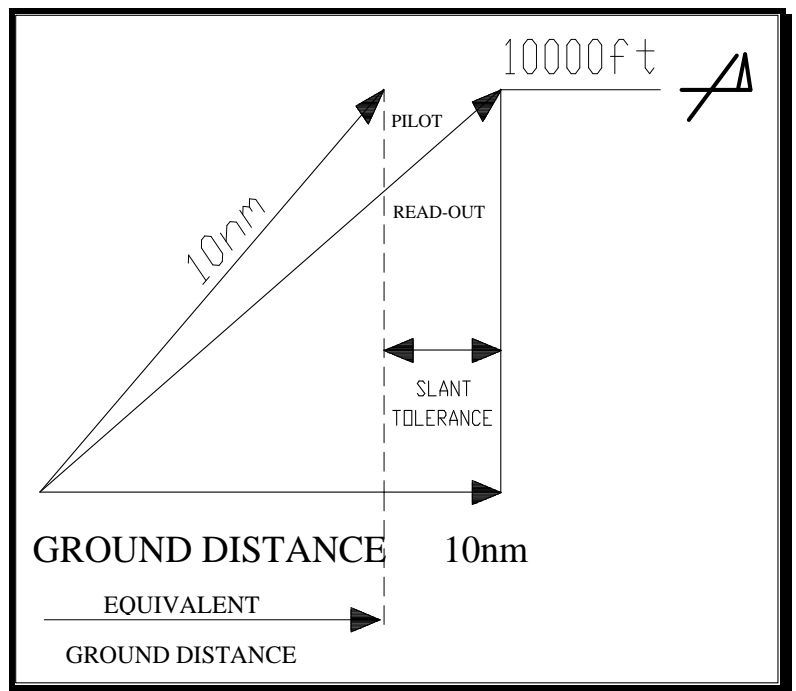
PANS-OPS

RNAV MINIMUM STABILISATION TRACK

RNAV

NOMINAL

The calculation of the minimum stabilisation distance between two RNAV waypoints gives the procedures designer an **indication** of the minimum distance required between two waypoints. The basis of the calculations is a section, titled " Minimum Length Of A Segment Limited By Two Turning Way-Points ", of an ICAO Obstacle Clearance Panel working paper.

In the Waypoint section pick from the graphics screen or enter manually in the dialogue box the position of the waypoint. Select the type of waypoint, either fly-over or fly-by. A fly-over waypoint is one that must be crossed prior to a course change. While with a fly-by waypoint, the course change can be anticipated and so the waypoint is not crossed. The parameters in the Aircraft section determine the required turning radius for a course change. Be advised that the bank angle is half the course change, if less than 50°, otherwise a 25° bank angle is used. If the appropriate RNAV symbol has not been previously inserted at the waypoint position it can be done by marking the Insert RNAV symbol box as shown in the dialogue box diagram. The parameters used can be written on the layer "RNAV-text" by selecting the Write text box as shown in the above dialogue box. The tracks to and from the waypoint can be entered manually or any two points can be picked from the graphics screen to determine the angle of the track. The calculated minimum stabilisation distance is drawn as a single polyline. Certain features in the diagram were added for clarification.
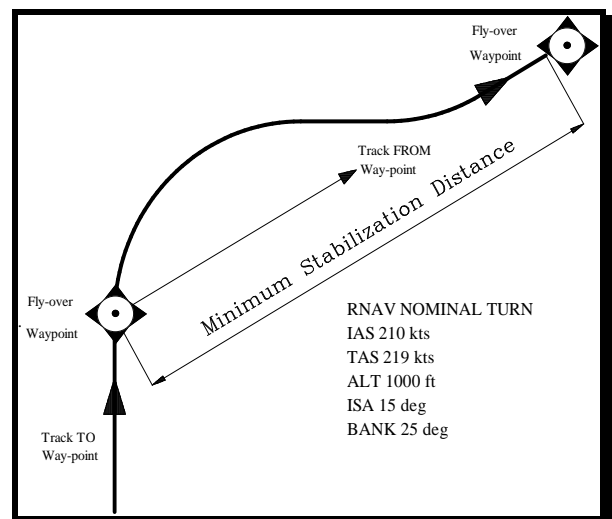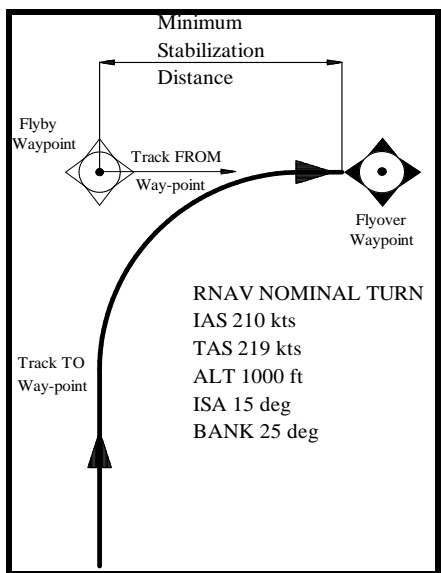
RNAV PROTECTION AREA

PANS-OPS

RNAV

AREA

The RNAV protection area program calculates and draws the cross track tolerance (XTT), along track tolerance (ATT) and half the area width (½ A/W) for an RNAV waypoint.

**RNAV PROTECTION AREA**

VOR/DME Position
Pick Point <
X: 149.9
Y: 101.3

Waypoint Position
Pick Point <
X: 303.2
Y: 194.9

RNAV Track: 030   Pick Track <

Type of Waypoint
◉ IAF IF
○ FAF SDF TP MAPt Dep
○ DER

Draw Tolerance
☒ Fix Area
☒ Area Width

Results in Kilometres
XTT= 2.08   ATT= 1.01   1/2 A/W= 4.98

QUIT   CALCULATE

In the RNAV Protection Area dialogue box enter the VOR/DME and Waypoint Positions or select them from the graphics screen. The nominal RNAV track can be entered manually or any two points on the graphics screen can be selected to determine the track.

The Type of Waypoint section establishes the intended use of the waypoint and directly influences the calculated results. Select either Initial Approach Fix (IAF) and Intermediate approach Fix (IF) or Final Approach Fix (FAF), Step Down Fix (SDF), Turning Point (TP), Missed Approach Point (MAPt) and a Departure way-point (Dep). Finally a fictitious waypoint at the decision end of the runway (DER) can be constructed by selecting the DER button. The calculated tolerances can be automatically drawn by selecting the area tolerance required in the Draw Tolerance section. In the dialogue box diagram the Fix area, i.e. XTT and ATT, will be drawn and the Area Width will be omitted.

To calculate and draw the tolerance areas the Calculate button must be selected. The results of the calculation will be automatically entered in the Results in Kilometres section. In the following diagram of an RNAV waypoint tolerance the VOR, RNAV Waypoint, nominal track and text have been added for clarification. For this program to work efficiently it is advisable to have both the VOR/DME and intended RNAV waypoint visible within the graphics screen area.

VOR/DME

AREA WIDTH

NOMINAL TRACK

CROSS TRACK

WAY POINT

ALONG TRACK
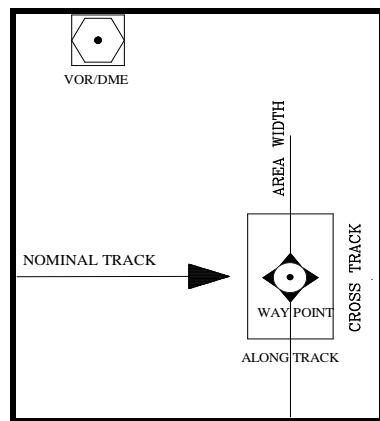
CREATING A NAVIGATIONAL FIX

PANS-OPS

CREATE A FIX

This program constructs a fix established by two navigational aids.

FIX CREATION

Tracking Aid
◉ VOR   Position   *RADIAL*
   Pick Position <   < Pick
   X: 0.0
○ NDB   Y: 0.0   030

Intersecting Aid
◉ VOR   Position   *RADIAL*
   Pick Position <   < Pick
○ NDB   X: 1000.0
○ DME   Y: 1000.0   260

OK   Cancel

The tracking aid section deals with the navigational aid that the aircraft will be using to establish the track flown. Select the type of navigational aid and enter its position either by X and Y co-ordinates or by picking a position from the graphics screen. The radial or track is entered in the appropriate box or can be selected from the graphics screen by picking two points.

The intersecting aid section deals with the navigational aid that the aircraft will be using to establish his position (fix) along the track flown. Once again, select the type of navigational aid and enter its position either by X and Y co-ordinates or by picking a position from the graphics screen. . The radial, track or DME distance is entered in the appropriate box or can be selected from the graphics screen by picking two points. When DME is selected the "*RADIAL*" box changes to "*Distance (nm)*" and the value entered is in nautical miles. In some instances, especially using DME, it is not possible to construct a fix. In such instances the program will stop and return the calculated fix tolerances without constructing the fix. This enables the manual construction of the fix.
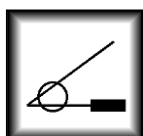
VOR OFFSET GATE

PANS-OPS

900M

VOR OFFSET GATE

Runway Threshold
   Pick Point <
   X: 0.00
   Y: —   0.00

Runway Direction :
150   <Pick Direction

OK   Cancel

According to Pans-Ops, when establishing an offset VOR approach, the final approach track must pass through a window 900m from the threshold. The VOR offset gate program draws this window or gate.

Enter the runway threshold or pick a position from the graphics screen. Enter or pick from the graphics screen, the in-bound direction of the runway. Selecting OK will draw a circle, of width 150m, at 900m from the threshold. This is the window or gate that the final approach track must pass through.

GATE   RWY

W
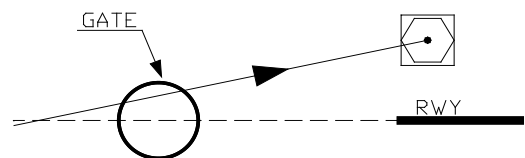
WAVIONIX AIRPORT SURFACES PLANNER

Protection Surfaces

   The first step in constructing and analysing the ICAO Annex 14 surfaces is the determination of the runway characteristics. In the Wavionix system a polyline or a line represents the runway. Prior to starting the **Wavionix Annex 14 Surfaces Planner** it is worth while to establish the main points on the runway. These points would include the runway ends and significant points along the runway length. Obviously the more control points entered the more accurate will be the constructed surfaces and the calculated position altitudes.

   After marking the runway control points in three dimensions the drawing (i.e. as points), either a line, a polyline or a 3d polyline can be drawn between the positions to represent the runway. If only two positions (i.e. the runway ends) are marked in the drawing a single line or polyline can be drawn. However if more than two positions are used only a polyline not a series of lines must be drawn. Finally if the runway control positions are not level (i.e. the altitudes of the control points change) a 3d polyline (Autocad command **3dpoly**) only should be used to represent the runway.

   Once the runway has been constructed as a line, a polyline or a 3d polyline start the Wavionix Annex 14 program. In the first section Runway, of the Annex 14 Aerodrome Surfaces dialogue box, the select runway button allows the selection of the previously constructed runway.

Main Annex 14 Aerodrome Surfaces dialogue

When selecting the runway, the end point of the line or polyline closest to the position where the line or polyline is picked is taken as the threshold for the approach surfaces and the decision end of the runway (DER) for the departure surfaces. Care should be taken when selecting the runway, as any line or polyline can be taken by the program to represent the runway.
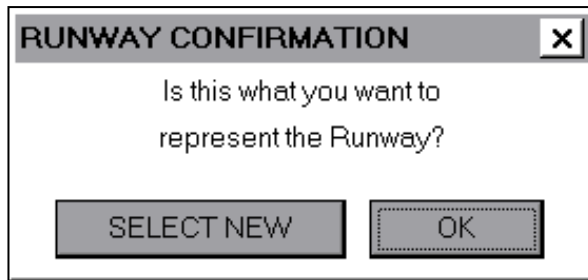
Once the line or polyline representing the runway has been selected, the selection is highlighted and the Runway Confirmation dialogue box appears. At this point you can carry on with the present runway selection or select a new line or polyline to represent the runway.

Runway Confirmation dialogue box

In some situations it is possible to have two or more runway control points with a standard slope between them. In such a situation it may be useful to increase the number of control points between the given control points and so increase the accuracy of the output. In this case, prior to starting the Annex 14 program mark the basic control points in the drawing but do not draw the line or polyline between them.

After starting the program select the Setup button in the Runway section. A new dialogue box, Annex 14 Runway Setup, will appear. Pick the first point along the runway from the graphics screen by using the Autocad sub-command snap to a node and snapping to the point previously drawn. The Z value of the co-ordinates is the altitude of the basic runway control point. The number of vertices box determines the number of vertices or control points that will be created between the position chosen and the next position.
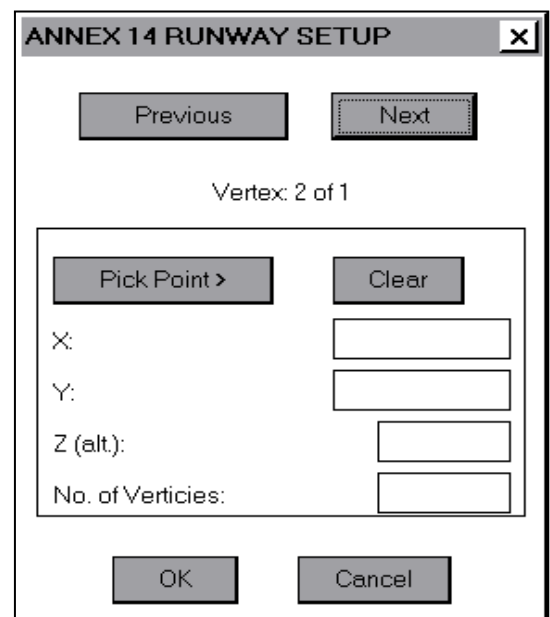
Setup dialogue box

When the OK button is selected a 3d polyline is drawn between the basic control positions, with the number of new control points corresponding to the number of vertices entered. The slope between the basic control positions picked determines the altitude of the new control points. After the 3d polyline is drawn you are returned to the main dialogue box.

If a new runway line is created with the Setup sub-program the runway must be selected again by using the Select Runway button in the main dialogue box. This selection process must be carried out to determine which end of the runway is the threshold or the departure end.

Select the type of runway and approach in the Runway Classification and Type of Approach sections. The selection made in these two sections determines which surfaces can or cannot be constructed. Choose the surfaces to be constructed from those available in the Construct Surfaces section. The marked surfaces will be constructed when the OK button is selected. The departure surface changes depending on whether a turn of more than 15° will be performed or not. Departure surfaces with a turn of greater than 15° can be drawn by selecting the >15deg box.

The constructed surfaces will be created on a new layer with the same name as the surface created. If the layer already exists the program will number the subsequent layers sequentially. The parameters used by the program to construct the surfaces are written on the layer Annex 14-text for reference. This layer is 'frozen' after construction, so will have to be thawed if you wish to view the parameters used in the surface construction. This can be done with the Autocad Layer command.

The default calculation parameters are the standards recommended by ICAO in Annex 14 and can be changed by selecting the Change Parameters button. The Datum Altitude for the Inner-Horizontal surface is defaulted to the threshold altitude. If the runway has not been selected prior to changing the parameters, the Datum Altitude box in the Annex 14 Parameters dialogue box will show THR ALT. This stands for the threshold altitude and means that this value will be used when the runway is selected. If any of the parameters are changed a note **NON-STANDARD** will appear in the main Annex 14 Aerodrome Surfaces dialogue box.


Annex 14 Parameters dialogue box

Depending on the selection in the Runway Classification and Type of Approach sections some surface parameters will not be available for change, as they are not constructed in certain situations. In such circumstances the surfaces will have N/A (not applicable) in the parameter edit boxes.

If after changing the standard parameters and returning to the main dialogue box either the Runway Classification or the Type of Approach is changed the parameters will automatically revert back to the standard ICAO Annex 14 values.

The constructed surfaces are useful in determining penetration of the surface by obstacles. This is easily achieved by using the standard Autocad Shade command. However it is quite often necessary to determine the amount of surface penetration. To do this, the altitude of the surface must be known at the penetration point. This value can then be compared with the obstacle altitude at the position, to determine the amount of penetration. To establish, for any position, the relevant surface and its altitude, start by selecting the Altitude of a Position button in the main dialogue box.

This sub-program does not require the surfaces to have been constructed or even marked in the Construct Surfaces section. However the values used in the calculations are dependent on the selections made in the Runway Classification and Type of Approach sections. Also the >15deg box in the Construct Surfaces section determines the values to be used when calculating whether a position is within the departure surface or not. Obviously if non-standard parameters are in use then these will be used in the position altitude calculations.
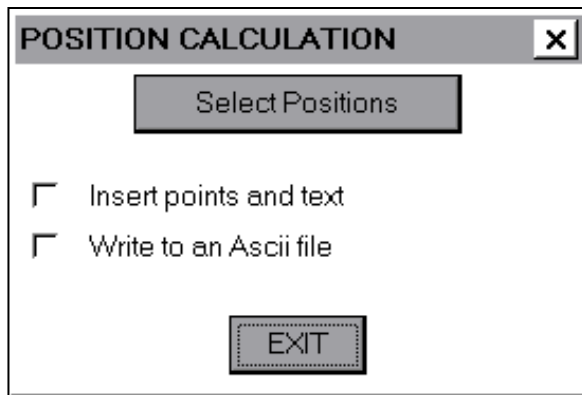

Position Calculation dialogue

After starting the Position sub-program the Position Calculation dialogue box appears. The position picked can be marked and the results of the position calculations automatically written in the drawing itself, by marking the Insert points and text box. You can also export the results to an ASCII file by checking the Write to an ASCII file box. Selecting the Select Positions button clears the screen of the dialogue box and allows the selection of a position from the graphics screen.

After a position has been selected the program calculates the relevant surface or surfaces and determines the height of each surface at that position. If the Insert points and text box was marked in the Position Calculation dialogue box the program marks the position selected with a point and writes the results of the calculations just below the position.

Note that in some instances more than one surface may be present at a given position. The program will return all surfaces present at a specified position.
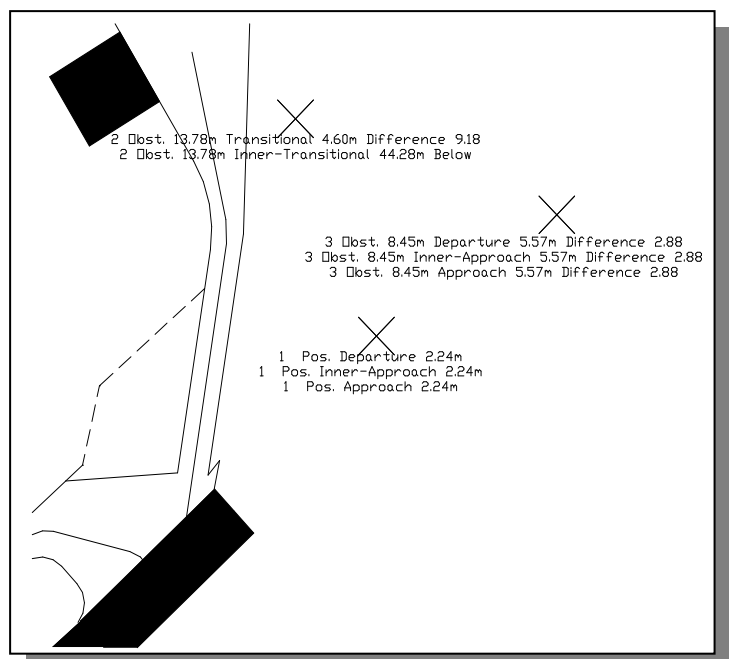
When a two dimensional position is picked from the graphics screen the program will return a position and the relevant surfaces at that point with their altitudes. If however, a three dimensional position is picked from the graphics screen the program will mark this position as an obstacle. Then list the obstacle altitude and the relevant surfaces combined with their calculated altitudes. In the case where the obstacle is above the surface the difference between the two altitude values is calculated and shown, otherwise it is marked simply "Below".

POSITION RESULTS

```
1 Pos. Inner-Approach 2.24m
1 Pos. Approach 2.24m
2 Obst. 13.78m Transitional 4.60m Difference 9.18
2 Obst. 13.78m Inner-Transitional 44.28m Below
3 Obst. 8.45m Departure 5.57m Difference 2.88
3 Obst. 8.45m Inner-Approach 5.57m Difference 2.88
3 Obst. 8.45m Approach 5.57m Difference 2.88
```

Continue   Exit
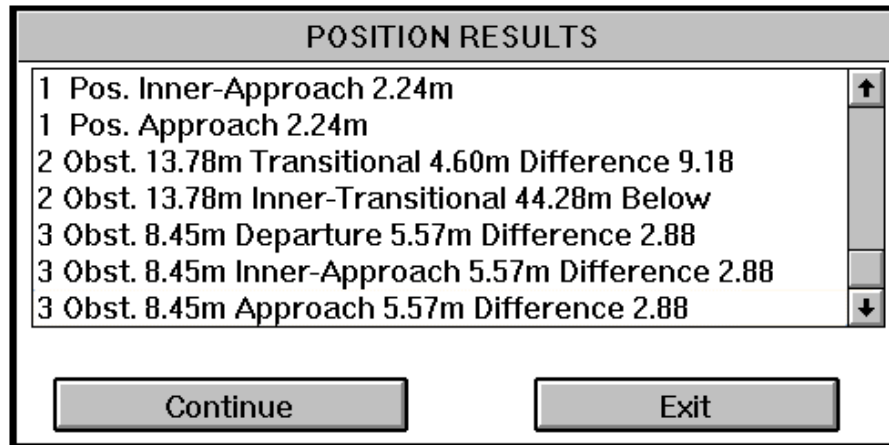
Position Results dialogue box

After calculation and writing the results in the drawing the program will also return the calculated results to the Position Results dialogue box. A continual consecutively numbered record of positions checked will be kept as long as you remain in the same Autocad drawing. In the above diagram three positions were picked from the graphics screen. Seven surfaces were present at these positions. Of the three positions the last two were three-dimensional positions and so were listed as obstacles. In the Position Results dialogue box the Continue button will allow the selection of further points. While the Exit button will return you to the main dialogue box, unless the Write to an ASCII file box was marked in the Position Calculation dialogue box.

If the Write to an ASCII file box was checked, then prior to returning to the main dialogue box you can select a name and directory in the File selection dialogue box for an ASCII file of the position results. After writing the text file the program will return to main Annex 14 Aerodrome Surfaces dialogue box.

The resulting ASCII text file can have any name and three-letter extension, but it is advisable to give the file an extension of "TXT" so it can be easily recognised as a text file by other programs. The data fields in the text file are separated by a semicolon (;). This makes it easier to import the data into a database or spread sheet. An example will now be given as to

```
1;Position;624440.79;5042440.40;;Departure;2.24;;
1;Position;624440.79;5042440.40;;Inner-Approach;2.24;;
1;Position;624440.79;5042440.40;;Approach;2.24;;
2;Obstacle;624376.87;5042603.82;13.78;Transitional;4.60;Difference ;9.18
2;Obstacle;624376.87;5042603.82;13.78;Inner-Transitional;44.28;Below;
3;Obstacle;624583.49;5042531.60;8.45;Departure;5.57;Difference ;2.88
3;Obstacle;624583.49;5042531.60;8.45;Inner-Approach;5.57;Difference
;2.88
```

Resulting ASCII text file

how to import this text file into an Excel spread sheet. The principles involved are the same for almost all databases and spread sheets. Exit Autocad and start Windows. In Windows start the Microsoft Excel spread sheet program. From the drop down 'File' menu in Excel, select 'Open'. Select the created ASCII text file, in this example the file is named results.txt. Then select the OK button. To make it easier to find the text file you may wish to select 'Text Files (*.prn *.txt *.csv)' in the 'List Files of type: box' at the bottom of the Open dialogue box.
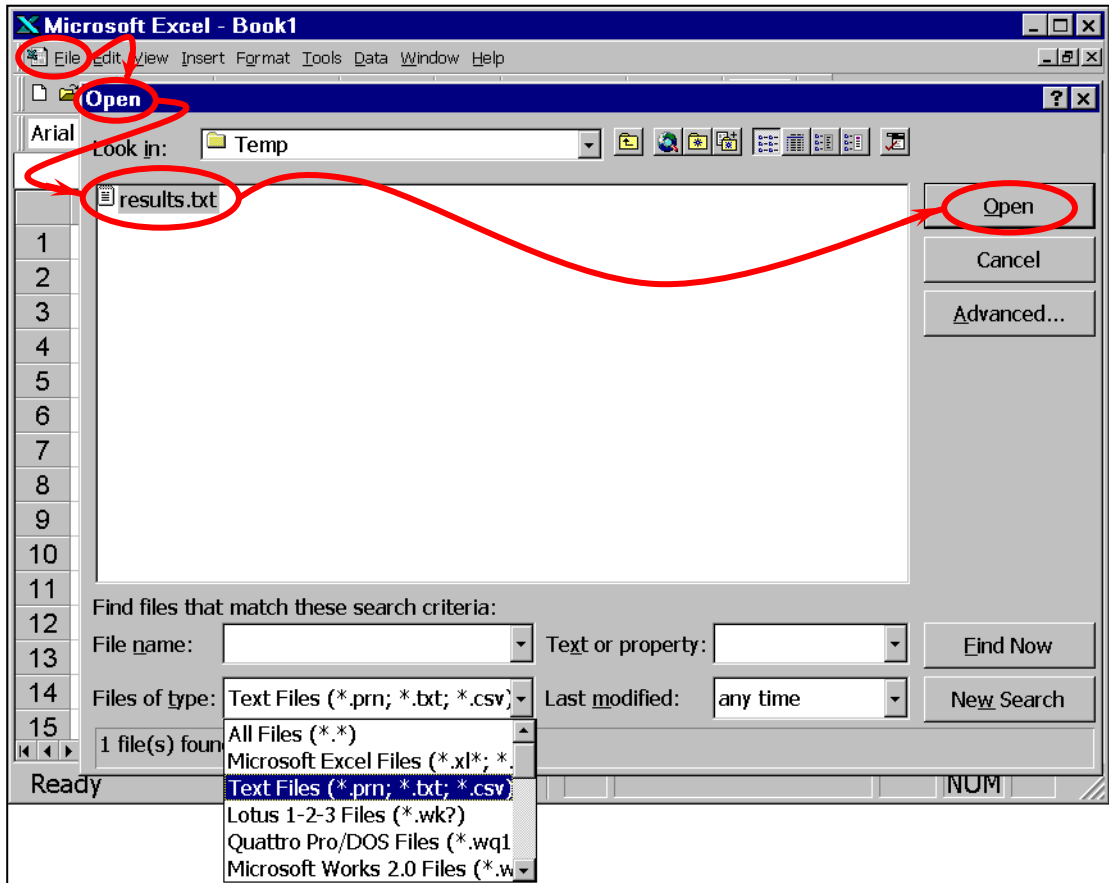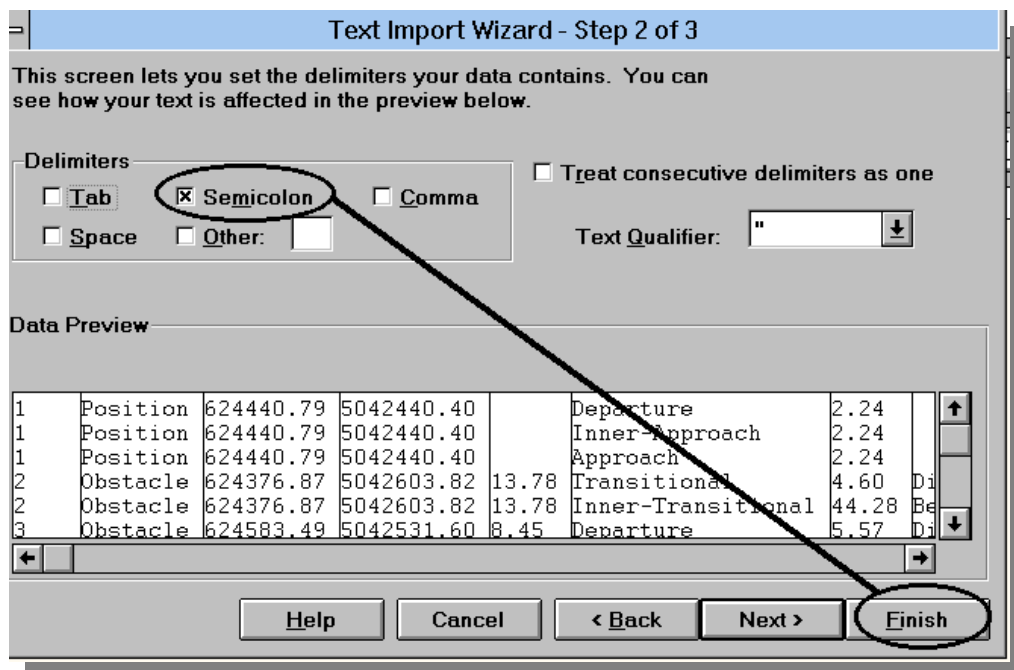
Excel open dialogue box

Once these steps have been completed some sort of conversion program will start
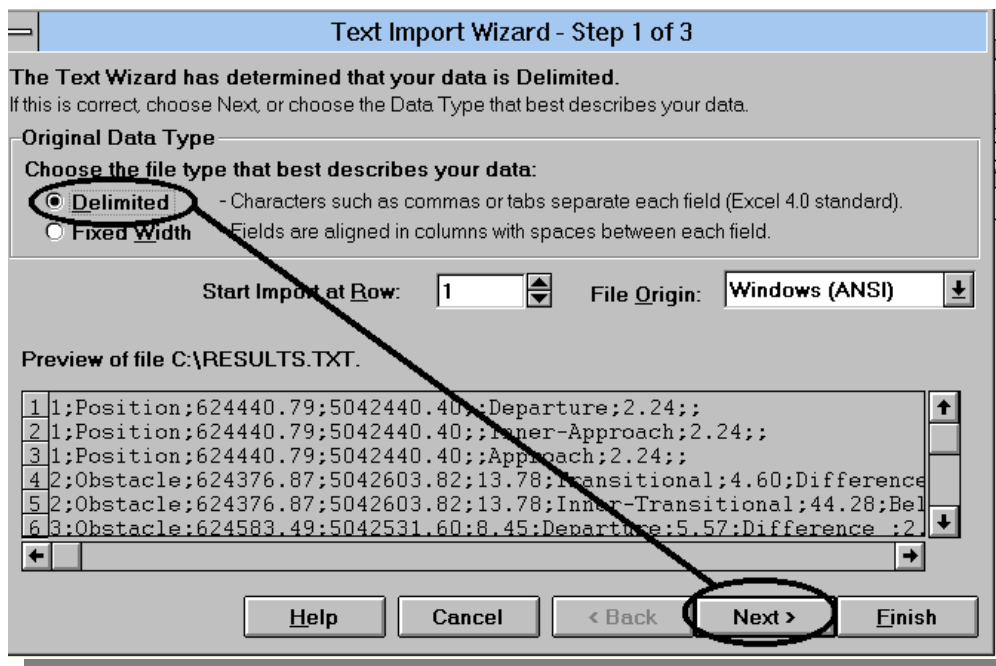
When the program starts choose the Deliminated toggle and proceed to the next step (2) by selecting the next button.

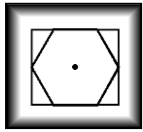Excel Text Import Wizard - Step 1

Excel Text Import Wizard - Step 2

In this step (2) select semicolon in the Delimiters section and deselect all other delimiters. Finally select the 'Finish' button to enter the text data into the spreadsheet. In the spreadsheet below row 1 has been added for clarification.
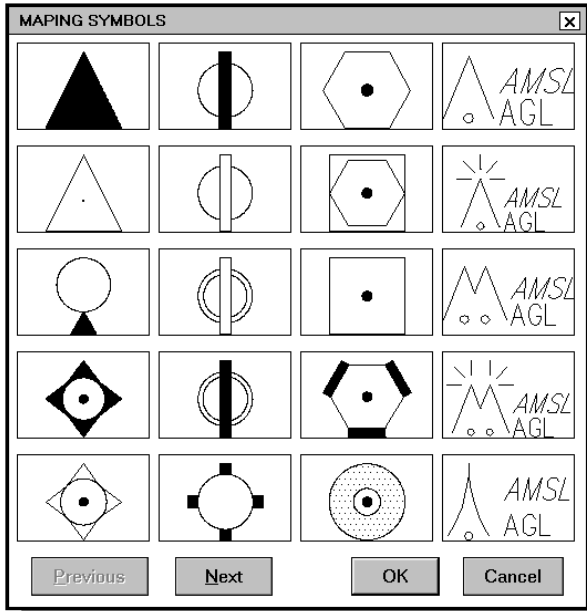

Resulting Excel Spread Sheet

CHARTING

SYMBOLS

All of the commonly used ICAO or Jeppesen charting symbols are available as blocks.

To insert the appropriate symbol, select the symbol from the list. Position the symbol as desired in the drawing, by clicking on a position. The scale of the symbol is dependent on the eventual plotting scale of the chart. All of the symbol blocks have as their insertion point the centre point of a circle. So an Autocad snap to the centre of a circle or the insertion point will find the exact position of the symbol.

V5

When inserting obstacle symbols the altitude (AMSL) and height (AGL) are also requested, these values do not have to be entered if not required. The altitude and height values can be changed later by the Autocad command "_ddatte" or the button

Do not confuse the obstacle symbols which are used for charts, with a three dimensional circle that represents an obstacle in procedure design.
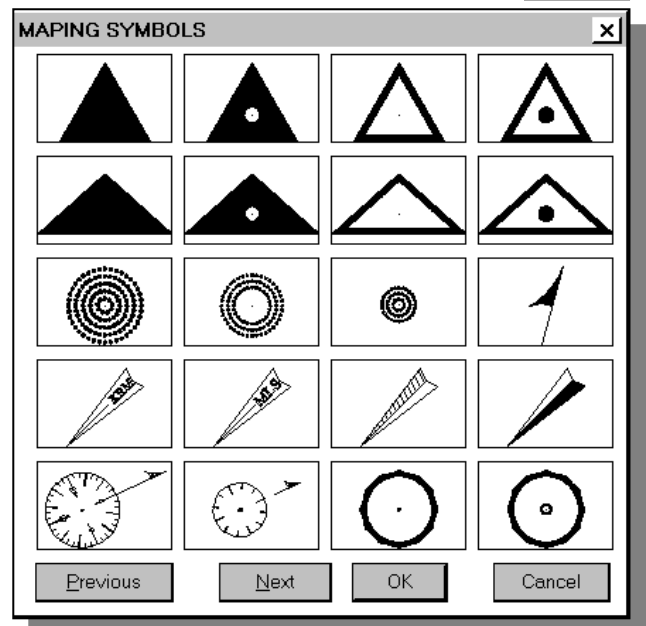
For the routing symbols, use the bearings and distance program. This program is detailed in the tools section of this manual.

V5

MINIMUM SECTOR ALTITUDE SYMBOL

This program will insert the minimum sector altitude **symbol** into a chart.

In the Symbol section of the dialogue box input the centre position of the symbol or pick a point from the graphics screen. The size of the symbol can be determined by picking any two points from the graphics screen or a value can be entered manually in the Size box. This value is the diagonal distance from corner to corner of the symbol. The Centred On box is the text that is written in the centre of the circle, while the Radius NM value is the distance marked on the top of the symbol. The Sector section is comprised of the out-bound tracks or radials from the centre point. These values must be listed in a clockwise order. The Altitude section includes the
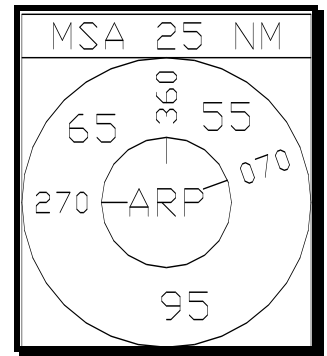
altitude values of the defined sectors (i.e. between the radials/tracks). For this reason, the value boxes are slightly offset downwards.

MORSE CODE

This program will automatically convert input from the keyboard into Morse code. After the standard text questions i.e. start point, height etc., have been answered any subsequent **lower case** input from the keyboard will be converted into Morse code. Upper and lower case characters can be combined if required, to produce a combination of normal text and Morse code. The Morse code can be changed back to normal text by using the Autocad modify command to change the text style to anything other than the style WPD. Previously written normal lower case text can be converted at any time to Morse code by changing the style of the text to WPD.
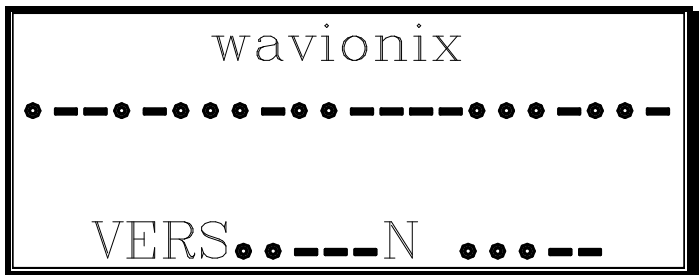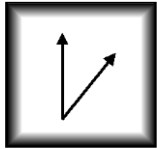
VARIATION SYMBOL

VARIATION SYMBOL

Variation
Degrees 00
Minutes 00
West/East W
Date 30.5.95

Bearings
Magnetic True
◉ ○

Altitudes
Feet Meters
◉ ○

Arrow Length 1000 | Pick Length <

OK | Cancel

This program does not in any way change the arbitrary set-up of angles in the drawing it merely inserts a variation symbol into a chart.

The Variation section of the dialogue box determines the written variation text. The West/East box determines the placement of this text and the magnetic arrow, either right or left

VAR 00°00' W (30.5.95)

BEARINGS ARE MAGNETIC
ALTITUDES IN FEET

of the true north arrow, while the Bearing and Altitudes sections establish the text that is written under the arrows. The size of the North direction arrow and the text is determined by the value in the Arrow Length box. This value can be entered manually or a length can be selected from the graphics screen
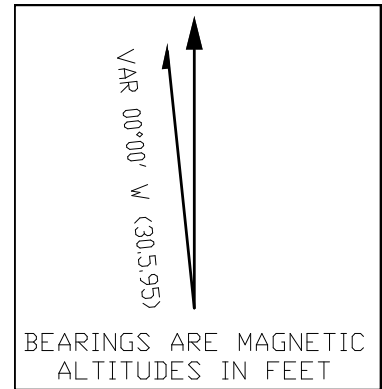
SCALE SYMBOL

This symbol draws a scale symbol for inclusion in a chart and does not in any way change the scale of the drawing. The chart or drawing should be in **meters** and the scale is determined at plotting time. Therefore, it is advisable to know, before drawing the symbol, the scale required to fit the chart on the required size of paper. Use the dialogue box to change the insertion point, length of the symbol in 5 km increments and the eventual scale.

SCALE SYMBOL

Position
Pick Point <
X: 0.0000
Y: 0.0000

Length
(5 km increments) 20

Scale 1: 500'000

OK | Cancel

SCALE 1:500'000

0   5   10
NM
KM
0   5   10   15   20
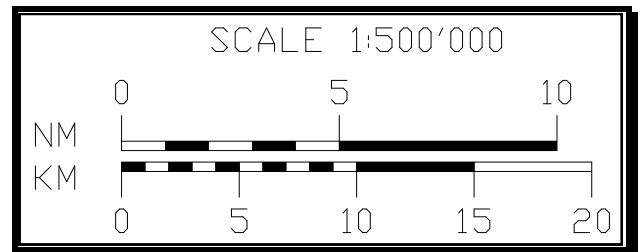
APPROACH CHART

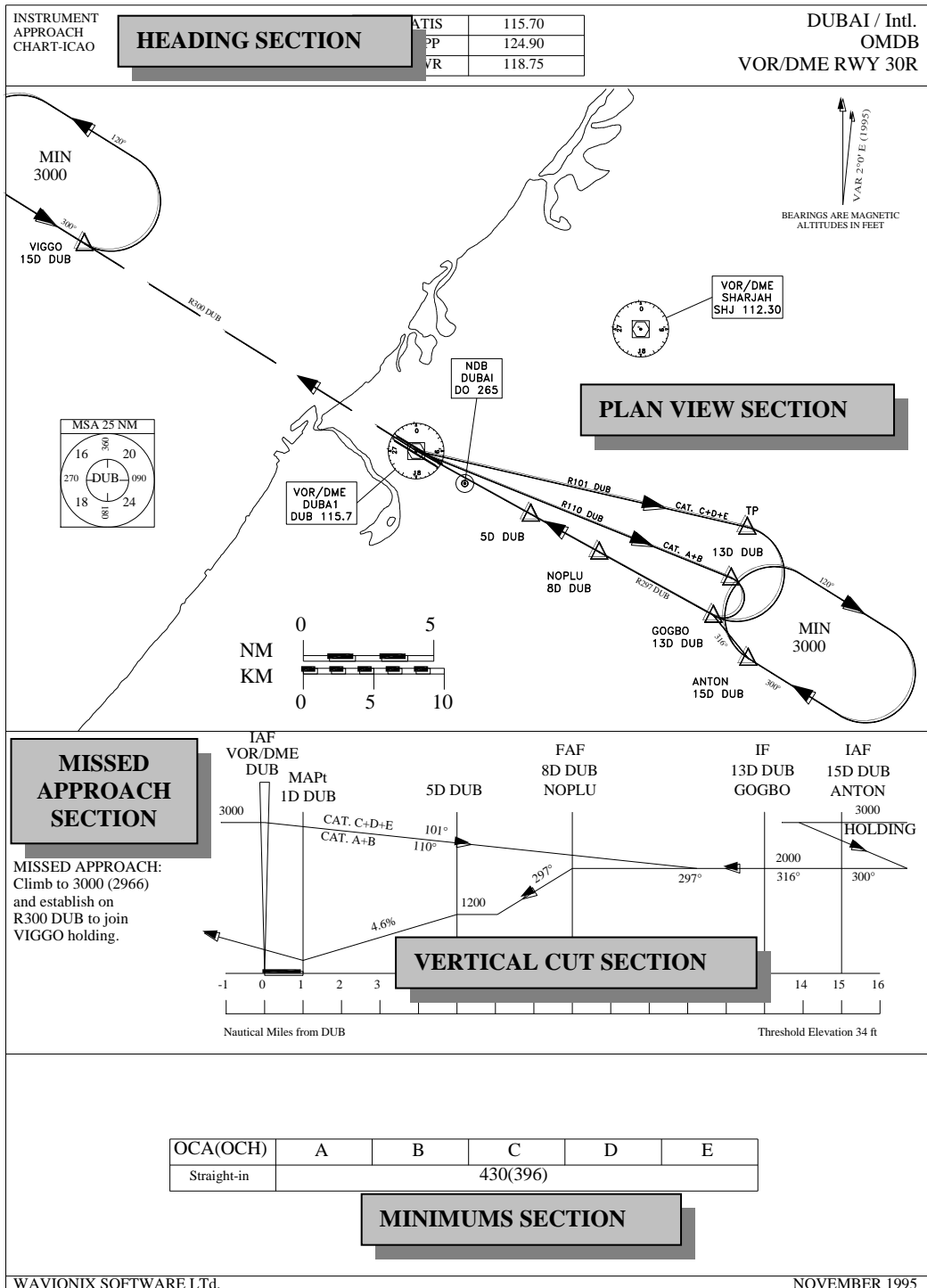The program Approach Chart enables the procedure designer to present an approach procedure in a format recognisable to the aviation community. The basic ICAO approach chart has been divided up into four sections with one sub section. These sections are Heading, Plan view, Vertical cut and Minimum's, while the vertical cut section has the sub section MAPt text.

In the Approach Chart, -Heading- dialogue box enter the various data that will be placed at the top of the approach chart. The Frequency section of this dialogue box has three lines where the relevant frequencies and designations can be entered. The Name section, includes the chart identification and is written in the top right hand corner of the completed approach chart. Airport Elevation (Elev.) and Runway Elevation can be entered in either meters or feet depending on the settings in the Altitudes portion of the Units section. The portion Distances in the Units section determines the distances that will eventually be drawn in the vertical cut section of the approach chart.

If the Approach Chart dialogue boxes have been previously completed and saved, this data can be loaded with the Data File Load button. When a data file is loaded the values and settings of all dialogue boxes default to the loaded data.

The Next button will move the user onto the next dialogue box Plan View while Cancel will terminate the program.

Error! Objects cannot be created from editing field codes.

The Approach Chart program does not draw what is in the plan view section, as this varies so dramatically from procedure to procedure and country to country. However when the intended procedure is initially constructed the nominal tracks, navigational aides and significant features should have been included in the drawing on separate layers. These features are what the user should use to establish the plan view.

Prior to starting the Approach Chart program it is advisable to use the Autocad "_layer" command to thaw and turn on all layers, in the original procedure design drawing, that include nominal tracks, navigational aides and significant terrain features etc. Freeze all layers on which are placed obstacle protection areas and features that are not required in the intended plan view section.

The section Area in the Approach Chart - Plan View- dialogue box enables the selection of the desired area of an existing drawing to be taken as the plan view section of the eventual approach chart. This area can be entered manually in the sub sections, First corner and Other corner, or the two corners can be obtained from the graphics screen by selecting the Pick Area< button.

The Zoom button will zoom the graphics screen view to the area co-ordinates, while the Zoom-P button will zoom to the previous view. These two zoom buttons are useful in viewing a portion of the plan view area. Note that the dialogue box can be moved to another position within the graphics screen by selecting the dialogue box heading and dragging the box to a new position while holding down the select button. The area selected for the plan view determines the size and shape of the entire approach chart including all entities drawn by the program within it.

The Insert Symbol section enables the insertion of the symbols Minimum Sector Altitude (MSA), Variation and Scale. See the previous command descriptions for a detailed explanation of these symbol insertion programs.

The entire approach chart will be drawn on the current layer unless the New Layer box is selected. If this box is selected then all entities within the designated plan view area will be copied onto a newly created layer 'Chart1' and this will become the current layer. This enables the changing, after completion of the chart, of the entities within the plan view area without effecting the original drawing. For example, once the approach chart is completed, drawing entities may extend beyond

the boundaries of the plan view. These drawing entities could be trimmed by using the Autocad "_trim" command while the original drawing entities remain the same on a separate layer.

The Next button will move the user onto the next dialogue box Vertical Cut while the Previous button will return the user to the Heading dialogue box and the Cancel button terminates the program.

The Approach Chart -Vertical Cut- dialogue box establishes the navigational aid and fix positions to be inserted in the vertical cut section of the approach chart.

Nine positions can be entered while the tenth position is always the position of the Runway (RWY). For each position a name and distance can be given. The units of distance are either Nautical Miles (NM) or Kilometres (KM) depending on the value selected in the Units section of the Approach Chart -Heading- dialogue box. The type of point on the vertical cut can be selected as either a navigational aid (NAV)

or a fix position (POS) and determines the form of position marker drawn in the vertical cut. This can be either an elongated triangle for a navigational aid or a line for a fix position.

The base line distances are not always taken as distances from the threshold. For this reason, the runway position is a variable and the Base line reference point can be changed. Changing the base line reference point merely changes the text that is written under the base line.

The Clear button clears all values and sets all positions to POS.

The representation of the approach can start at either the left or right of the approach chart depending on the orientation of the procedure. This orientation can be changed with the Left to Right or Right to Left buttons depending on whether the runway is to the left or right of the start of the approach (FAF). This convention may seem to be opposite to what is expected, however it used to enable conformity to other programs in the **Wavionix Procedures Designer**.

The Next button will move the user onto the next dialogue box MAPt text, while the Previous button will return the user to the Plan View dialogue box and the Cancel button will terminate the program.

The vertical step down track or nominal glide path angle is not drawn by the program as a more professional representation can be done easier by using the standard Autocad commands once the basic approach chart has been created.

The Approach Chart -MAPt Text- dialogue box has seven lines that can be filled with missed approach information.

All text written by the program will be in the text style in use when the Approach Chart program was started.

Once again, the Next button will move the user onto the next dialogue box MAPt text, while the Previous button will return the user to the Plan View dialogue box. The Cancel button will terminate the program. The initial six columns in the Approach Chart -Minimum's- dialogue box is a stylised representation of the eventual minimum's box in the approach chart. In the first column, select the type of approach(s) for which boxes in the minimum's section of the approach chart will be drawn. The first approach is a variable that can be entered by the user; in this case, 'Straight-in' has been entered. The next five columns are the actual minimum's for a specific aircraft category. Only the categories that are selected with the category box at the top of each column will be included. Text in the Administration box will be written in the bottom left hand corner of the approach chart and the text in the Date box will be written in the bottom right-hand corner. The clear button will clear all values, while the Data File Save button will save the values and settings of all dialogue boxes to a file for future reference or amendment.

Once the basic approach chart has been completed, it can be amended using the standard Autocad commands. Drawing entities can be moved, trimmed and sized to customise the approach chart.
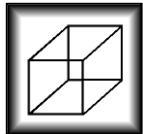
TOOLS

General

   A set of drawing tools was developed to assist the procedures specialist to complete repetitive and time consuming tasks quickly.

3-DIMENSIONAL AIRSPACE

TOOLS

3D-AIR

   This program will help in the conversion of any two-dimensional drawing into a three dimensional structure. Firstly select the entities to be given a vertical dimension and then input the desired vertical limits. The program is very useful in creating three-dimensional airspace and converting airport-building plans into three-dimensional structures, for obstacle assessment. It is a good idea to put entities with the same altitude on the same layer and colour designate them for ease of recognition.

COPYING TO ANOTHER LAYER

TOOLS

LAYER-COPY

   Occasionally it is of use to copy drawing entities on to another layer to enable amendment without changing the original. This program will copy entities onto a new layer (the target layer). If the target layer is not present the program will create a new layer with the requested layer name.

MULTI-POLYLINE WIDTH
CHANGE

TOOLS

MULTI-WIDTH

   If it is required to change the width of a large number of lines or polylines (i.e. routes), use this command to automate the process. Input the new width and select successive lines or polylines. If a line is selected the program will change the line into a polyline prior to changing its width.

CIRCULAR TEXT

TOOLS

CIR-TEXT

   Writing text around an arc is accomplished with this program. The program initially requests the start point and height of the text. This is followed by a request to select the defining arc or circle. Once the text has been written and it is desired to change the position of the text around the circle or arc, use the Autocad "_rotate" command with the centre of the arc or circle as the base point.

MULTI SCALE CHANGE

TOOLS
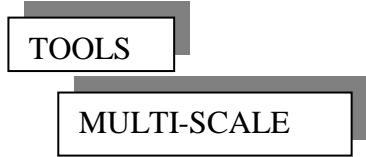
MULTI-SCALE

Changing the size of a large number of drawing entities (i.e. chart symbols), without changing their position, is very time consuming using the standard Autocad commands. The Multi-Scale program automates this process to a single step. Input the required scale change and select the entities to change. The base point of the scale change depends on the entities being changed: -

| ENTITY	BASE POINT
Circle, Arc	Centre Point
Line, Polyline, Polygon	First Point
Text, Blocks	Insertion point
3dface, Solid	First corner

Digitising

The following programs can help with the digitising process but the user should spend the time and read the section of the Autocad manual dealing with Tablets and Digitisers. The user should also note that these tools are not in fact programs at all but Macros, a succession of scripted keyboard entries. So care should be taken when using these commands as a false entry will cause the script to collapse but an undo command will return your system to the starting configuration. The **Wavionix** Tabwpd keyboard command helps to reset the position of the command menus on the tablet. This command can be used at **any time** in a drawing session to set up the tablet menus

TOOLS

DIGITISING

DIGITISER
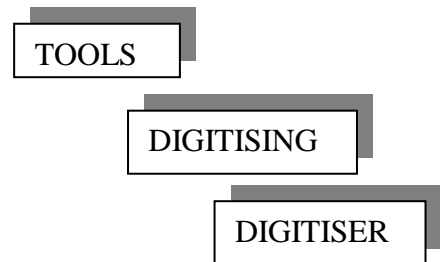
DIGITISER

This program will help to change the digitiser from a menu tablet to a digitising tablet and vice versa. The program automates the Autocad Tablet command and because the desired configuration is already known some of the standard questions have been omitted

TOOLS
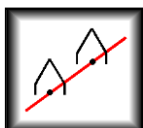
DIGITISING

3D-POLY

DIGITISING 3-DIMENSIONAL POLYLINES
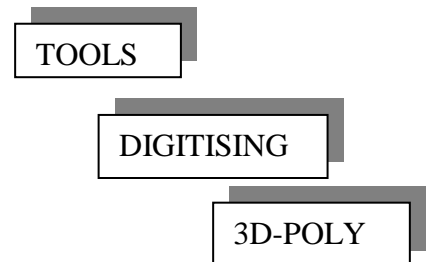
Digitising three-dimensional polylines is a specific use of the digitiser and so after digitiser calibration, the program automatically enters the 3D-polyline command. Digitise the required points and enter the altitudes, ↵ Return will finish the command. Once the 3D-polyline command is completed the program will ask for the tablet reference points to reset the digitiser to a menu board.

TOOLS

DIGITISING

3D-CIRCLE

DIGITISING 3-DIMENSIONAL CIRCLES

Many programs in the **Wavionix Procedures Designer** only recognise obstacles in a three-dimensional circle format. This program will facilitate the digitising of obstacles from a map, in this format. After digitiser calibration, the program automatically enters the Autocad "_circle" command. Set the radius of the obstacle circle to equal the position tolerance of the map. It is also possible to automatically number the obstacle circles consecutively. It is recommended that you do so as this saves considerable t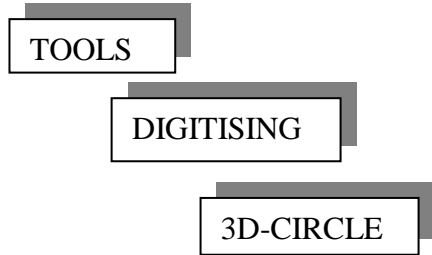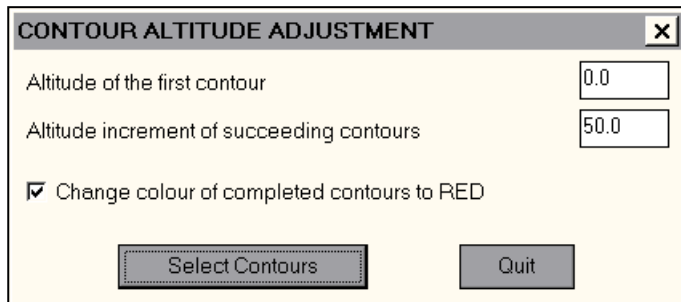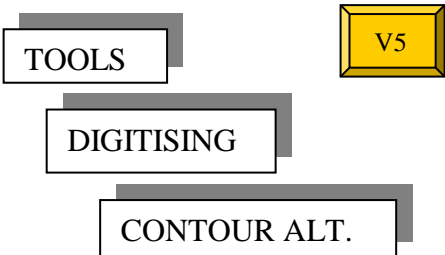ime and confusion at a later date. Digitise the required points and enter the altitudes, ↵ Return will finish the command. Once return is entered the program will ask for the tablet reference points to reset the digitiser to a menu board. The obstacle number is written in the centre of the obstacle circle and placed on a new layer "OBTEXT.

TOOLS

V5

DIGITISING

CONTOUR ALT.

CONTOUR ALTITUDE ADJUSTMENT

CONTOUR ALTITUDE ADJUSTMENT	✕
Altitude of the first contour	0.0
Altitude increment of succeeding contours	50.0
☑ Change colour of completed contours to RED	
Select Contours	Quit

This command is very useful in positioning digitised contour lines in 3 dimensional space. Once the command is started the contour altitude adjustment dialogue box appears. The altitude of the first contour is the altitude of the first contour that you will select after the Select Contours button is pushed. The increment box is the altitude increments between the subsequent contours selected and this value can be positive or negative. When working in three dimensions and viewing from above (two dimensions) it is difficult to determine which contours have been changed and which still need to be worked on. This problem is solved, by changing the completed contours to the colour red. Once all contour adjustment is completed then the colour of the contours can be changed back to "bylayer" by using the modify command.

TOOLS

FILE

TEXT IMPORT

TEXT

TEXT IMPORT
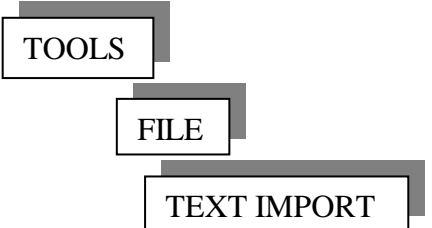
This program will import into a drawing almost any file as plain text. All characters in the file are imported and so include any software control characters. These characters can be deleted in the drawing or the file can be saved initially as a text file with the original file creation software prior to importation.

TOOLS

POLYLINES TO CIRCLES

POLY->CIR

Sometimes it is of value to represent a polyline or mesh as three-dimensional obstacle circles. As obstacle circles can define a position tolerance and are required for obstacle assessment of a procedure. Using the Polylines to Circles tool, contour lines or a terrain mesh can be represented as obstacle circles and subsequently enable the determination of the obstacle walls required by the ICAO ILS CRM program. In the following diagrams the terrain contour lines (polylines) and terrain mesh are solid lines while 3 dimensional obstacle circles were inserted by the polylines to circles command. The Wavionix CRM creation program was used to create the obstacle walls tangential to the circles. This modelling of terrain for a CRM obstacle file needed only a minute to create, the same could be done for railways and power lines etc.

Enter the Obstacle Radius in meters in the appropriate box of the Polyline to Obstacle Circles dialogue box. In most cases this value represents the mapping tolerance of the polyline. The program places a circle at every vertex position on the polyline and if the Number Obstacles box is selected the circles are numbered consecutively from the First Number value. The obstacle number is written in the centre of the obstacle circle and placed on a new layer "OBTEXT".
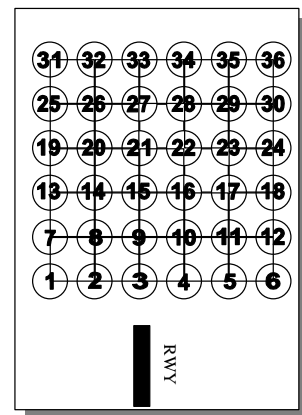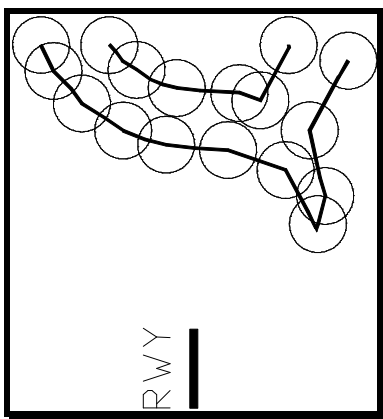
Autocad has the ability to fit a curve to a polyline. Use this facility sparingly, as the accuracy of the polyline is lost and a significant number of inaccurate vertexes are added. For safety reasons the Polyline to Circles program will put obstacle circles at **all** vertices in the polyline database. This causes extra circles to be put at the control points (i.e. 1,11,12,13) in addition to the fitted polyline vertices (i.e. 2 to 10).

TOOLS
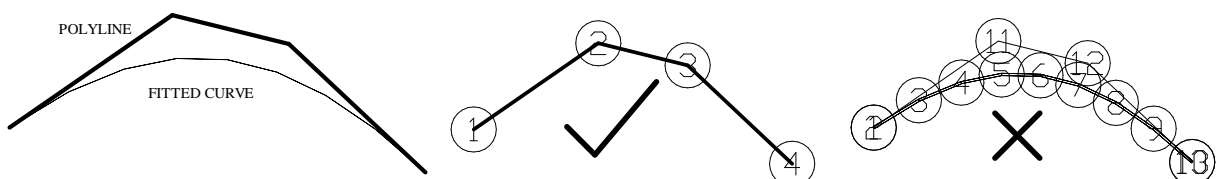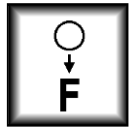
FILE

CIRCLES->FILE

CIRCLES TO A FILE
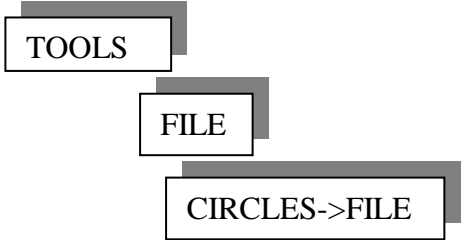
This program enables the exportation of obstacle circles into an ASCII text file for use in hard copy documentation or mathematical manipulation. Initially the standard Autocad file dialogue box appears. Write the name of the file to create in the box provided. After the intended file is opened or created the program will ask for the Number Of Decimal Places? This is the accuracy required for the exported grid co-ordinates and up to 13 decimal places can be given. Once the accuracy is established select the obstacle circles, a window can be used, as the program will filter out all drawing entities other than circles. The program establishes the centre position of the circles in grid co-ordinates (X, Y and Z) and their radius (position tolerance). These values are then written to the new file. The file can be read by most word processing and spreadsheet software.
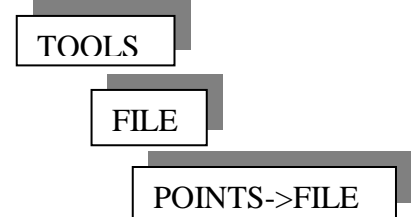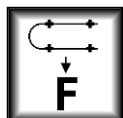
TOOLS

FILE

POINTS->FILE

POINTS TO A FILE

This program is basically the same as the previous program Circles to a File. The main difference is that **single** positions can be selected from the graphics screen for inclusion into the ASCII text file. Positions can be continually selected until ↵ Return is entered from the keyboard.

TOOLS

FILE

POLYLINE->FILE

POLYLINE TO A FILE

POLYLINE IN A DRAWING

ARC

RADIUS X CENTRE

VERTEX

VERTEX

VERTEX

VERTEX
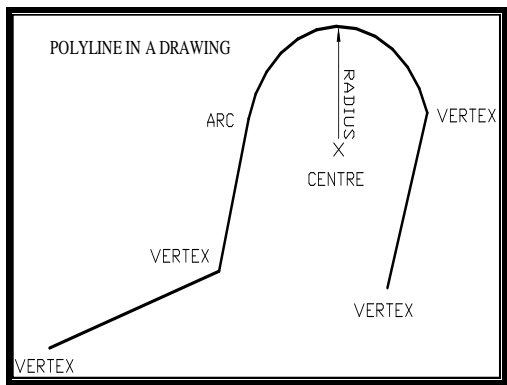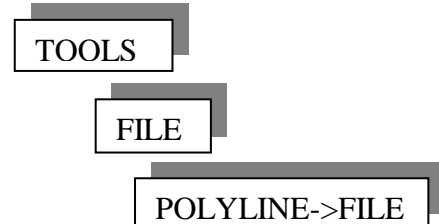
This program is basically the same as the previous programs. The main difference is that **polylines** are selected from the graphics screen for inclusion into the ASCII text file. Polylines can be continually selected until ↵ Return is entered from the keyboard. The format of the ASCII text file is slightly different from the program Circles to a File. Not only is it important to know when one polyline ends and another begins but also portions of polylines may include arcs. The first line in the ASCII file is the number of the polyline i.e. the first selected, the second selected etc. The second line starts with

Resulting Ascii file
ASCII TEXT FILE
LINE1 X Y Z
VERTEX 89.5 60.7 0.0
VERTEX 162.2 85.6 0.0
ARC 174.9 134.8 0.0
CENTRE 213.5 124.9 0.0
RADIUS 39.8
VERTEX 251.5 136.8 0.0
VERTEX 234.4 80.2 0.0

the word Vertex or Arc followed by the grid co-ordinates. This format continues until the end of the polyline or an arc is encountered. If an arc is encountered the entry for the first point on the arc starts with the word Arc. The Centre position and the radius follow this entry.

DATA BASE INSERTION
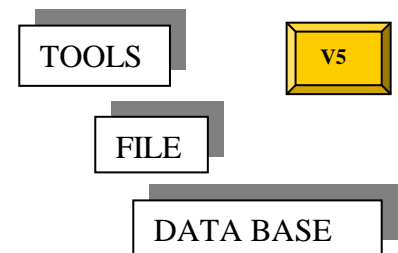
   With this program it is possible to import a database of positions and other information. For example a database of navigational aid positions and operating parameters or airspace structure and usage.

   However before imputing the data in to your drawing it must be converted into a format that is recognisable by the Wavionix Data Base accessing program. This format is an Ascii text file (CSV) with the fields separated by a semicolon. The resulting text file should look like this: -

```
NAME;X;Y;Z;TYPE;note1;note2;note3;note4;note5;note6;note7
WPD2103;804193.6;191610.2;15.71575;vor;info;;;;;;
WPD0701;643121.5;208781.3;65.47982;ndb;info;;;;;;
WPD0702;659676.7;174618.3;98.4389;obst1;info;;;;;;
WPD0703;637510.3;157271.3;89.56;obst2;info;;;;;;
WPD0705;614553.1;184188.4;89.90942;par;info;;;;;;
WPD0706;621076.1;179946.9;21.58961;;info;;;;;;
```

It looks complicated, but an example will be given using an Excel spreadsheet, as this is one of the most common software of this type in use. This example will step by step show the setting up and conversion of a database into the Wavionix format.

Data Order

   Firstly the order of the database has to be determined. The first seven fields/columns must contain the following data and be in the following order: -

A	B	C	D	E	F	G
NAME	X GRID VALUE	Y GRID VALUE	Z GRID VALUE	TYPE	LATITUDE	LONGITUDE

This order can be easily and quickly achieved with the cut and past commands within Windows.

Field A
   This field contains the text that will be written under the position marker.
Fields B and C
   These two fields determine the X and Y values that establish the position of the marker or symbol in the Autocad grid reference system. The data base insertion program first checks these fields for a value. If these fields are empty then the program will check the values of fields F and G. If both fields are empty then the marker position reverts to position 0,0 in Autocad.
Field D
   This value is the altitude or height of the position marker and can be left blank.

Field E

The type of symbol to be inserted or the action to be taken is determined by this field.

Symbols

If in the final drawing a symbol will represent a data base entry (i.e. navigational aid), the required symbol can be automatically entered by changing the value of this entry to the appropriate symbol code as listed below. For symbols obst1 to obst6 the last two fields **K** and **L** are the values that will be used as the written altitude and height.

Required Symbol			

Data Base Symbol Code			
repc	ad1	vor	obst1
repnc	ad2	vord	obst2
repv	ad3	dme	obst3
wpfo	ad4	vortac	obst4
wpfb	ad5	ndb	obst5
par	ad5	mrk1	obst6
hel	ad7	mrk2	
gld	ad8	mrk3	

	A	B	C	D	E	F	G	H	I
31	TOR				**VORD**	N591008.80	E0101533.36		
32	SOMPO				**REPC**	N590532	E0111436		
33	OA				**NDB**	N595056.03	E0102801.84	352 KHZ -L	
34	FBU				**VORD**	N595347.93	E0103652.92	112,900 MHZ	CH76X
35	bunnef-jorden				**REPNC**	N594318	E0104335	VFR reporting point	

Airspace

Airspace boundaries can be automatically constructed in the drawing. The beginning of the airspace boundary must begin with the code "**as**" in field E, subsequent boundary entries are coded with "**a**" and the final entry with the code "**af**". To construct the airspace in three dimensions, code "**3D**" must be entered in field **I**. In a 3-dimensional construction the lower level is the value in field **D** and the upper level is the value in field **H**.

If a circular area (restricted/danger area) is to be created then two codes in field E are applicable. The first code is "**ack**" and advises the program that the radius value, which must be entered in field **J**, is in kilometres. While the second code "**acn**" indicates that the radius value in field **J** is in nautical miles. Once again, if the result is to be in three dimensions then the code "**3D**" must be entered in field I.

	A	B	C	D	E	F	G	H	I	J	K
53	FBU SECTOR1			**4500**	as	N602600	E0101800	14500	**3D**	OSLO APP	CLASS D
54	FBU SECTOR1			**4500**	a	N602600	E0104900	14500	**3D**	OSLO APP	CLASS D
55	FBU SECTOR1			**4500**	a	N601600	E0105200	14500	**3D**	OSLO APP	CLASS D
56	FBU SECTOR1			**4500**	af	N601000	E0095600	14500	**3D**	OSLO APP	CLASS D
57	RD 52			**2500**	ack	N601600	E0105200	20000	**3D**	**7.5**	Resricted Area

AIRSPACE

2D

3D
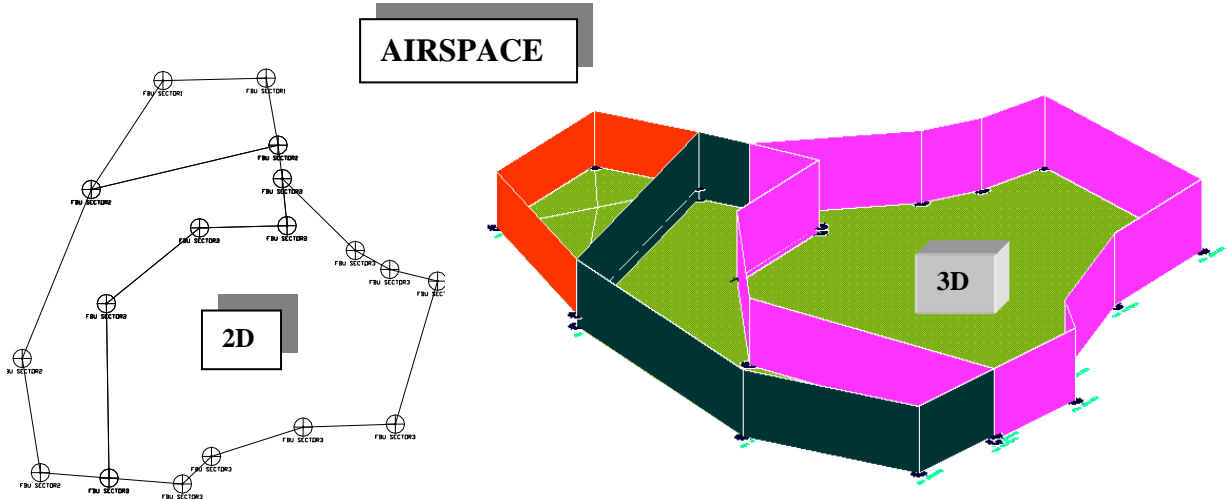
Routes

If the data base entries will be routes in the final drawing, the route construction can be automatically done by the program. The beginning of the route must begin with the code "**rs**" in field E, subsequent route segments with the code "**r**" and the final route entry with the code "**rf**". The magnetic variation at each position can be placed in field **H**.

	A	B	C	D	E	F	G	H	I	J
53	UG 9			4500	rs	N602600	E0101800	**0**		Upper green 9
54	UG 9			4500	r	N602600	E0104900	**0.35**		Upper green 9
55	UG 9			4500	r	N601600	E0105200	**0.35**		Upper green 9
56	UG 9			4500	rf	N601000	E0095600	**0**		Upper green 9
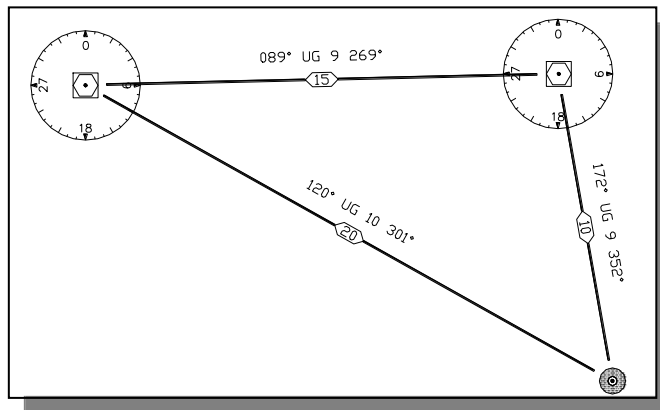
Fields F and G

This is the Latitude (field f) and the Longitude (field g) of the position. This position information must be in the following format: -

Latitude   **Longitude**
N/Sddmmss.sss   E/Wdddmmss.sss

Note that the program checks for entries in field **B and C** prior to checking fields f and g.
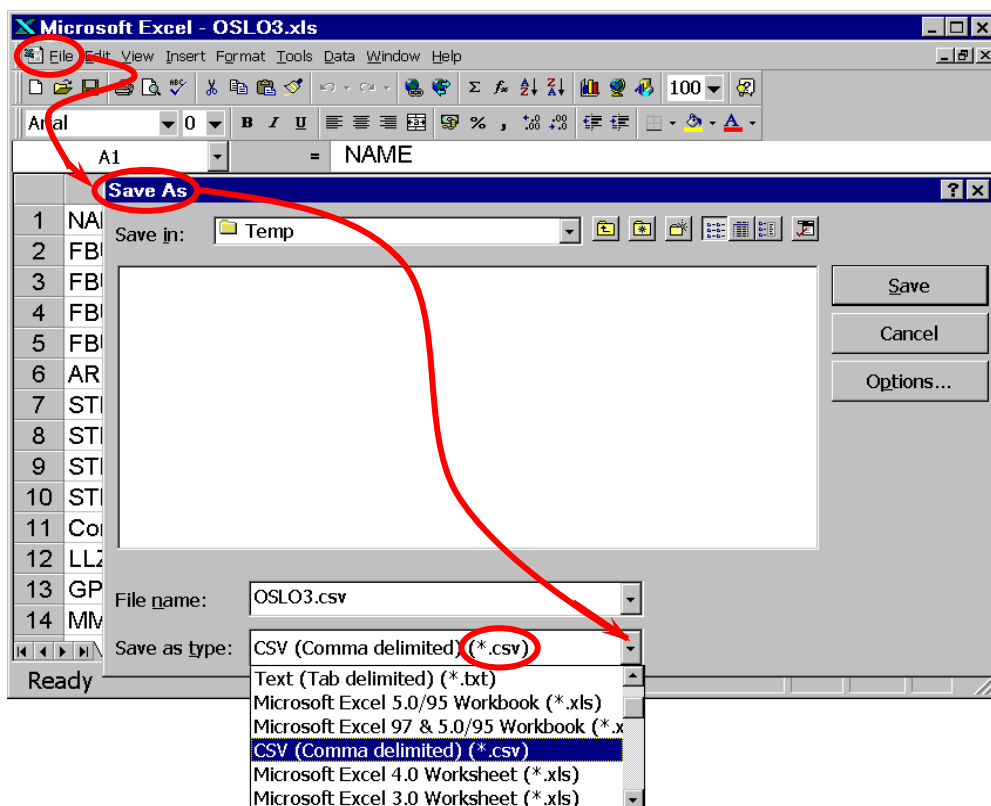
Fields H-L

The fields H to L are for information that will sit behind the position marker or symbol, to be retrieved if required.

Organisation of Data

   It is possible to include all data in a single data base file however this is not advisable. Data can be lost or corrupted destroying a single file. If the data is divided in to a series of files, for example routes, nav aids and airspace, it is much easier to retrieve the correct data. Try to establish some sort of order in the file system prior to their creation. Files could even be organised by region or airport.

Exporting the Data

   Now that the database is in the correct order it must be exported as a text file in the comma separated values (CSV) format. This means that in the exported text file the database fields are separated by a semicolon " ; " this is essential, as otherwise the **Wavionix** program will not be able to determine when one field finishes and another begins. The process sounds complicated however it is easily achieved by clicking on the correct buttons in the database. In Microsoft Excel select 'File', 'Save As', then in the 'Save as Type' section select CSV and finally 'Save'.


   If you have a situation were Excel is exporting the text file (*.CSV) with commas (,) separating the data fields instead of semicolons (;). The Wavionix Data Base program will not work and you will have to change the List Separator in Windows. In the Windows 95/NT select the Control Panel in Start settings. Then select Regional settings and in number change the comma (,) in the List Separator to a semicolon (;). Now Excel will export and recognise text files where the fields are separated by a semicolon (;).
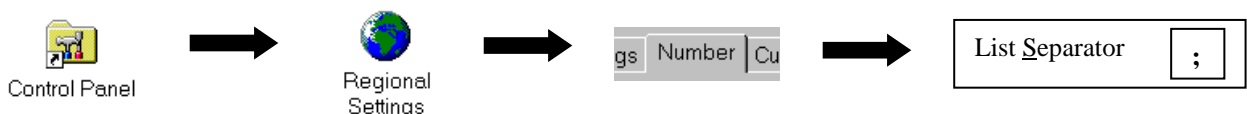
Importing the Data

Now start Autocad and open the drawing in which you wish to insert the database.
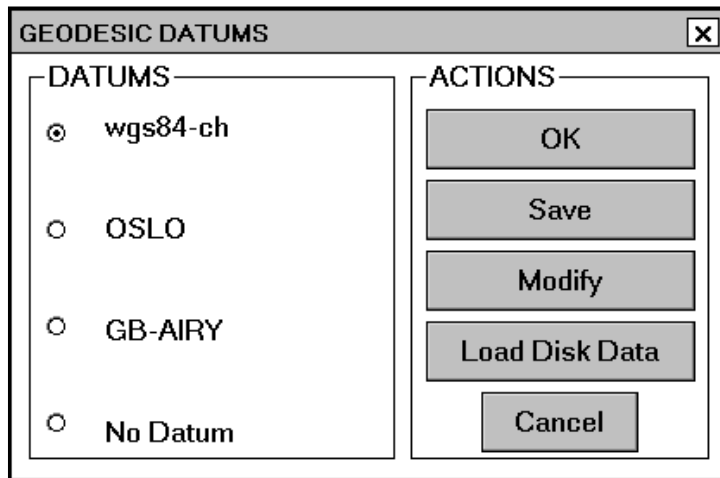
Firstly you must establish a geodesic datum for conversion from Latitude/Longitude to grid reference. If there are no Latitude/longitude entries in the database, to be converted, then "No Datum" can be selected. Refer to the geo section of this manual for an explanation of setting up and modifying a geodesic datum. If you wish to change an existing datum select the "Modify" button and if you require the default geodesic datum's select "Load Disk Data". Selecting the "Save" button saves a modified geodesic datum.
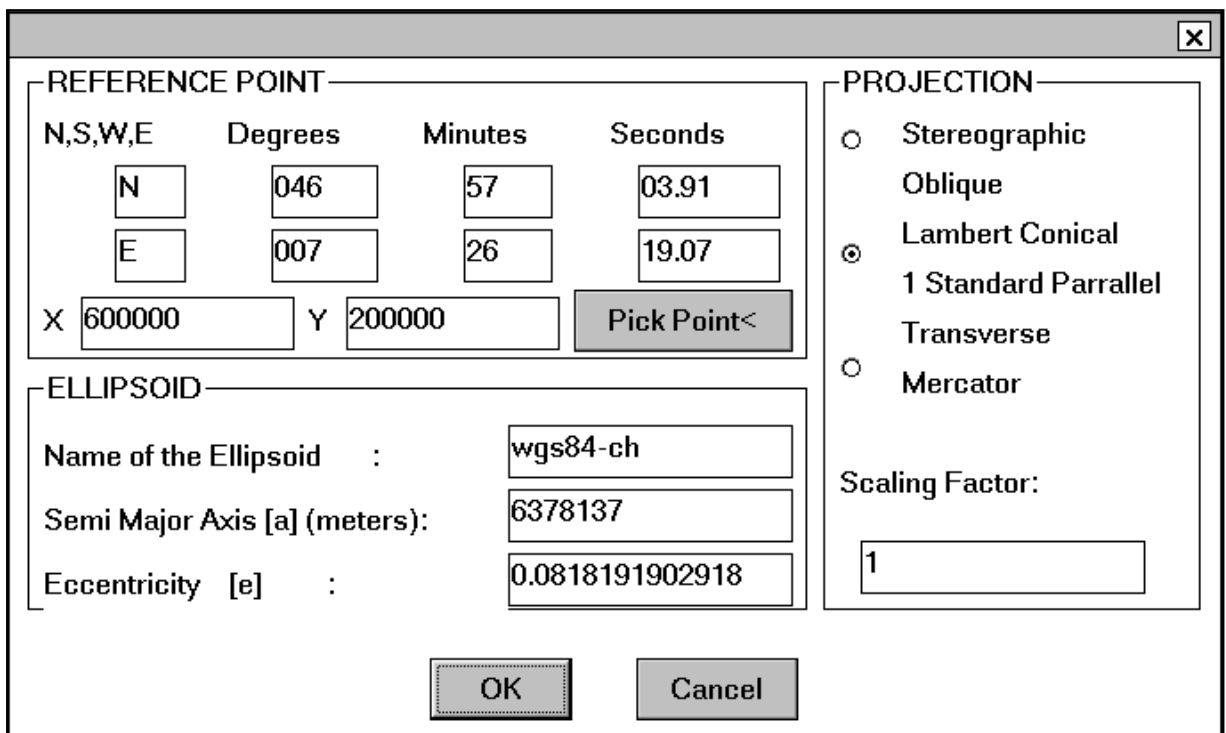
Changing a geodesic datum, refer to the Geo section

Once the geodesic datum is established the Data Base Insertion dialogue box will appear.


Enter the file name in the box provided or click on the Browse button to browse through the hard disk for a converted data base file (*.csv). Select the type of default position symbol to be inserted, the size of which can be changed with the Scale of symbol setting. This means, that if no symbol code entry is in the "Type" field (field E) the selected default symbol will be inserted.

The first symbol "obstacles" is simply a circle and is used to represent three-dimensional obstacles, as used by other applications in the **Wavionix Procedures Designer**. When this symbol is selected a further dialogue box appears. Within this dialogue box the radius (position tolerance) and numbering of the obstacle circles can be entered. Three-dimensional circles are especially useful in certain situation, however in this instance the information in columns A and E to L are not available.

In some cases it may not be desirable to insert the entire data file. To insert a portion of the data file change the Entry to start at (No.) box to the number of the starting entry of the data file and the Entry to finish at (No./End) box to the number of the data file entry to finish at. If the Entry to finish at value is "End" then the program will continue, inserting position symbols, until the end of the data file

In the following diagram the inserted position symbols and names are entered from a data file. The other entities can be entered later for clarification or if already determined can be used for checking of a database. To access the remaining data behind the symbol, type the Autocad command "_ddatte" or click the ⬚ button and select the position symbol.

A dialogue box 'Edit Attributes' will appear, as shown in the diagram, the information data can then be viewed and edited.
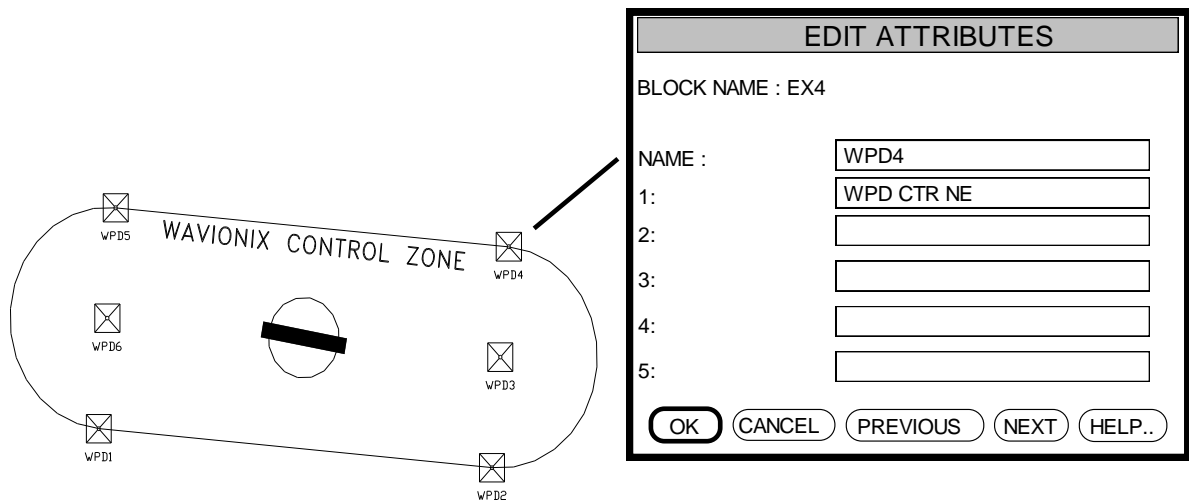
To undo the multiple insertions of a large database could take some time. To solve this problem, the Data Base program creates an 'undo mark' prior to insertion of the position symbols so the Autocad "_undo-back" command will now only undo until the start of the Data Base program. Note that once the Autocad "_undo-back" command is carried out the 'undo mark' is removed.

TOOLS

V5

DATA SEARCH AND CHANGE

DATA SEARCH and CHANGE

Using the program Data Base Insertion is an excellent way of importing a large amount of position data. However such a large visual position database (drawing) can become unwieldy. With possibly thousands of position points, finding one specific point or changing any of the properties of the points singly would take so much time as to invalidate the use of such a visual information system. Now it is possible to amend and manipulate this visual data quickly and efficiently with the Data Search and Change program.
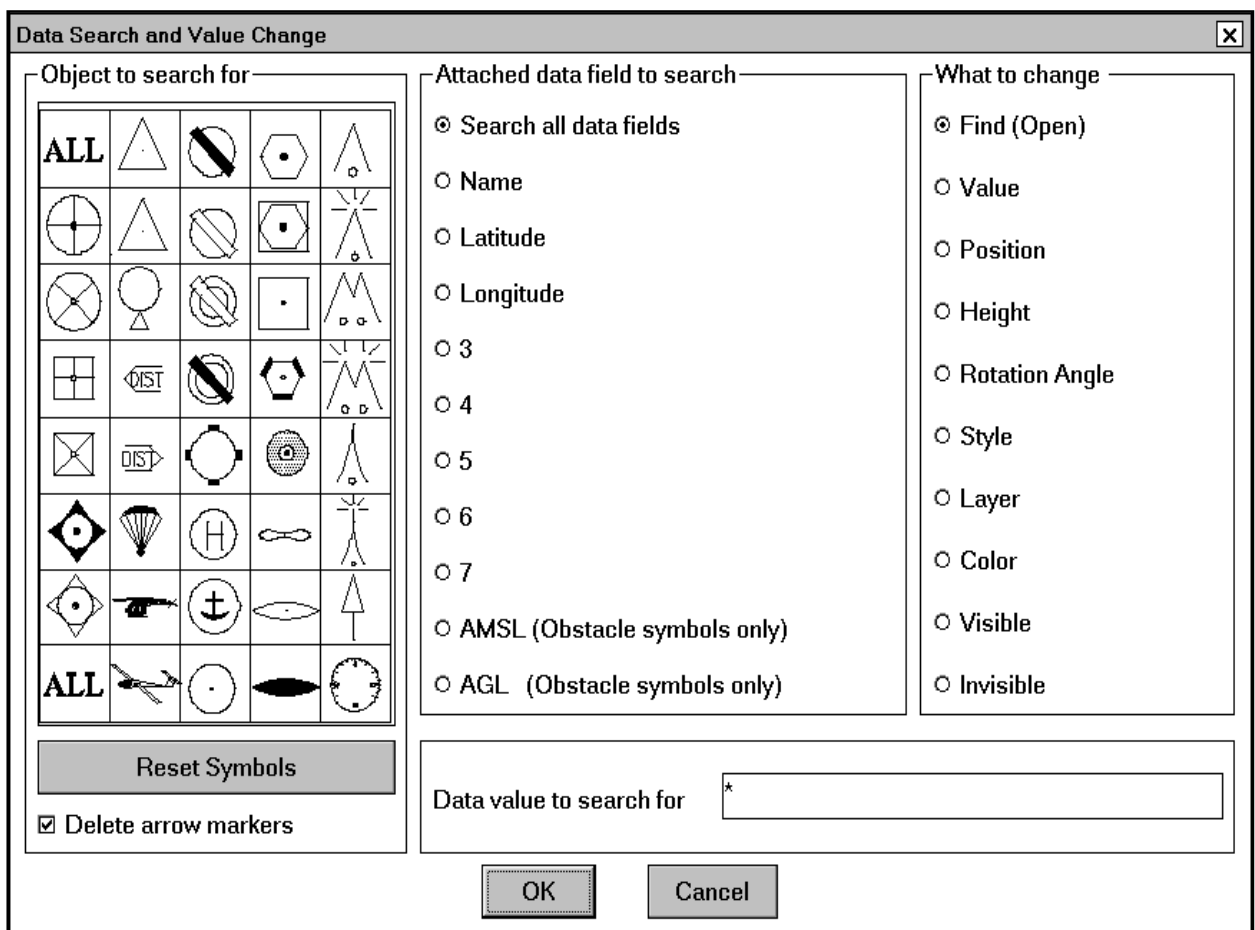
The sections in this dialogue box can be divided into:

What to search?	Where to search?	What to search for?	What to do?
Object to search for	Attached data field to search	Data value to search for	What to change

What to search?

The **object to search for** section allows the selection of either all symbols or a specific symbol to search for. The four symbols in the top left-hand corner of the symbol images are the default symbols for the Data base insertion program. To select a symbol simply click on the symbol, to return to the symbol selection image select the Reset Symbols button. When data is found the Data Search program inserts a large visual arrow symbol. These can be deleted by checking the Delete arrow markers box.

Where to search?

Each symbol inserted into the drawing by the Data base insertion program has eight fields including the name attached to it. Data contained in these fields can be searched for and the fields searched restricted. This option is available by selecting the required field in the **Attached data field to search** section. Entries 3-7 correspond to the information entries.

What to search for?

Any value or text can be entered in the **Data value to search for** box. If no value is required then entering an asterisk (*) will select all values.

What to do?

In the **What to change** section various properties of the symbols and their associated data can be changed. If it is only needed to find the position of certain data then the Find (open) field should be selected. If more than one entry is found the program only shows the position markers, however if a single entry is found the object is indicated and the data fields are opened for editing.

TOOLS

VCUT
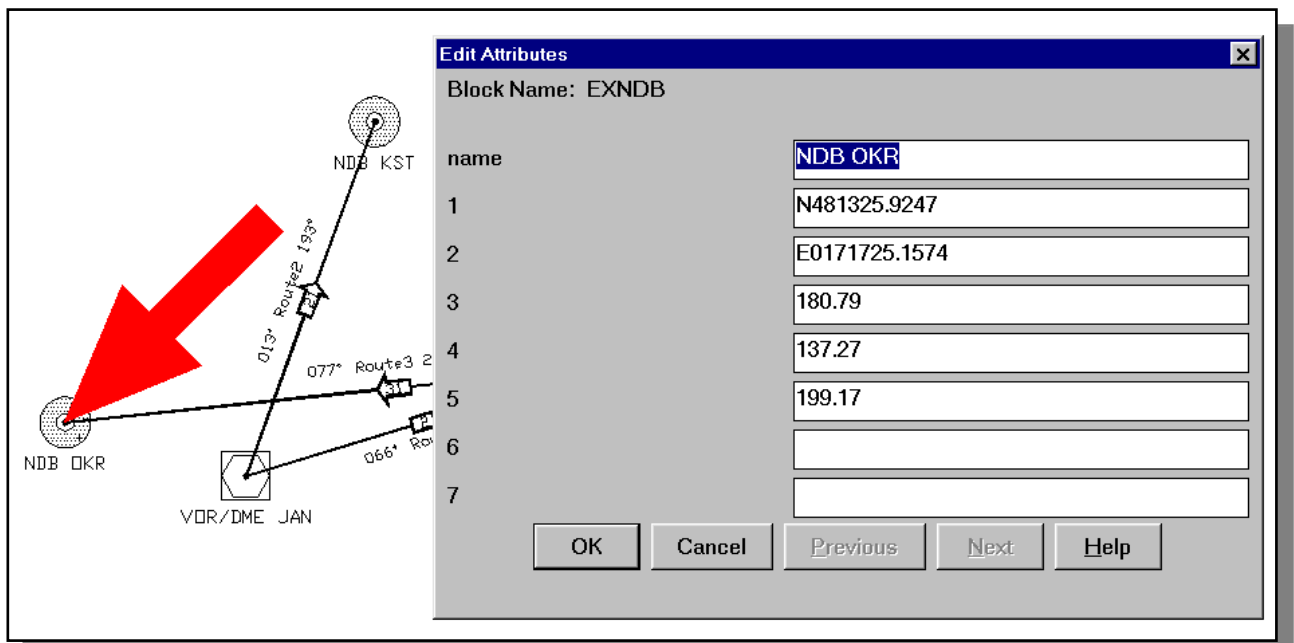
SETUP
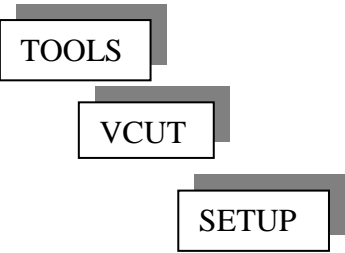
VERTICAL CUT SET UP

A vertical cut can be of use in a number of scenarios, for example determining altitudes on the glide path, demonstrating obstacle penetration, establishing minimum procedure design gradients etc. Another specific example is the 15 % step-down exclusion area as shown in ICAO Doc. 8168 Vol. II page 3-16 figure III-2-11; this can be assessed and calculated visually without mathematical calculation by using a vertical cut. The Vcut Setup program was developed to help in the set-up of a vertical cut drawing.

The diagram inside the dialogue box, Vertical Cut Setup, is a stylised version of the vertical cut. The Left to Right and Right to Left buttons change the diagram and the eventual construction, by putting the runway (RWY) start position either to the left or right of the screen. The Distances In: - section enables the input of nautical miles or kilometres on the Base Line.

The section Used For: -, determines the different uses of the vertical cut. If Departure is selected, as in the dialogue box diagram, two lines are drawn, the uppermost line representing the procedure design gradient and the lower line representing the varying Minimum Obstacle Clearance (MOC). The 5m DER (base line) crossing height is automatically added.

When approach is selected the second edit box, in this section, is unavailable and the first edit box changes to represent the nominal Glide Path (GP) angle. This value determines the angle of the single line drawn from the threshold (THR) representing the nominal approach path.

GP   (deg)   3

RDH   (m)   15

The final selection of ILS changes the two edit boxes to Glide Path (GP) and Reference Datum Height (RDH). With this selection a line is drawn to represent the glide path angle and the value of the RDH is automatically added to the position of the line above the threshold (base line). All gradient lines are drawn on a new layer "GRADIENT".

The base line section determines the position and length of the vertical cut. The runway threshold or start position of the base line can only be established by selecting a position from the graphics screen with the <Pick Start Position button. This position is an arbitrary position and the only requirement being that it is in a space clear of other entities in the drawing. The position picked from the graphics screen is shown under the <Pick Start Position button for information only. The length of the base line can be entered in either nautical miles or kilometres depending on the selection in the Distances In: - section. Distances along the base

Base-Line

<Pick Start Position

(102.8/287.9)

Length (Km)   3

☒ Distances Marked

Specific Distances Marked

Distance (Km)   Text

line can be added by selecting the Distances Marked box. These distances are in either nautical miles or kilometres depending on the value of the Distances In: - section.

The values entered in the Specific Distances Marked section refers to specific distances such as the turning point or a step-down fix. The Distance entered can be in either nautical miles or kilometres depending on the value of the Distances In: - section.

Vertical cut obstacle insertion

The process of positioning of plan view obstacles in a vertical cut is accomplished with three different programmes, they are, VOBST1 VOBST2 and VOBST3. This is due to the fact that ICAO using conservative methods establishes different distances to climb to over fly an obstacle. These varying distances are dependent on the obstacle position and whether the procedure is, climb straight ahead, turning at a fix or turning at an altitude. In the Plan View portion of the diagram to the right, the three different programs have been placed in three different sectors. The sectors 1 to 3 determine which obstacle insertion program should be used. For example obstacle 1 is in sector 1 and so Vobst1 would be used, while obstacle 2 is in sector 2 so Vobst2 would be the applicable program. In sector 3 only use Vobst3 if the aircraft is turning at an altitude otherwise use Vobst2. Refer to ICAO Doc. 8168 Part II for more information.
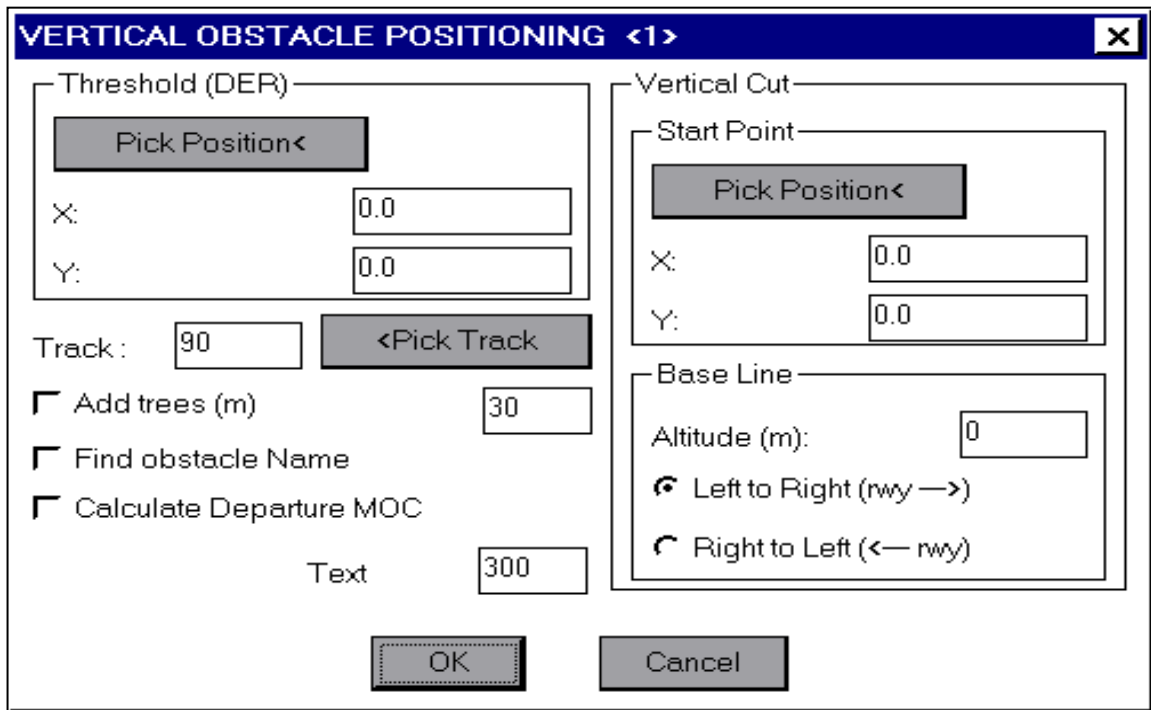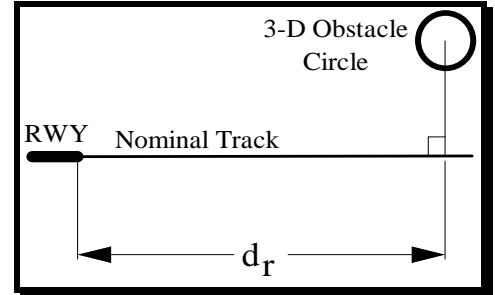
DO

VOBST1

TOOLS

VCUT
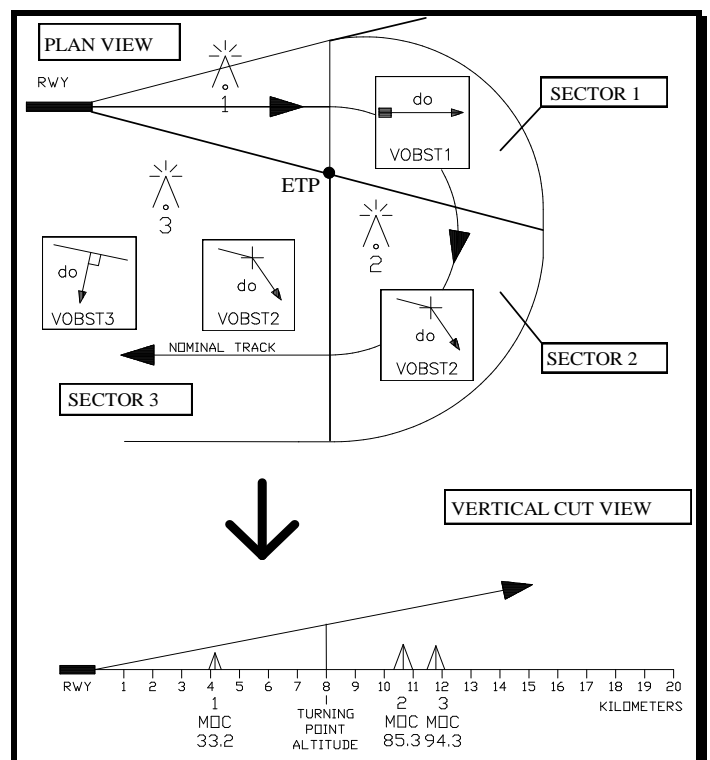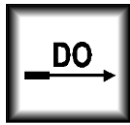
VOBST1

This is the most basic of the three vertical cut obstacle insertion programs and is used for obstacles in the straight ahead portion of the procedure (approach, missed approach and departure. The distance (d_r) from the threshold to the obstacle is determined as shown in the diagram to the left.

3-D Obstacle Circle

RWY   Nominal Track

d_r

VERTICAL OBSTACLE POSITIONING <1>   ×

┌─Threshold (DER)─────────────

   Pick Position<

   X: 0.0

   Y: 0.0

   Track : 90   <Pick Track

   ☐ Add trees (m)   30
   ☐ Find obstacle Name
   ☐ Calculate Departure MOC

            Text   300

┌─Vertical Cut─────────────
  ┌─Start Point─────────

     Pick Position<

     X: 0.0

     Y: 0.0

  ┌─Base Line─────────

  Altitude (m):   0
  ◉ Left to Right (rwy —>)
  ○ Right to Left (<— rwy)

            OK   Cancel

The Position of the threshold or Decision End of the Runway (DER) in the plan view and the position of the start of the vertical cut are entered in the Vertical Obstacle Positioning <1> dialogue box. These two control points can be entered manually or positions can be selected from the graphics screen by selecting the respective Pick Position< button.

The Track box refers to the nominal track in the plan view and can be entered manually or any two points can be selected from the graphics screen to determine the track.

A height can be added to obstacles or spot heights to allow for trees or buildings. To do this check the Add trees box as shown in the dialogue diagram. When this box is selected the adjacent height value box is available and any height value can be entered. Usually this value is 30m.

In the case of a departure the variable minimum obstacle clearance (MOC) can be calculated by checking the Calculate Departure MOC box. When this box is selected the following Text box is available. This value determines the height of the text of the calculated MOC value that will be written under the obstacle.

In the Vertical Cut section the Base Line Altitude value is the user determined altitude of the vertical cut base line and is usually the altitude of the threshold or DER. This value will be subtracted from the obstacle altitude to give the height of the obstacle above the vertical cut base line (i.e. THR or DER).

Finally the previously drawn vertical cut can be either from left to right or right to left as determined by the Vertical Cut Setup program (see Vertical Cut Setup). Select either left to right or right to left as applicable.

V5

Once the OK button is selected the Vobst1 program will give the user, at the command prompt, two options for obstacle selection either Circles or Position, while entering ↵ return will finish the program.

If P or position is entered Vobst1 will commence to ask for three-dimensional positions (X, Y, Z), in the plan view and an obstacle identification number or name. Entering ↵ return at this point will return the user to the main selection prompt.

If C or circles is entered Vobst1 will ask for the selection of 3-dimensional obstacle circles. The obstacle circles can be selected individually or by using a window. In the window method all entities other than circles will be filtered out. If the "find obstacle name" box is checked in the main dialogue box, then Vobst1 will search within the centre of the obstacle circle for a name and enter this in the vertical cut along with the obstacle. Entering ↵ return at this point will return the user to the main selection prompt.

The output of the Vobst program into the vertical cut is the obstacle, name and MOC the other entities in the diagram were added for clarification. In this case both the Add trees and Calculate Departure MOC boxes were checked.
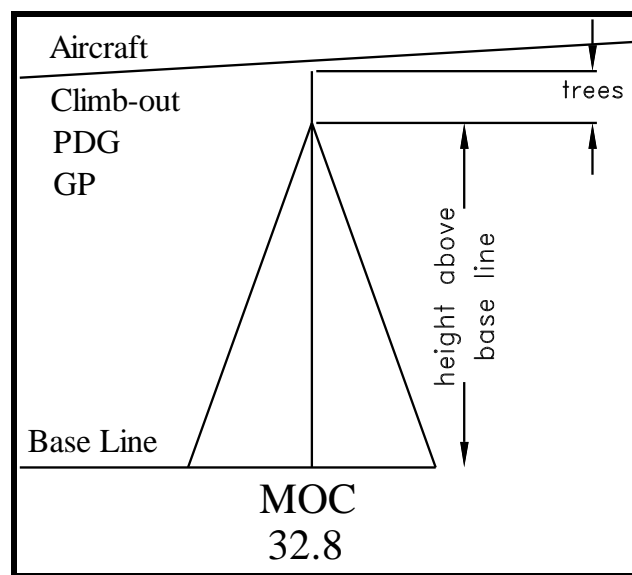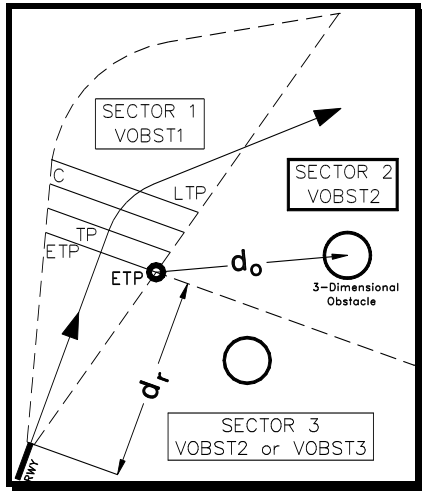
TOOLS

VCUT

VOBST2

VOBST2

The program Vobst2 is used to position plan view obstacles in a vertical cut when a turn is prescribed in the procedure (missed approach and departure).

This program should be used for obstacles in sector 2 and only obstacles in sector 3 when the turn is commenced at a fix as shown in the diagram. The distance to climb to an obstacle is the sum of the straight-ahead portion (d_r) plus the distance from the Earliest Turning Point (ETP) to the obstacle (d_O). This sum is used in the calculation of the Minimum Obstacle Clearance (MOC) for a departure. ICAO Doc. 8168 Vol. II states that during a turn the MOC applicable shall be the greater of the calculated MOC or 90m. The Vobst2 program writes the greater value under the obstacle in the vertical cut when requested.

The Vertical Obstacle Positioning <2> dialogue box for the program Vobst2 is very similar to the Vertical Obstacle Positioning <1> dialogue box for the program Vobst1 and only the differences between the two dialogue boxes will be explained.

Because the Earliest Turning Point (ETP) is an important control position for determining the distance d_O it is required that the user enter this position in the ETP section of the dialogue box or select a point from the graphics screen with the pick position button. Obviously the ETP chosen should be the closest to the obstacle.

The section of the dialogue box labelled Straight Ahead Portion determines the out-bound track from the threshold or Decision End of the Runway (DER). This track combines with the ETP position to establish the distance d_r.

The output of the program is the same as that for the program Vobst1, the only difference being the distance from the start point in the vertical cut ($d_r + d_O$) and the calculated departure MOC.

V5

      Once the OK button is selected the Vobst2 program will give the user, at the command prompt, two options for obstacle selection either Circles or Position, while entering ↵ return will finish the program.

    If P or position is entered Vobst2 will commence to ask for three-dimensional positions (X, Y, Z), in the plan view and an obstacle identification number or name. Entering ↵ return at this point will return the user to the main selection prompt.

    If C or circles is entered Vobst2 will ask for the selection of 3-dimensional obstacle circles. The obstacle circles can be selected individually or by using a window. In the window method all entities other than circles will be filtered out. If the "find obstacle name" box is checked in the main dialogue box, then Vobst2 will search within the centre of the obstacle circle for a name and enter this in the vertical cut along with the obstacle. Entering ↵ return at this point will return the user to the main selection prompt.
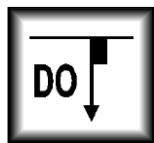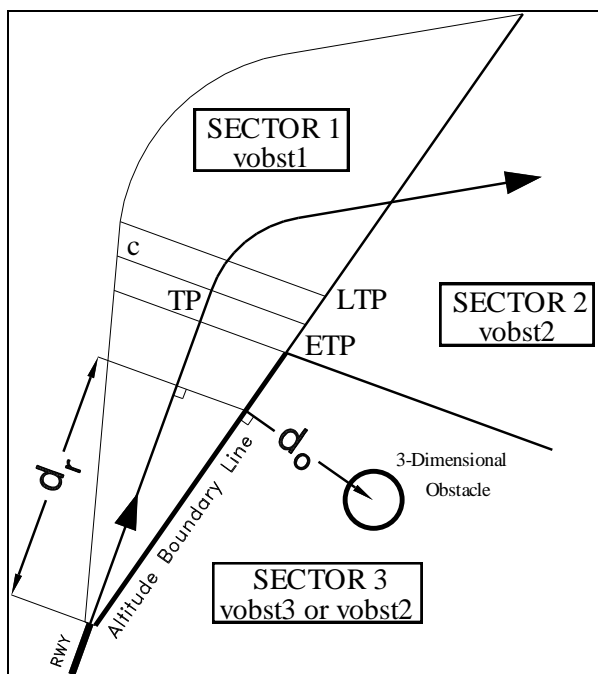
TOOLS

VCUT

VOBST3

VOBST3

    The program Vobst3 is used to position plan view obstacles in a vertical cut when a turn at an altitude is prescribed in the procedure (missed approach and departure).

    This program should be used for obstacles in sector 3 only, while Vobst1 and Vobst2 are used for obstacles in sectors 1 and 2 respectively. The distance to climb to an obstacle is the sum of the straight-ahead portion (d_r) plus the distance from the thick altitude boundary line to the obstacle (d_O). This sum is used in the calculation of the Minimum Obstacle Clearance (MOC) for a departure. ICAO Doc. 8168 Vol. II states that during a turn the MOC applicable shall be the greater of the calculated MOC or 90m. The Vobst2 program writes the greater value under the obstacle in the vertical cut when requested.

    The Vertical Obstacle Positioning <3> dialogue box for the program Vobst3 is very similar to the Vertical Obstacle Positioning <1> dialogue box for the program Vobst1 and only the differences between the two dialogue boxes will be explained. The section of the dialogue box labelled Straight Ahead Portion determines the out-bound track from the threshold or Decision End of the Runway (DER) and is required to establish the distance d_r. The section Vertical Cut has included a sub section Aircraft. This section establishes the position of the turning altitude on the vertical cut base line.

The first box Altitude Over Start Point (m) is the altitude of the aircraft over the starting point of the vertical cut base line as entered in the Start Point sub section of the vertical cut section. In a departure this value would be 5m but a missed approach could have any value. Enter in the Turning Altitude box the commencement of turn altitude in meters and in the Climb-out box enter the percentage climb-out or procedure design gradient in percent. These values are used in the determination of the turning altitude position on the vertical cut base line. This position can be marked for reference by selecting the Mark Turning Altitude box.

Once the dialogue box is completed and the OK button is selected the Vobst3 program initially asks for the selection of the Altitude Boundary Line.
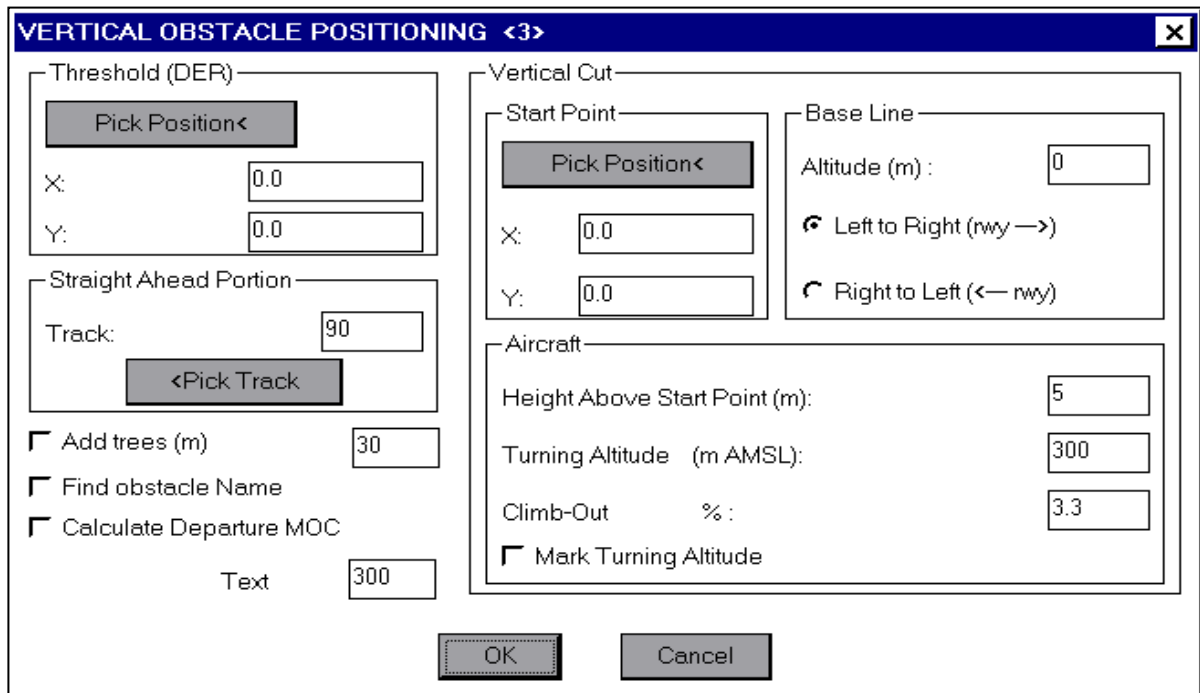
This is the tolerance area line of the straight-ahead portion of the procedure and must be similar to that shown in the initial diagram at the beginning of the Vobst3 program description.

> **V5** Once this selection is completed the Vobst3 program will give the user, at the command prompt, two options for obstacle selection either Circles or Position, while entering ↵ return will finish the program.

If P or position is entered Vobst3 will commence to ask for three-dimensional positions (X, Y, Z), in the plan view and an obstacle identification number or name. Entering ↵ return at this point will return the user to the main selection prompt.

If C or circles is entered Vobst3 will ask for the selection of 3-dimensional obstacle circles. The obstacle circles can be selected individually or by using a window. In the window method all entities other than circles will be filtered out. If the "find obstacle name" box is checked in the main dialogue box, then Vobst3 will search within the centre of the obstacle circle for a name and enter this in the vertical cut along with the obstacle. Entering ↵ return at this point will return the user to the main selection prompt.
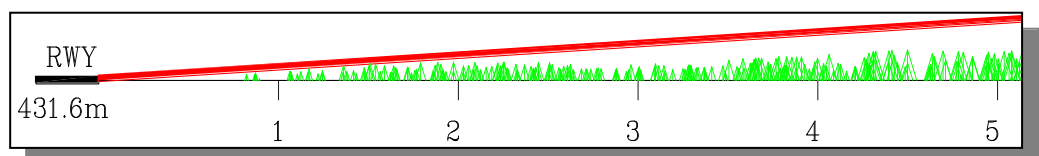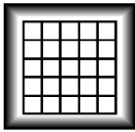
MESH

   Use this program to draw a mesh covering a specific area. The mesh can be used to show grid co-ordinates or provide a terrain base when using the Autocad shade command. The program requires the user to specify an area by selecting the bottom left hand corner and the upper right hand corner of a rectangle. Next the program asks for the number of ' M ' vertices, this is the number of squares in the X direction (East, West). The number of ' N ' vertices or squares in the Y direction (North, South) is automatically calculated to cover the area selected and correspond to the distance between the "M" vertices. This means that the vertices form exact squares. However the constructed mesh may be slightly larger by one square than the area selected if a rectangular area is defined as opposed to a square area.

CONTOUR-SIMULATED TERRAIN MESH

   Three-dimensional polylines can be converted into a three dimensional simulated terrain mesh with this program. The Contour program is not intended to be used for checking of obstacle infringement of a procedure, as obstacle position precision is lost with this program. For such detailed checking three-dimensional circles should be used. However the simulated terrain created by the Contour program can be used effectively to demonstrate a procedure in three dimensions. It is easier for a non-procedures specialist to recognise the problem areas of a procedure when the terrain is in a more realistic format.

   After starting the program use the button Select Polylines in the Simulated Terrain dialogue box to select the contour polylines. If other drawing entities are selected they will be filtered out and only the polylines will be retained. The number of polylines selected appears under the Select Polylines button.

   The Contour program calculates a mesh to the extents of the polyline(s) with the requested number of X (East, West) vertices as entered in the Mesh Vertices section. The program automatically determines the Y (North, South) vertices.

   The Surrounding Terrain section allows the user to input the altitude of the terrain outside the first contour polyline. This enables a smother transition from the edges of the mesh to the first contour polyline. Selecting the OK button commences the calculation and construction.

   The vertices of the mesh are positioned vertically corresponding to the nearest polyline vertex altitude (Z value). If no polyline vertex is in the immediate vicinity the mesh height is averaged between the height of the last polyline vertex to the left and the next polyline vertex height producing a smother height definition.

   The Contour program only evaluates the vertices of the polyline and does not take into account the line between two vertices. The averaging of vertex heights is only done in a left to right order and not top to bottom.

This is because the mesh is constructed line by line from left to right. To retain and average all points in a 255×255 mesh (65025 points) and to check these points against each vertex on each polyline would require large amounts of computer memory and an excessive amount of time.

The most important point in developing a simulated terrain mesh is to have a greater number of polyline vertices in the Y (North, South) direction and to ensure that the polyline is closed. For the best results try to arrange the number of mesh vertices to be such that the distance between them is approximately the equal to the distance between the polyline vertices.

If accuracy is not an important factor experiment using a number of mesh vertices less than 10 and use the Autocad "_pedit" command followed by "_smooth" on the mesh. This can some times smooth out the mesh to provide pleasant results.

The more polyline vertices and the more mesh vertices requested by the user the greater the mesh definition. The Autocad command "_pedit" followed by "_spline" can add vertices to a polyline. However be warned the greater the number of vertices the longer the program takes. With a large amount of vertices it is advisable to leave the program running overnight.

The following diagram took about 15 minutes to create and as can be seen the accuracy of the constructed simulated terrain mesh is not sufficient for procedure obstacle assessment. However the simulated terrain mesh without the contour lines is a satisfactory visual representation achieved with very little effort.
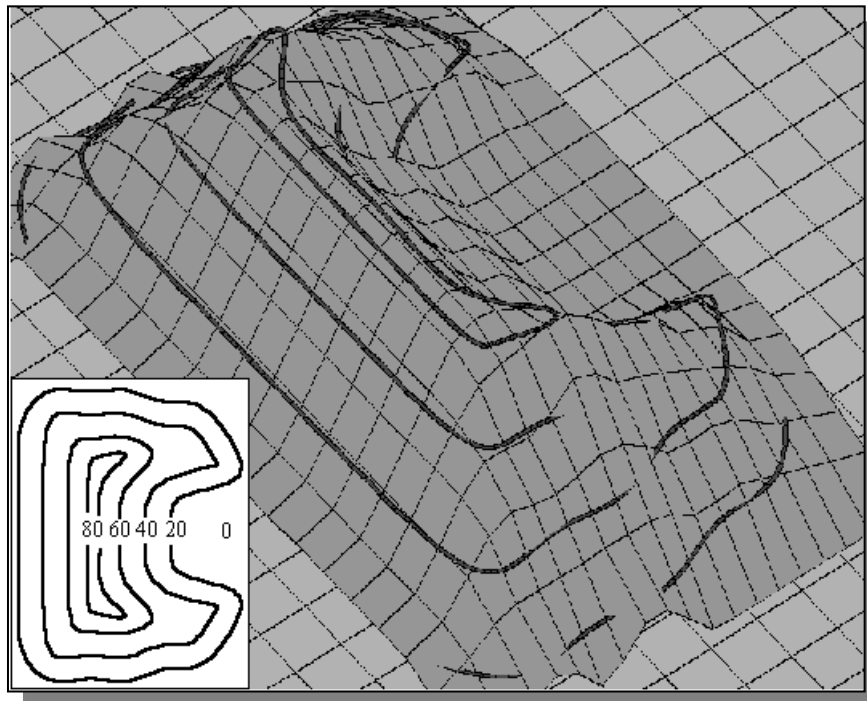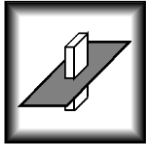
TOOLS

3D-FACE

3D-FACE

A large amount of obstacles can be quickly checked for vertical infringement by using the various constructed three-dimensional entities (i.e. ILS OAS, Radial etc.). However this efficient method of obstacle infringement recognition is not available when constructing turns. The 3D-Face program is a simple but powerful tool and alleviates the above problem by enabling the creation of a slopping three dimensional surface.

Once the program starts enter a corner of the surface to be created followed by the altitude of the point. Continue this process until all desired corners are defined and then enter ↵ Return from the keyboard. The created three-dimensional face is either a triangle or a quadrangle depending on the number of points entered. If more than four points are entered a new three-dimensional face is created.

An example will further explain the possibilities of this program. Take the case of an ILS missed approach with a turn at a height of 300m above the threshold. Use the OAS program to draw the obstacle assessment surfaces in three dimensions at a contour altitude corresponding to the turning height. The distance between point 1 and 3 depends on the procedure and the user. It is a simple matter to establish the aircraft altitude at points 3 and 4.

Distance (1 to 3) x Climb-out gradient + Turning altitude

Start 3D-Face and select points 1 and 2, entering the turning altitude (300m). Continue to select points 3 and 4, entering the calculated aircraft altitude.
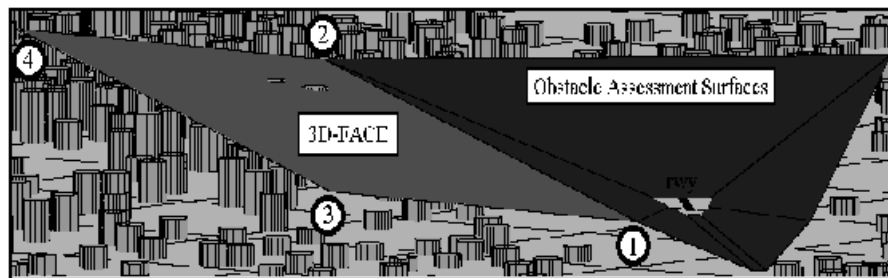
The Autocad "_shade" or "_hide" command can now be used to check an unlimited number of obstacles for penetration of the created surface. To check penetration of the minimum obstacle clearance (MOC), lower the surface by the required MOC. This lowering of the surface is easily achieved by using the Autocad "_move" command with a base point of 0,0 and a second point of 0,0,-90, where 90 is the MOC required. Lowering the surface by a further 30m enables the checking of trees or buildings that may not be included in the obstacle altitude. This is especially important when dealing with terrain spot heights. A further 3D-face could be created for the straight-ahead portion of the turn.

This program is not efficient for checking one or two obstacles but the time saved when checking a large number of obstacles is exponential. Once the number of critical obstacles is reduced to a manageable amount the obstacles could be paced in a vertical cut for a more in depth procedure manipulation or assessment.

Note that in the diagram for this program, the obstacles are represented as cylinders. This is only done for visual clarification and representing obstacles in this manner is not efficient. Obstacles should **only** be represented as three dimensional circles.

270 ← **D5**

BEARING AND DISTANCE

TOOLS   V5

BEARING DISTANCE

This program will calculate and draw the actual bearing and distance from one position to another using great circle geometry.

Firstly you must establish a geodesic datum for conversion from Latitude/Longitude to grid reference. Refer to the geo section of this manual for an explanation of setting up and modifying a geodesic datum. If you wish to change an existing datum select the "Modify" button and if you require to load the default geodesic datum's select "Load Disk Data". A modified geodesic datum can be saved to the hard disk by selecting the "Save" button.

Changing a geodesic datum, refer to the Geo section

Once the geodesic datum is established the Route Construction dialogue box will appear.

In the position 1 section enter the Latitude and Longitude of the first position or select the position from the graphics screen by selecting the Pick Position 1< button. The magnetic variation at this position can also be entered in this section. The second position can be entered in the same manner in the Position 2 section.

If the Calculate button is selected at this stage the true and magnetic bearing to position 2 will appear in the Position 1 section and the true and magnetic bearing to position 1 will appear in the Position 2 section. The distance in nautical miles and kilometres between position 1 and 2 will appear in the Distance Pos. 1 to Pos. 2 section.

If it is required to find a position at a specific bearing and distance, first start by clearing the Latitude and Longitude values in the Position 2 section by selecting the clear button. Then enter the bearing either as true or magnetic in the appropriate boxes in the Position1 section. The required distance should then be entered in the Distance Pos. 1 to Pos. 2 section or a distance can be picked from the graphics screen by selecting the Pick Distance < button. Finally select the calculate button to determine the Latitude and Longitude of the resulting position which will appear in the Position 2 section.

Draw the nominal track between the two positions by selecting the Draw Route box in the Construction section. After the Calculate button has been selected the Route Designation dialogue box will appear.
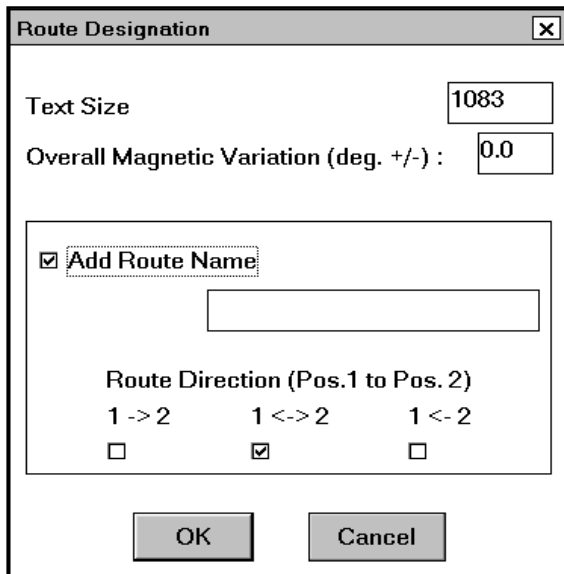
The size of the text and subsequently the size of the route symbol can be changed in this dialogue box. The overall Magnetic Variation box is only used with multiple position and will be discussed later. If a route name is to be added in the text, check the Add Route Name box and enter the name of the route. Check one of the three route direction boxes, one way from position 1 to position 2, bi-directional or one way from position 2 to position 1.

To draw the route using either ICAO or Jeppesen symbols select the required symbols in the Construction section.
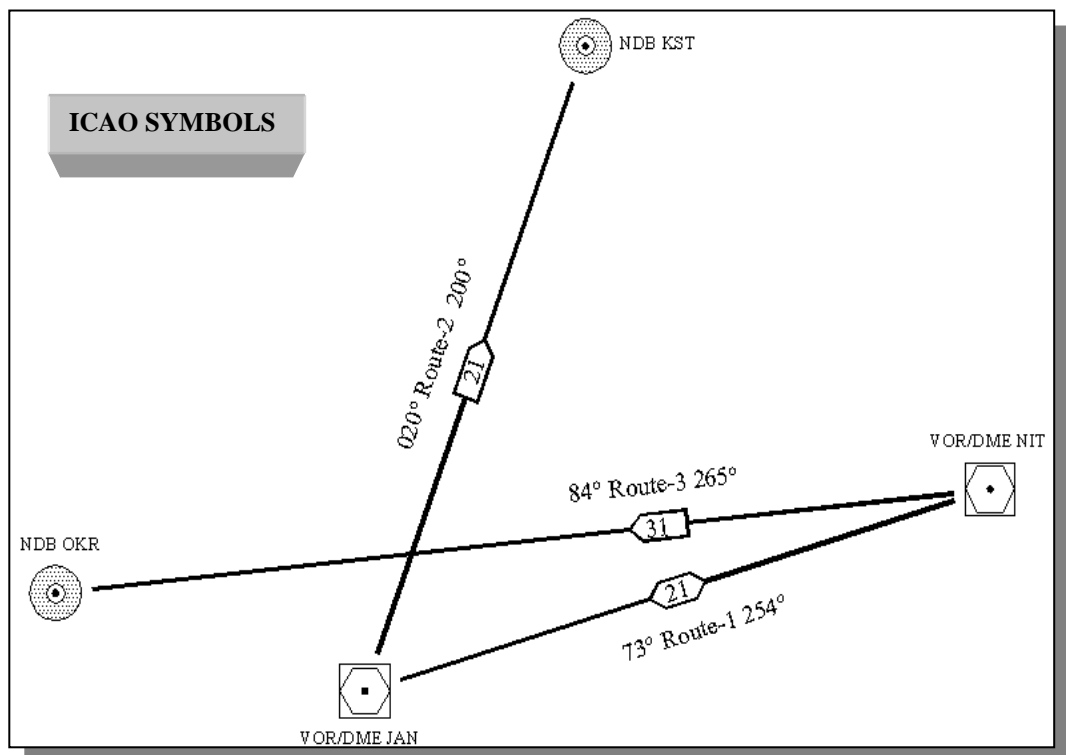
   If a number of routes need to be drawn, select the Multiple Positions < button in the main Route Construction dialogue box. This option is only available from the graphics screen and positions must be picked from the screen.

   Initially the Bearing and Distance program will request the first and second positions. After the positions are selected the Route Designation dialogue box will appear (explained previously). The program will then draw the route.

   After drawing the route the program will return to the command prompt and four options will be available for the next first position.

The options are: -

<div align="center">New position/Undo/Exit/<Last position></div>

The default Last position is the position that was previously position 2. This was done so that the user could seamlessly create joining route segments. The New position option allows the entry of a position from the graphics screen. Undo will delete the previously drawn route and Exit will return the user to the main dialogue box.

   The selection of the second position has two options. The options are: -

<div align="center">Designation/<Second position></div>

The default Second position option allows the entry of the second position from the graphics screen. The Designation option returns the user to the Route Designation dialogue box after the entry of the second position from the graphics screen.
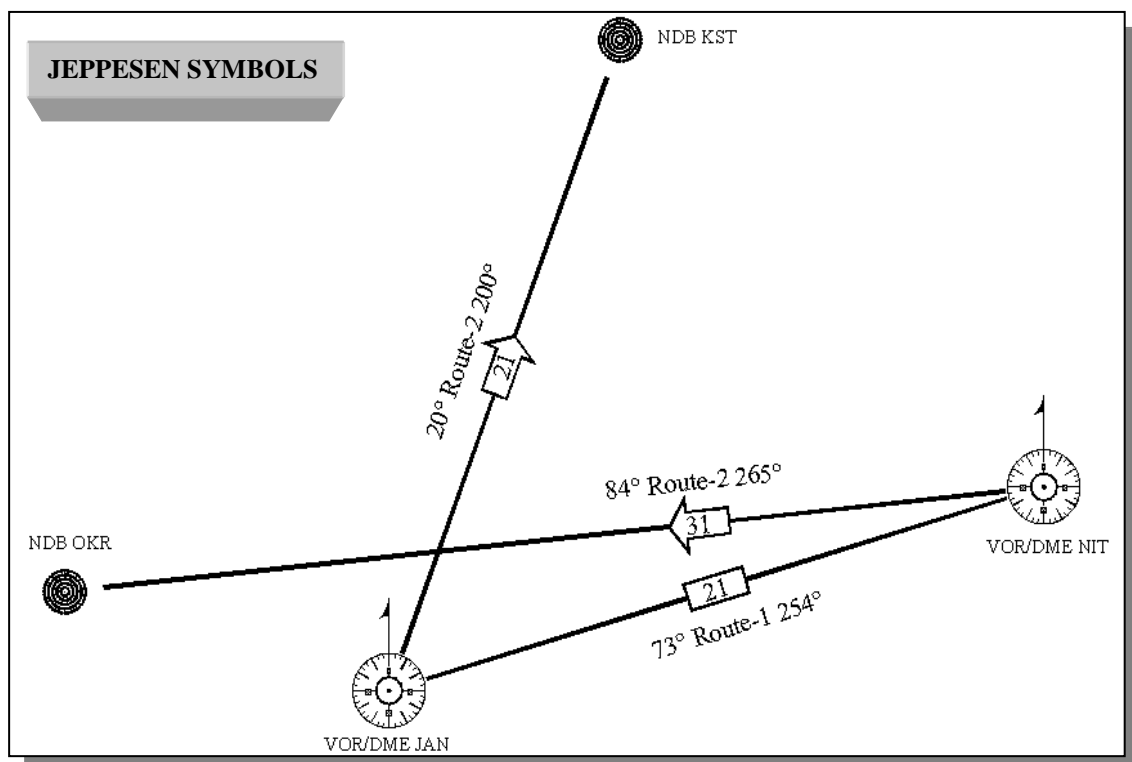
GEOGRAPHICAL CONVERSION

Positions and points on the computer graphics screen are in a flat two-dimensional grid format. This is the same as a sheet of paper or map used previously to design procedures by hand. The program Geographical Conversion is in response to the need of the procedures specialist to convert from geographical positions (latitude and longitude) to grid co-ordinates (X and Y). Once this conversion is completed positions can be plotted and placed on a map. However conversion is dependent on the cartography and geodesic datum used, which vary from country to country. The wide spread use of the World Geodesic System 1984 (WGS84) has to some extent standardised the varying datum's in use throughout the world.

Note that the Geographical Conversion program does not convert between one geodesic datum and another, it merely converts latitude and longitude into grid co-ordinates.

The program Geographical Conversion initially starts with the Default Values dialogue box. The user can select one of three previously saved geodesic datum's. This can be done by selecting the appropriate datum and the Load button. The Create button is unavailable at this time and will be explained later.

After selection of the datum to be used, the main Geographical Conversion dialogue box appears. This is where all the conversion between latitude and longitude and grid co-ordinates is carried out. However prior to conversion the cartography and geodesic datum may have to be changed.

DEFAULT VALUES

- ⦿ WGS84-CH
- ◯ CH-1903
- ◯ GB-AIRY

[Load] [create] [Cancel]

GEOGRAPHICAL CONVERSION

Reference Point
Lat. :N 046"57'08.66"
Long.:E 007"26'22.50"
X/Y :600000/200000
[Change]

Ellipsoid
Name : CH-1903
a : 6377397.155
e : 0.0816968312153
[Change]

Projection
Lambert
Conical
1 Parallel
[Change]

Insert :
☑ Text   Text height   [   ]   [Change Defaults]

Convergence:

☑ Point   Name   NAME   con1

Conversion

	Latitude	Longitude	X/Y Position
N,S,W,E	[ ]	[ ]	[Pick Point <]
Degrees	[ ]	[ ]	X: [ ]
Minutes	[ ]	[ ]	
Seconds	[ ]	[ ]	Y: [ ]

[End]   [->]   Convert   [<-]

The cartography and geodesic datum is divided into three sections, marked Reference Point, Ellipsoid and Projection. All three sections can be changed individually by selecting the appropriate Change button. Selecting this button activates the section's dialogue box and enables the changing of the relevant parameters. These change dialogue boxes will now be explained in order.

The Reference Point dialogue box changes the point at which the flat X and Y grid touches the Spheroid (Earth). This point is entered as a Latitude and Longitude. The X and Y values are arbitrarily the grid (computer screen) position of the Latitude and Longitude position and can be entered manually or a position can be picked from the graphics screen. Unless a standard meter grid system throughout the country is in use, it is advisable to choose a Latitude and Longitude position in the centre of the proposed construction area as this minimises standard flat plane conversion errors.

The Ellipsoid dialogue box determines the shape of the ellipsoid representing the Earth. The name of the ellipsoid can be any value as defined by the user and is intended merely as a memory aid. The Semi Major Axis [a] and the Eccentricity [e] can be readily obtained from the institution responsible for charting in the area concerned. This means that if the parameters [a] and [e] for WGS84 are entered a WGS84 position can be converted to a grid position. Care should be taken not to mix datum's or position types within a single area.

In the Projection dialogue box three different types of charting projections can be selected. It is advisable to select a projection that corresponds to the projection of the map to be used in the area of the procedure construction. If the map or grid reference has a scaling factor then enter the value in the Scaling Factor box. If you are not sure of the scaling factor for the map being used, then enter 1 in this box.

The Stereographic Oblique projection is a flat plane touching the Earth at a single point and so the standard conversion error increases with the distance of the position from this tangent point. For this reason the Stereographic Oblique projection should only be used within short distances of the reference point as entered in the Reference Point dialogue box.
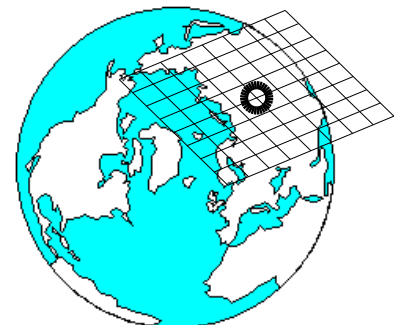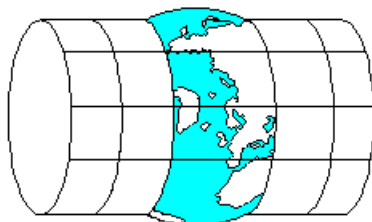
STEREOGRAPHIC

OBLIQUE
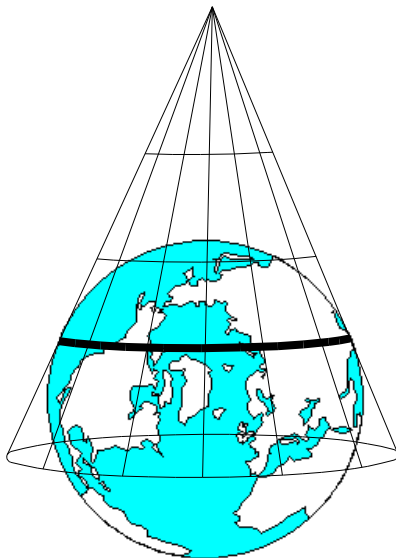
LAMBERT CONICAL
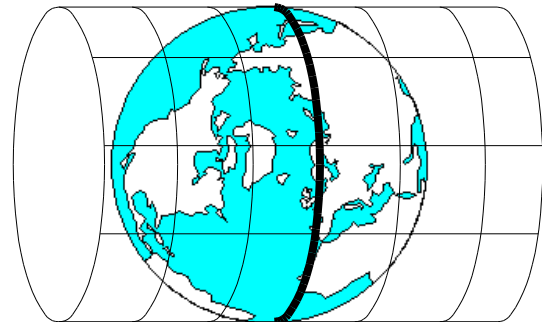
TRANSVERSE MERCATOR

The Lambert Conical projection has generally minimal standard conversion errors in the East West direction along the latitude of the reference point as entered in the Reference Point dialogue box. In this projection straight lines are great circle arcs.

Of the four types of charting projections that can be selected the Transverse Mercator projection is the most common. This projection has minimal standard conversion errors in the North South direction, along the longitude of the reference point and all rhumb-lines are straight lines.

Occasionally a situation will arise where the geographical conversion between latitude and longitude will not agree with an established system. This occurs when the map projection cuts the Earth in two places as opposed to touching the Earth at a tangent. The Wavionix Geographical Conversion program does not cover this situation, as too many different types of projections are possible. The errors in such a situation can be reduced to a minimum by entering a reference point in the centre of the construction area.

Below the datum boxes in the main Geographical Conversion dialogue box is the insertion section. If Text is selected the Text height box is available and a text height can be entered. This value is then used to automatically write the calculation results to one side of the grid position at calculation time. The name box is also available if you want a name for the position to be included in the drawing. When Point is selected a point will be placed at the grid position after calculation

This is also where the meridian convergence, that is calculated for the position is returned. The convergence should be added to any grid bearing obtained from Autocad, to determine the bearing in relationship to true North. The local magnetic variation can be added to this value to obtain the magnetic bearing, for annotation onto a chart.

The Change Defaults button activates the Default Values dialogue box. Three places are available and each one represents a complete set of datum values i.e. Reference Point, Ellipsoid and Projection. A whole new set of datum parameters can be loaded by selecting the Load button. The Create button saves the total present datum parameters in the position selected and overwrites the existing data in that position. The new name entered in the selected position is the Name value in the Ellipsoid section.

The Conversion section of the main Geographical Conversion dialogue box is where the actual position to be converted is entered. This section has the Latitude and Longitude position to the left and the X and Y grid position to the right.

To convert from latitude and longitude to an X/Y position enter the latitude and longitude in the appropriate boxes and select the **->** convert button. At this time the calculated results will be placed in the X: and Y: boxes and if the Point and Text boxes have been selected the position will be marked and the calculated results written in the drawing. To convert from an X/Y position to a latitude and longitude enter the grid position in the X: and Y: boxes or select a point from the graphics screen by selecting the Pick Point button. Selecting the **<-** convert button will write the calculated results in the Latitude and Longitude boxes. Once again if the Point and Text boxes have been selected the position will be marked and the calculated results written in the drawing.

It is important to note that no conversion will be carried out until either the -> or the <- button is selected. This means that if a new X/Y position is picked from the graphics screen, when the program returns to the main dialogue box any previous latitude and longitude values will be still be visible until one of the convert buttons is selected.

Finally it is an inherent property of all geodesic conversion formulas that positions can not be converted backwards to obtain the exact starting value.

CALCULATION

This program helps with standard arithmetic and trigonometric calculations.

The first section of the calculation dialogue box deals with the basic arithmetic functions (+ - * /). Three boxes are available to enter variables and have been labelled 'a', 'b', and 'c'. To perform a simple calculation, enter the values in boxes 'a' and 'b'. After the desired arithmetic function (+ - * /) button is pressed the result will be shown in box 'c'. In the previous diagram 1 was entered in both 'a' and 'b' variable boxes and the [+] button was pressed to give the result of 2 in box 'c'.

Sometimes it is of value to use the result of an initial calculation in a further calculation. To avoid having to type the result obtained in box 'c' into box 'a', for a further calculation, a swap-over button is available. This button is [a<->c] and values in boxes 'a' and 'b' can be swapped with the [a<->b] button. In Procedures design, the values used in various calculations are quite often distances determined within a procedure construction. So the distance values of 'a', 'b' and 'c' can be picked directly from the graphics screen, by selecting the appropriate [<pick dist.] button.

Quite often values in one set of units have to be converted into another set of units. These calculations can be done with the buttons in the Conversions section. When one of these buttons is pressed, the value in box 'a' is converted using a conversion factor, which is shown in box 'b', to obtain the result in box 'c'. In the following example 20000 m was entered in box 'a' and the button [M->NM] was pressed. Box 'b' shows the conversion factor used by the program and box 'c' shows the result of 10.799 nautical miles.

20000.0000	/	1852.0000	=	10.7991361
Metres				**Nautical Miles**

The Trigonometry section is used to perform basic trigonometry calculations.

┌TRIGONOMETRY────

Angle A	3.3000	Tan A ->	R	0.0576596372

Tan A	Sin A	Cos A	ATan R	ASin R	ACos R

This section contains two variable boxes labelled 'Angle A' and 'R'. If a value is entered in the 'Angle A' box and one of the three buttons [Tan A], [Sin A] or [Cos A] is pressed the result is shown in box 'R'. The converse is also true, if a value is entered in box 'R' and either [Atan R], [Asin R] or [ACos R] button is pressed the angle is shown in box 'Angle A'.

┌FUNCTIONS────

1	Tan A * b = a	2	a / Tan A = b	3	Atan (a/b) = A
4	Sin A * c = a	5	Cos A * c = b	6	b / Cos A = c
7	a / Sin A = c	8	Sqrt(a sqrd+b sqrd)=c	9	Sqrt(c sqrd-b sqrd)=a

The Functions section combines the arithmetic and trigonometric calculations in commonly used formulas, and the naming of the variables 'a', 'b', 'c' and 'Angle A' correspond to a right angle triangle as shown in the diagram. As can be seen, the side or value 'a' is opposite Angle A, side 'b' is opposite Angle B and side or value 'c' is the hypotenuse.
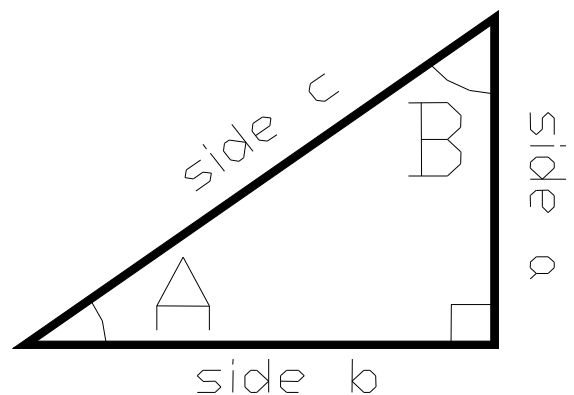
If 'Angle A' is equal to 3.3°, 'b' is equal to 8000 and value 'a' needs to be found, then pressing the function button [1] would return the following result.


Note that the result, value 'a', is shown not in position 'c' but in position 'a' and labelled '*RESULT*'. The result of any of the in-built function calculations is shown in the box corresponding to the value to be obtained and labelled with '*RESULT*'. Following are a few examples of how the function formulas can be used.

- Function 1 [Tan A * b = a] can be used to determine **Height Gain** or **Height Loss** over a specific distance.

The track miles (13 nm) and climb-out (2.5 %) are known, what is the height gain? Note that the percentage climb-out divided by 100 is the tangent of the climb-out angle (2.5% -> 0.025).

Enter 0.025 in box 'R', press the button [Atan R] to obtain the 'Angle A' (1.432), as this is required by the formula. Enter 13 in box 'b' and press function button [1]. The result is displayed in box 'a' (0.3250), because nautical miles were used as the distance the result is also in nautical miles. This can be easily converted to feet by pressing the conversion buttons (1974.7 ft).

to find
side a

side b
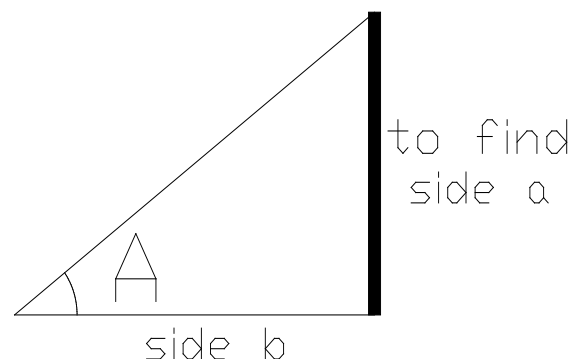
- Function 2 [a / Tan A = a] can be used to calculate the **Distance Required** for a specific height gain.

- Function 3 [Atan (a / b) = A] can be used to establish the **Climb-out Angle** and **Descent Gradients** required.

V5

TOOLBAR REFERENCE

TOOLS

3D - Airspace	Contour terrain mesh	Copying to another layer	Polyline to a file
3D - Face	Geodesic tool	Digitising 3D - circles	Vobst2
Circular text	Circles to a file	Database	Digitising 3D - polylines
Data search and change	Polylines to circles	Digitiser	Text import
Points to a file	Vertical cut setup	Mesh	Multi scale change
Calculation	Vobst1	Multi-polyline width change	Vobst3

PANS-OPS

Radials and tracks	Over-head tolerance	VOR, DME racetrack	Nominal turn
Departure	Create a fix	RNAV nominal	MOC in the sec. area
Holding pattern race track	Base turn	ILS basic surface	DME tolerance
Procedure turn	Turn protection area	RNAV area	VOR gate
ILS OA surface	Collision risk model	Visual circling	IAS to TAS

Charting

Symbols	Scale symbol	Variation symbol
Msa symbol	Morse code	Approach Chart

Wasp

Wasp

INDEX

No index entries found.

NOTES