

The SURPAC Least Squares Module Applications



Single Point Fixing (Resections, Intersections and Trilaterations)

[This application is Included in SURPAC "Lite"]

- The mathematical principle of this programme is the rigorous Least Squares adjustment by the variation of co-ordinates. The "Schreiber's Elimination" technique is used to minimize the variance-covariance matrix.
- This programme will handle any type of single Point fix using any combination of Triangulation and/or Trilateration, as well as a Height determination for the Free point, such as :-
 -  Point Trilateration [Y, X], or [E, N]
 -  Point Resection [Y, X], or [E, N]
 -  Point Resection [Y, X, Z], or [E, N, H]
 -  Point Resection [Z], or [H]
 -  Point Intersection [Y, X], or [E, N]
 -  Point Intersection [Y, X, Z], or [E, N, H]
 -  Point Intersection [Z], or [H]
- The current Co-ordinate File is used to extract the co-ordinates of the User defined Fixed Points used in the determination of the [Y, X] (or [E, N]) co-ordinates (and/or the Height, if required), of the new Point.
- The Observation data (Horizontal angles, Distances, Vertical angles, Target heights and Instrument heights) are extracted from a User defined General Observation File.
- The programme allows for the abstracting and combining of Multiple Arcs . Up to 8 Arcs (or faces) are allowed for a given Set-up. Each arc may include up to 30 sighted points. The observations are displayed showing the abstracting in the conventional survey manner, including the Mean and the Standard Deviation. The mean values of the Horizontal angles, the Vertical angles and Distances are used in the Single Point Fix calculation.
- For a Trilateration calculation, the programme will use any combination of Forward and/or Backward measured Distances to compute the new Point. The minimum number of distances is 3. The programme will search through the General Observation File , or defined portion of the File and extract all measured lines to and/or from, the new Point. All Distances will then be reduced and used to carry out a simultaneous Least Squares fix and adjustment of the Point's [Y, X] (or [E, N]) ordinates.
- The Network File Editor includes an "Active" column, which can be set to Active or Non-Active, for all the data lines displayed for a Single Point Fix calculation.
- A Data Line that is defined as Active is available and will be used in the calculation of the

new Point. An Active Data Line will have a Green Tick displayed in its “Active” column.

- A Data Line defined as Non-Active is data that exists, but which will not be used for the current calculation. A Non-Active Data Line will have a Red Cross displayed in its “Active” column, and the Observation information will be displayed in red Italic text. A Data Line's Active status can be changed using a single mouse click.
- The output, of a calculation consists of :-
 - the final co-ordinates of the new Point,
 - the orientation correction, in the case of a resection,
 - a comparison of observed quantities with final quantities and a list of observational residuals,
 - the standard deviation of unit weight for the observation set,
 - the standard error-ellipse parameters,
 - a list of [Y, X] (or [E, N]) ordinate axis cuts for each ray,
 - a list of input data for the height fix (if required) and the computed height differences along with their adjustments and final values.



Planimetric Control Network Adjustment [Y, X] or [E,

N]

- The mathematical principle of the Programme is the method of rigorous least-squares adjustment by means of the parametric adjustment, or variation of co-ordinates, technique.
- This principle is, however, modified by employing techniques, such as the Schreiber's Elimination technique, which optimize the use of computer space and time, whilst still maintaining the rigorous nature of the fundamental principle.
- The Programme is composed of five sub-routines, carrying out the following stages :-
 1. The creation of the Network File by automatic observation data compilation from a User defined SURPAC Observation File.

The programme is able to handle up to 8 Arcs (or faces) of observations for each Set-up point. Each arc may include up to 50 sighted points. The Multiple Arcs are abstracted and combined in an Abstract Sheet, showing all observed data as well as the Mean and the Standard Deviation. These mean values are used for the Network adjustment.

The Network File Editor includes an “Active” column, which can be set to Active or Non-Active, for all the data lines displayed and Points in the Network.

A Data Line that is defined as Active is available and will be used in the calculation of the Network. An Active Data Line will have a Green Tick displayed in its “Active” column.

A Data Line defined as Non-Active is data that exists, but which will not be used for the Network calculation. A Non-Active Data Line will have a Red Cross displayed in its “Active” column, and the Observation information will be displayed in red Italic text. A Data Line's Active status can be changed using a single mouse click.
 2. The extraction of the Co-ordinates of the defined Fixed points in the Network from the current Co-ordinate_file.

The provisional Co-ordinates of the Free Points are calculated using the Fixed Points and the network observational data.

3. The main "number crunching stage", in which the least-squares adjustment is carried out.

The [AtWA] and [AtWF] matrices are determined directly from the observations and from the co-ordinates of the Fixed points . All the orientation unknowns are eliminated using the Schreiber technique, and the upper triangle of the [AtWA] is compressed into a vector.

The "Modified Bordering" technique is used to invert the compressed form of the [AtWA] matrix, and the vector of corrections X is calculated from $X = - [AtWA]^{-1} * [AtWF]$. In most cases, only a single iteration is necessary as the provisional co-ordinates provide good approximates to the final values.

4. The final adjustments to the provisional co-ordinates are computed and applied to the provisional values. The standard error ellipse parameters for all unknown points are computed using the standard deviation of unit weight.

5. This is the output stage for the observations giving a full listing of observed directions, t-T corrections, plane equivalent directions, the oriented directions, the adjustments and then the final directions.

Distances are treated in a similar manner, with the listing displaying measured horizontal distances, the projection corrections, where applicable, the plane projection distances, the adjustments and then the adjustments and then the final distances. The printout finally displays the adjusted co-ordinate values for the Free Points, with their associated standard error ellipse parameters.

From the screen display of the Network output, it is possible to call for a Plot of the Network, showing all Points, observed an measured quantities and the error ellipses.

- This programme can be used for the computation and adjustment of survey control networks of almost any configuration, for example, Traversing, Triangulation, Trilateration and Triangulation (mixed) networks.
- The individual configuration of a network is immaterial to the Programme, as long as redundant observations exist for each of the Free Points in the network. The strengths, and/or weaknesses, of the network will become apparent from an examination of the resultant error ellipse parameters.
- The size of the control Network being adjusted can vary from a single unknown point up to a network containing 500 Points, with the maximum number of Free Points being 499.



Trig Height Network Adjustment [Z] or [H]

- The mathematical principle of the Programme is the method of rigorous least-squares adjustment.
- As for the previous Adjustment programmes, this principle is modified by employing techniques which optimize the use of computer space and time, whilst still maintaining the rigorous nature of the fundamental principle.
- The Programme is composed of five sub-routines, carrying out the following stages :-

1. The creation of the Network File by automatic observation data compilation from a User defined SURPAC Observation File.

The programme is able to handle up to 8 Arcs (or faces) of observations for each Set-up point. Each arc may include up to 50 sighted points. The Multiple Arcs are abstracted and

combined in an Abstract Sheet, showing all observed data as well as the Mean and the Standard Deviation. These mean values are used for the Network adjustment.

Vertical angles may be logged with the horizontal plane being assumed to be at 0 degrees, 90 degrees, 180 degrees or 270 degrees. The maximum vertical angle, therefore, is 45 degrees above or below the horizontal plane.

The Network File Editor includes an "Active" column, which can be set to Active or Non-Active, for all the data lines displayed and Points in the Network.

A Data Line that is defined as Active is available and will be used in the calculation of the Network. An Active Data Line will have a Green Tick displayed in its "Active" column.

A Data Line defined as Non-Active is data that exists, but which will not be used for the Network calculation. A Non-Active Data Line will have a Red Cross displayed in its "Active" column, and the Observation information will be displayed in red Italic text. A Data Line's Active status can be changed using a single mouse click.

2. The extraction of the co-ordinates and heights of the defined Fixed points in the Network from the current Co-ordinate file.

The provisional Heights of the Free Points are calculated using the Fixed Points and the network observational data. The programme will compute corrections for the earth's Curvature and for Refraction.

3. The main "number crunching stage", in which the least-squares adjustment is carried out.

The [AtWA] and [AtWF] matrices are determined directly from the observations and the heights of the Fixed points. The upper triangle of the [AtWA] matrix is compressed into a vector.

The "Modified Bordering" technique is used to invert the [AtWA] matrix, and the vector of corrections, X, is calculated from $X = -[AtWA]^{-1} * [AtWF]$.

4. The final adjustments to the provisional heights are computed and applied to the provisional values. The standard error parameters for all unknown point heights are computed using the standard deviation of unit weight.

5. This is the output stage for the observations, giving a full listing of observed vertical Angles, heights of instrument and heights of target, the calculated height differences, their adjustments and then the final height differences. The adjusted heights, along with their associated error parameter are also listed.

- This programme can be used for the computation and adjustment of survey control height networks of almost any configuration.
- The individual configuration of a network is immaterial to the Programme, as long as redundant observations exist for each of the Free Points in the network. The strengths, and/or weaknesses, of the network will become apparent from an examination of the resultant height error parameters.
- The size of the Height Network being adjusted can vary from a single unknown point up to a network containing 500 Points, with the maximum number of Free Points being 499.



Spirit Level Network Adjustment [Z] or [H]

- The mathematical principle of the Programme is the method of rigorous least-squares adjustment.

■ This programme also employs optimizing the use of computer space and time, whilst still maintaining the rigorous nature of the fundamental principle.

■ The Programme is composed of five sub-routines, carrying out the following stages :-

1. The creation of the Network File by automatic observation data compilation from a User defined SURPAC Level Observation File.

The Network File Editor includes an "Active" column, which can be set to Active or Non-Active, for all the data lines displayed and Points in the Network.

A Data Line that is defined as Active is available and will be used in the calculation of the Network. An Active Data Line will have a Green Tick displayed in its "Active" column.

A Data Line defined as Non-Active is data that exists, but which will not be used for the Network calculation. A Non-Active Data Line will have a Red Cross displayed in its "Active" column, and the level information will be displayed in red Italic text. A Data Line's Active status can be changed using a single mouse click.

2. The extraction of the heights of the defined Fixed points in the Network, from the current Co-ordinate_file.

The provisional Heights of the Free Points are calculated using the Fixed Points and the measured level data.

3. The main "number crunching stage", in which the least-squares adjustment is carried out.

The [AtWA] and [AtWF] matrices are determined directly from the level differences and the heights of the Fixed points . The upper triangle of the [AtWA] matrix is compressed into a vector.

The "Modified Bordering" technique is used to invert the [AtWA] matrix, and the vector of corrections, X, is calculated from $X = - [AtWA]^{-1} * [AtWF]$.

4. The final adjustments to the provisional heights are computed and applied to the provisional values. The standard error parameters for all unknown point heights are computed using the standard deviation of unit weight.

5. This is the output stage for the observations, giving a listing of the measured Height differences, their adjustments and the final Height differences derived from the adjustment. The adjusted heights, along with their associated error parameter are also listed.

■ This programme can be used for the computation and adjustment of level circuit networks of almost any configuration.

■ The individual configuration of a network is immaterial to the Programme, as long as redundant observations exist for each of the Free Points in the network. The strengths, and/or weaknesses, of the network will become apparent from an examination of the resultant height error parameters.

■ The size of the Height Network being adjusted can vary from a single unknown point up to a network containing 500 Points, with the maximum number of Free Points being 499.