9 NETWORK ADJUSTMENT

From the main menu select *Execute* | *Adjust Network*, or click on the *Network Adjustment* button on the main toolbar.

9.1 Overview

The network adjustment can be computed only after the line has been preconditioned as only data de-skewed to the shot event is used. The adjustment method is the fully integrated weighted least squares method.

A network is a set of nodes selected from all available nodes in the database, joined by observations. Nodes with fixed offsets are joined by derived observations which are automatically computed. As many different networks as desired may be defined and saved.

On entering the Network Adjustment, a network diagram and the control window are displayed.

9.2 Nodes

Each node's type and relation to its reference node determines how that node is used in the adjustment. These attributes are normally defined in the P2 header or automatically assigned by the program. If manual nodes have been created then it is the operator's responsibility to set them appropriately.

9.2.1 Types

VESSEL	Vessel reference point, from P2 header.
GUN	Centre of source, from P2 header.
STREAMER	Streamer reference point, centre of near receiver group, from P2 header.
NETWORK	Network node, e.g. acoustic transceiver, RGPS antenna, from P2 header.
COMPASS	Streamer compass, from P2 header.
BUOY	Towed buoy, from P2 header.
TAILBUOY	Buoy referenced to streamer, usually positioned independently from the streamer and used to compute streamer rotation and stretch, automatically assigned.
SATELLITE	Satellite antenna, e.g. DGPS, from P2 header.
ECHO	Echosounder transducer, from P2 header.
DEPTH SENSOR	Streamer depth sensor, from P2 header.
STATION	Fixed base station, e.g. Syledis, from P2 header.

9.2.2 Relations

FIXED	The node is rigidly fixed to the reference node and observations will be automatically derived from the offsets in the network adjustment.
FREE	The node is positioned by observations and the offsets are nominal only.
STREAMER	The node is attached to a streamer at a fixed offset from the streamer reference point given by the Y value.
CONSTRAINED	Reserved for future use.

9.3 Networks

Before the adjustment can start a network must be defined and saved, or a previously saved network loaded. For the first adjustment in a project the entire network is automatically saved as “Whole”.

If the Network Adjustment parameters have been previously saved with a network configuration then that configuration will be automatically loaded each time the Network Adjustment is started.

To load a previously defined network select *Configuration* | *Load Network* from the control window menu, and select the network configuration file. If no network file exists this option will be disabled.

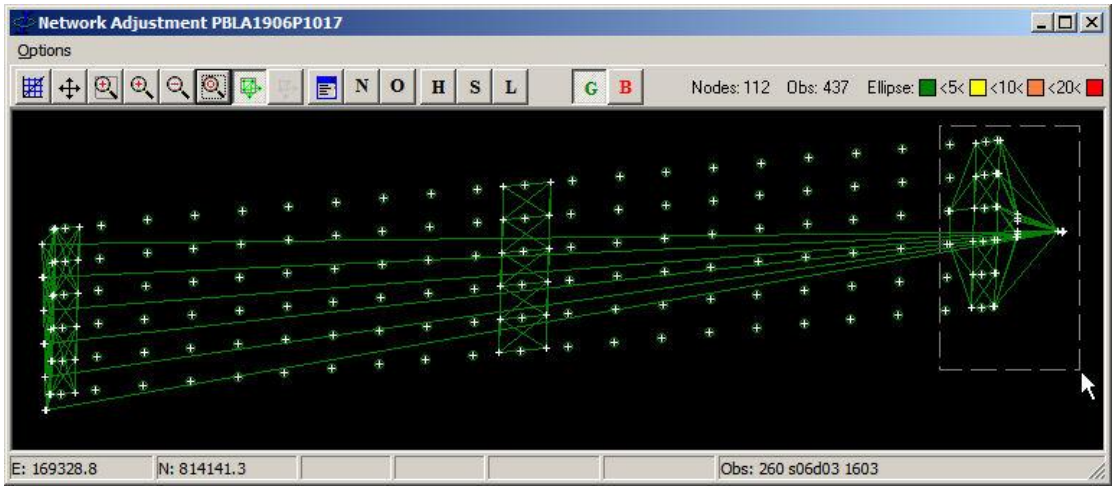


Figure 9-1

To define a network, with the *Select Nodes* button depressed, as shown in Figure 9-1 above, use the left mouse button to drag a box around the nodes to include in or exclude from the network (see Figure 9-1). Alternatively, just click on the *Node List* button to make a manual selection. The Node List window as seen in Figure 9-2 appears.

Select the required nodes either by highlighting them in the list, clicking on the node in the network diagram with the left mouse button, or by drawing a rectangle around the required nodes with the *Select Nodes* button depressed.

For nodes which are very close together each mouse click will scroll to the next node at the location.

Use the *Invert Selection* button to invert the selected nodes if it is required to exclude the selection.

Use the appropriate arrow buttons in the *Node List* window to change the network configuration. Nodes in the *Nodes Available* list will not be included in the network configuration. Nodes in the *Nodes Used* list will be included in the configuration. The

diagram is automatically updated each time the nodes in the *Nodes Used* list change. Click on *OK* to implement the configuration, or *Cancel* to revert to the previously displayed network.

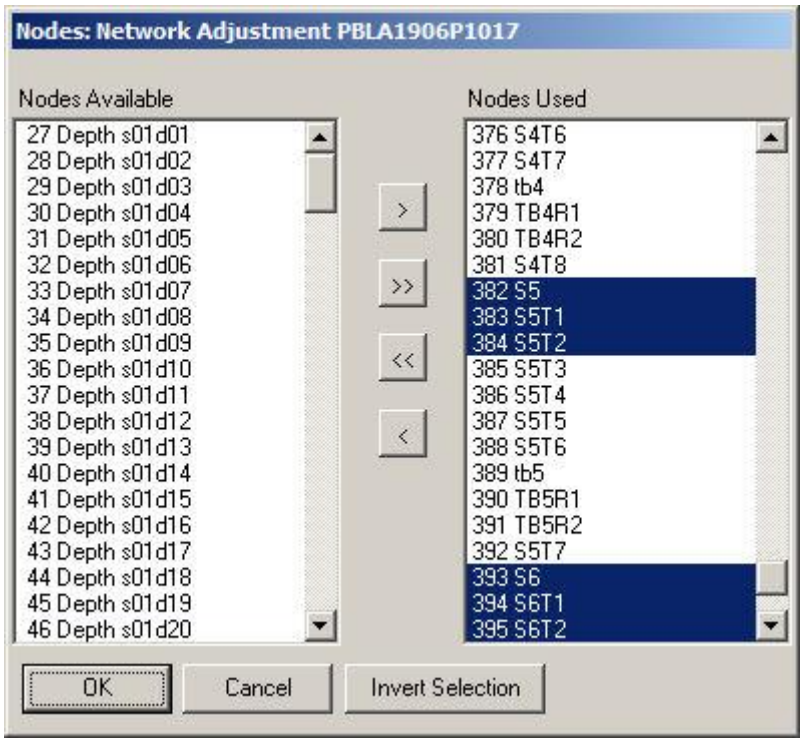


Figure 9-2

Note: Nodes not included in the network will not have coordinates output. Nodes for which coordinates are required for output to P1/90, e.g. echosounder, must be included in the network even if they are not required for a successful adjustment.

Once a network has been defined save it by selecting *Configuration* | *Save Network* from the control window menu, and type in an appropriate name.

9.3.1 Redundant Nodes

Networks, defined initially by the P2 header, often comprise nodes which are superfluous to requirements, i.e. nodes which are located in the same horizontal position as another node (co-located node). These are known as redundant nodes. The presence of redundant nodes unnecessarily increases the computational burden during adjustment, sometimes significantly. The time taken to adjust one shot is exponentially proportional to the number of nodes in the network.

A redundant node may be manually dispensed with by re-referencing any observations to or from it to its co-located node, and then excluding it from the network.

This can be automatically achieved by clicking on the *Refine Network* button in the *Network* page of the main Network Adjust window (see Figure 9-7). Any node except

for those of *Type* VESSEL, COMPASS, DEPTHSENSOR or STATION, whose *X* and *Y* coordinate are within 0.1m of another node is considered redundant and is removed from the network. Observations and other nodes which are referenced to this node are then re-referenced to the co-located node. Changes made to the node and observations definitions are logged and displayed immediately.

Note: This function, if used, should be used on the first line of a project, before any network definition is performed. Once refined, the network configuration should be saved. Subsequent saving of default nodes and observations n the Database module will obviate the need to refine the network for subsequent lines.

Network refinement can be undone by clicking on the *Undo Refine* button.

Warning: A redundant node may have a different *Z* offset from its co-located node. If very short *Range* type observations are related to a redundant node then errors may be introduced as a result of non-rigorous reduction of these ranges to the horizontal. If the change in *Z* offset is the same at either end of an observation then no error will result.

9.3.2 Vessel-only Networks

The situation sometimes arises when a full network has already been computed and changes are subsequently made to the absolute positioning. Such changes may include:

- Re-processing of DGPS or radio-navigation data
- Excluding or including individual systems
- Excluding or including radio-navigation ranges
- Small changes to the datum and/or projection data*

Because all computed nodes positions in the network are vessel-relative it is necessary only to re-adjust the vessel and DGPS and/or radio-navigation nodes.

When this is done, in order to preserve the whole network statistics (unit variance, degrees of freedom and number of iterations), the *Output* | *Adjustment Statistics* checkbox should be unchecked.

***Warning:** If significant changes are made to the datum or projection e.g. change of datum and/or projection, then a full re-adjustment is required because of potential significant changes to the grid scale factor and convergence.

9.3.3 OBC Acoustic Networks

When adjusting the network to compute acoustic pinger positions the network will be automatically configured if

1. The project acquisition system is set to GATOR RECEIVER
2. The adjustment menu option *Configuration* | *Auto-detect Pinger Network* is checked. This option is checked by default for GATOR RECEIVER projects.

This option is useful when, as is often the case, different vessels are used for pinging, and saves the user from having to manually configure the network for each vessel. The resultant network contains only the nodes necessary to compute the pinger position.

9.4 Streamer Rotation and Stretch

SeisPos provides the option to compute rotation and stretch for each streamer. By default the option is switched on. The computed values are the least squares estimates and are therefore optimal.

In order to be able to compute streamer rotation for a streamer the following conditions must be satisfied for each shotpoint:

1. For each streamer the streamer reference node, type STREAMER, must be included in the network.
2. At least one node of type *TAILBUOY* must exist in the network.
3. The tailbuoy must have observations available to position it independently from the streamer.
4. At least one observation tying the streamer to the tailbuoy must exist. The observation(s) do not have to be directly from the streamer to the tailbuoy but can be indirect e.g. if streamer 1 has no tailbuoy an acoustic range from streamer 1 to streamer 2 and then from streamer 2 to tailbuoy 2 will suffice to enable streamer 1 rotation to be uniquely computed.
5. At least one observation of type *MAGNETIC COMPASS* must exist on the streamer.

In order to be able to compute streamer stretch for a streamer the above conditions 1 to 4 must be satisfied.

The computed values for rotation will depend, amongst other factors, on the value(s) for magnetic variation used. A mean value significantly different from 0 is usually indicative of incorrect magnetic variation which should then be corrected in the database prior to re-adjusting the network.

The computed values for stretch will depend, amongst other factors, on the defined offsets of the tailbuoy nodes and acoustic nodes on the streamer. If the latter have already been adjusted to account for stretch then it is possible for stretch to be computed as a negative value.

Two stretch models are supported:

Linear – all parts of the streamer are considered to stretch by the same amount.

Inverse square – the amount by which the streamer stretches is considered to decrease with distance from the front of the streamer and is in proportion to the inverse square of the distance from the front of the streamer.

9.5 Magnetic Variation

If more than one magnetic variation station has been defined in the P2 file or database then the value for magnetic variation at each vessel position is computed from all stations using the inverse square method.

9.6 Streamers without Compasses

If the streamers do not have compasses, which may be the case where a full lattice of acoustic observations are defined along the full length of the streamers, then only those streamer nodes to/from which observations are defined may be included in the network. Therefore the streamer reference point nodes, type STREAMER, should be excluded unless, exceptionally, they have acoustic or manual observations to/from them.

The *Solve Rotation* and *Solve Stretch* checkboxes should be unchecked.

A Compass-less solution may also be achieved by removing all streamer compass nodes from the network.

9.7 Streamer Shaping

If streamer compasses are present then these are used to define a series of circular arcs along each streamer. These arcs are then used in the P1/90 output stage to compute the receiver group positions.

If no streamer compasses are present then each streamer will be modelled using a polynomial of order equal to the number of nodes found on the streamer. The polynomial coefficients will be used in the P1/90 output stage to compute the receiver group positions.

9.8 Running the Network Adjustment

Select the node configuration as described above. Optionally change the options, described below. The default values should be applicable to most networks of average data quality.

Start the adjustment by clicking on either the *Start* button or the *Step* button. Using the *Step* button will compute the adjustment for one shotpoint only and the process will be paused until the *Start* button or *Step* button is clicked. If stepping through the adjustment clicking on the *Resume* button will resume continuous execution.

To pause the adjustment click on the *Pause* button. The current shot will be computed after which execution will be suspended until the *Resume* button or *Step* button is clicked.

To stop the adjustment click on the *Stop* button. The process will continue until the current shot has computed.

As each shotpoint is computed, all the adjustment output data is immediately written to file. The data files are overwritten only for the shotpoints computed, with the result that any part of a line can be adjusted without affecting previously written data. The adjustment can be stopped at any time without loss of data. Summary report files are written at the end of each adjustment using an incremental file naming system so that previous reports are not overwritten.

Whilst the adjustment is running, the current shotpoint and the estimated time of completion are shown in the Control window toolbar.

9.8.1 Batch Processing

Multiple lines may be selected for adjustment. From the menu select *File* | *Select Lines*.

When Batch Processing is implemented, the first and last shotpoints for each line is automatically set as the first and last good shotpoints as specified in the Project.

To stop Batch Processing, from the menu select *File* | *Stop Batch Adjustment*.

When Batch Processing completes, a summary is displayed providing the first and last shotpoints successfully adjusted, and the adjustment status: *Complete* or *Incomplete.*

9.8.2 Log

Each time an adjustment is started a new Log window will open in the SeisPos main window. A sample log is shown in Figure 9-3. The same information is appended to the Log file for the line.

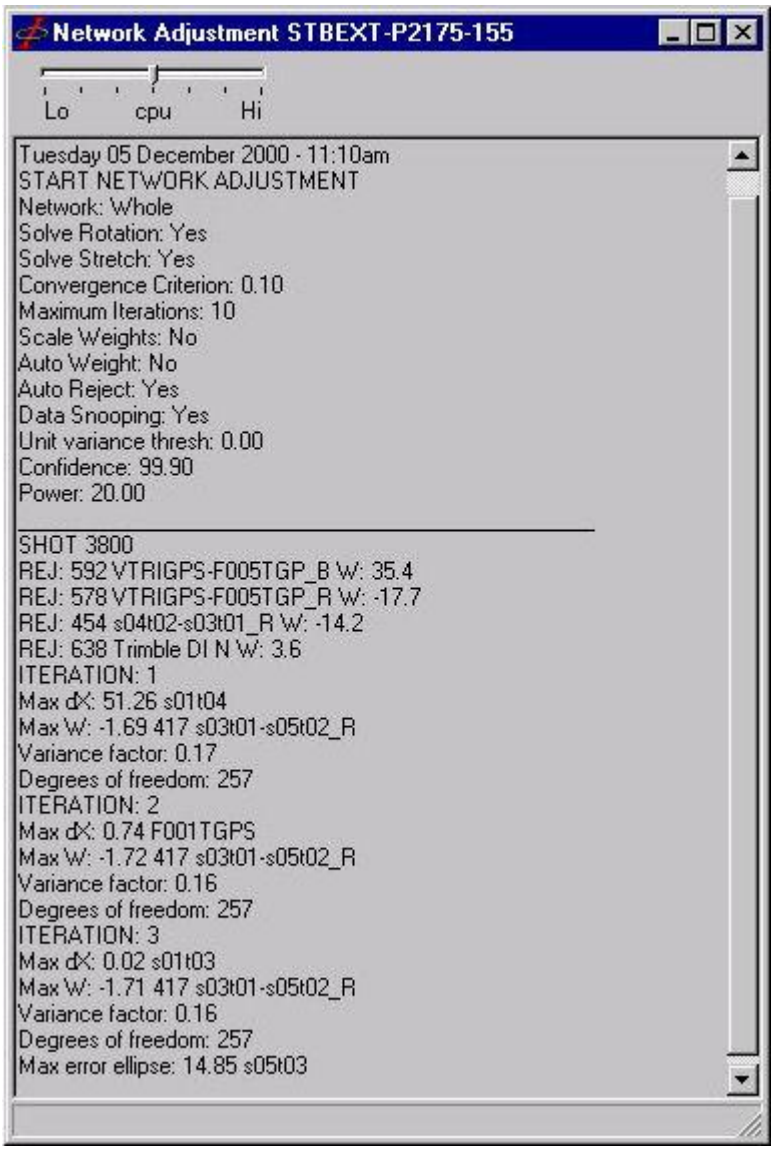


Figure 9-3

Most of the information written to the log is self explanatory; the following are explained for clarity:

REJ:	If Auto-Reject is switched on, the number and name of an observation which has been rejected, followed by its normalised residual.
Max dX:	The maximum movement of any node from the previous iteration. The value is followed by the name of the node to which it applies.
MaxW:	The maximum normalised residual from all observations used. The value is followed by the number and name of the observation to which it applies.
Max error ellipse:	The semi-major axis of the 95% probability error ellipse for the least precise node in the network.

Magnetic Variation: If more than one magnetic variation station has been defined then the computed value for each vessel position will be logged.

9.8.3 CPU

The adjustment execution runs in the background allowing all other SeisPos modules to be executed.

As the adjustment process is necessarily computationally intensive control over the process priority is enabled by using the sliding control which appears at the top of the Log window, as shown in Figure 9-3. Use of this control has a significant effect on the speed of execution of other programs. If a screen saver is to be used then it is recommended that the CPU is set between mid-way and high.

9.8.4 Network Display

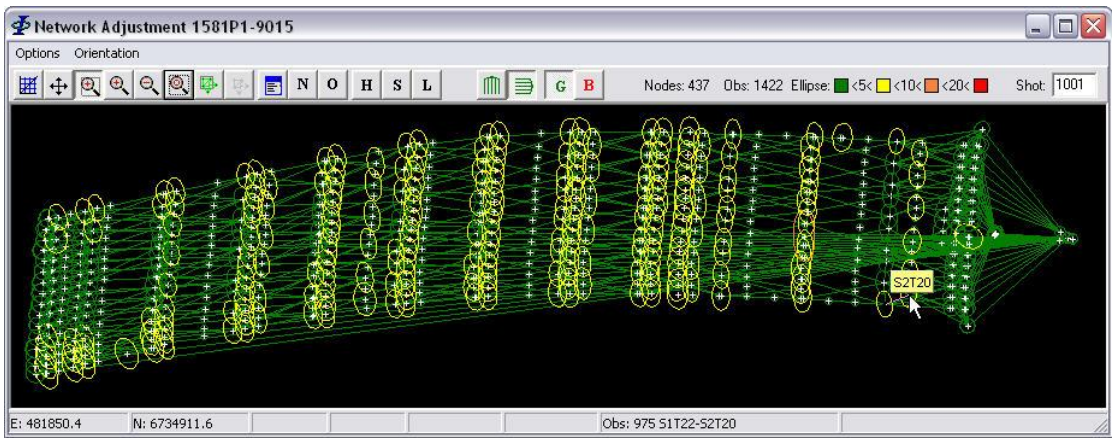


Figure 9-4

The network updates after each shotpoint has been computed. The content of the display depends on the Plotting Options selected (see below).

Error ellipses, if enabled, are displayed for each network node and are for 95% probability. The ellipse scaling is fixed, and the orientation true. The ellipses are colour coded according to the value of the semi-major axis. The colours can be changed by clicking on the relevant colour code in the key in the Network Diagram toolbar.

Observations used are shown in green, and those auto-rejected, or with missing data in red. Observations not used, or manually rejected are not shown.

Node positions are displayed true to scale which depends on the aspect ratio of the Network Diagram window.

The Easting and Northing of the mouse cursor in metres position is displayed below the diagram.

All other common Network Diagram functions are described in section 6. Network Diagram.

9.8.4.1 Orientation

Two orientation options are selectable form the menu:

Automatic: Toggle the orientation buttons in the toolbar to orient up or right.

Manual: Enter the orientation rotation field in the toolbar, or hold down the left or right arrow key until the desired orientation is obtained.

9.8.4.2 Display Node or Observation Statistics

If the *Node Stats* or *Obs Stats* page, or the *Time Series* page is open then clicking on a node or observation in the Network Diagram will display the statistics for that node or observation. Repeated clicks will scroll through nodes or observations that are close together.

9.9 Parameters and Information

This section describes the adjustment parameters available and also the node and observation statistical displays. The internally specified default values apply when the Network Adjustment module is used for the first time in a project and should be applicable for most adjustments.

To save the parameters and the current node configuration file if one has been saved, select *File* | *Save Parameters* from the menu. Subsequent adjustments will then default to these parameters and configuration. The *Output* parameters are not saved and all outputs are enabled by default.

Important: If Automatic Processing is to be carried out on subsequent lines save the node configuration by selecting *Configuration* | *Save Network* from the menu and then save the parameters. The saved network configuration and adjustment parameters will then be used for automatic processing.

9.9.1 Options

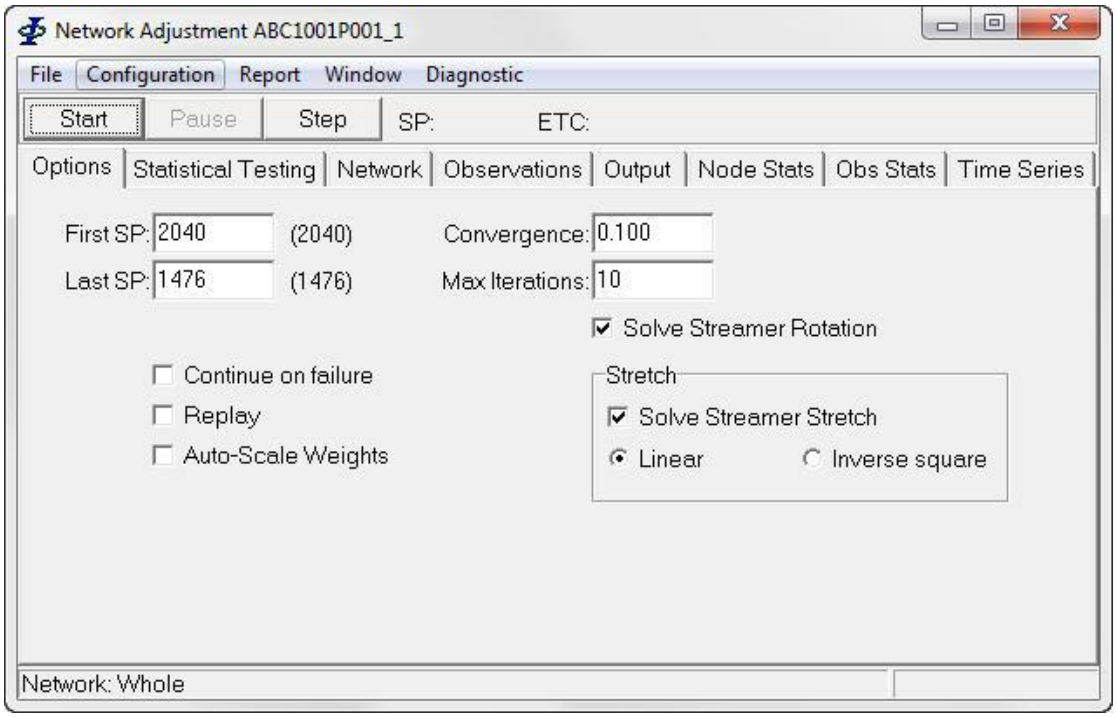


Figure 9-5

First/Last SP: The shotpoint range for which adjustment is to be computed. The default range is that of the first and last good shotpoint shown in the project details for the line. If the first shotpoint specified is chronologically after the last shotpoint then the increment (see below) will be set negative and the line will be adjusted in reverse.

Convergence: The maximum movement, in metres, of any one node

	easting or northing between iterations below which convergence is deemed to have been achieved. The default value is 0.1m.
Max Iterations:	The number of iterations for any one shotpoint beyond which the adjustment will be aborted. The default value is 10.
Continue of failure:	When checked, if a node cannot be solved, the adjustment will be recomputed without that node, for up to 10 node failures. If the shot still cannot be solved then the adjustment will continue from next shot on failure, and an unsolved shot report, including unsolved nodes, will appear on completion of the adjustment.
Replay:	Replays the network adjustment for the shot range specified, displaying the network and all selected time series plots.
Solve Streamer Rotation:	If checked, rotation will be solved by method of least squares for each streamer providing the necessary observations exist.
Solve Streamer Stretch:	If checked, stretch will be solved by method of least squares for each streamer providing the necessary observations exist.
Linear:	Stretch is distributed equally along the streamer.
Inverse square:	Stretch is distributed as a function of the inverse of the square of the distance of the node from the streamer reference point (centre near group). I.e. stretch is assumed to be greater towards the front of the streamer.
Auto-Scale Weights:	If checked, all observation standard deviations will be scaled in order to achieve a variance factor close to unity. The default is off.

9.9.2 Statistical Testing

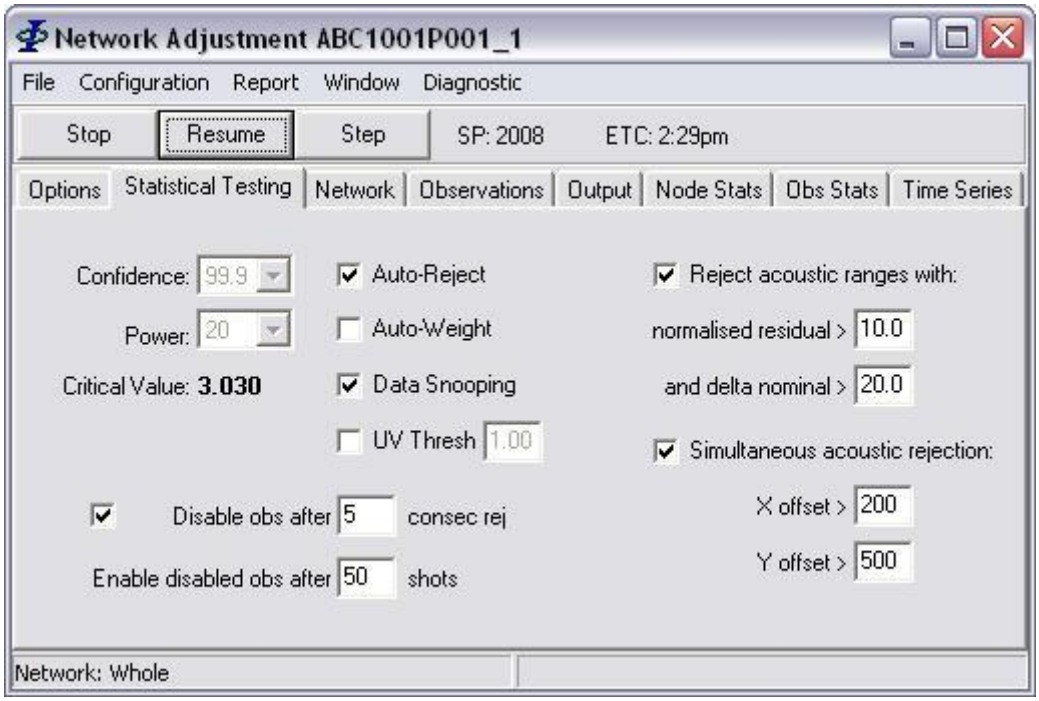


Figure 9-6

Confidence: 100 – α where α is the percentage probability of rejecting a good observation. The default value is 99.9.

Power: The percentage probability that errors the size of the reported marginally detectable errors will be accepted. The default value is 20.

Critical Value: A function of confidence, the normalised residual above which an observation will be rejected or down weighted if auto-rejection or auto-weighting is implemented.

Auto-Weight: If checked, auto-weighting will be implemented and auto-rejection turned off. Setting an observation's SD to fixed will prevent it from being down weighted.

Auto-Reject: If checked, auto-rejection will be implemented and auto-weighting turned off. The default is on. Setting an observation's SD to fixed will prevent it from being rejected.

Data Snooping: If unchecked, auto-rejection or auto-weighting will be applied to all observations whose normalised residual exceeds the critical value. If checked, the Baarda method is implemented – observations will be rejected/down weighted one by one until there are none whose normalised residual exceed the critical value. The default is on.

Unit Variance: If checked, rejection/down weighting will be applied only if

	the unit variance exceeds the specified *threshold*.
Threshold:	See above.
Disable obs:	If checked, the number of consecutive auto-rejections after which an observation will be disabled.
Enable obs:	The number of shots after which a disabled observation will be re-enabled.
Reject acoustic ranges:	Allows for simultaneous rejection of acoustic ranges which pass the specified criteria. This is a time saving measure for use with very large datasets.
Simul. acoust. rejection:	Allows for simultaneous rejection of acoustic ranges which are not correlated i.e. are far apart in the network. The values specified are the minimum inline and crossline distance between the centres of the ranges before they can be simultaneously rejected. This is a time saving measure for use with very large datasets.

9.9.3 Network

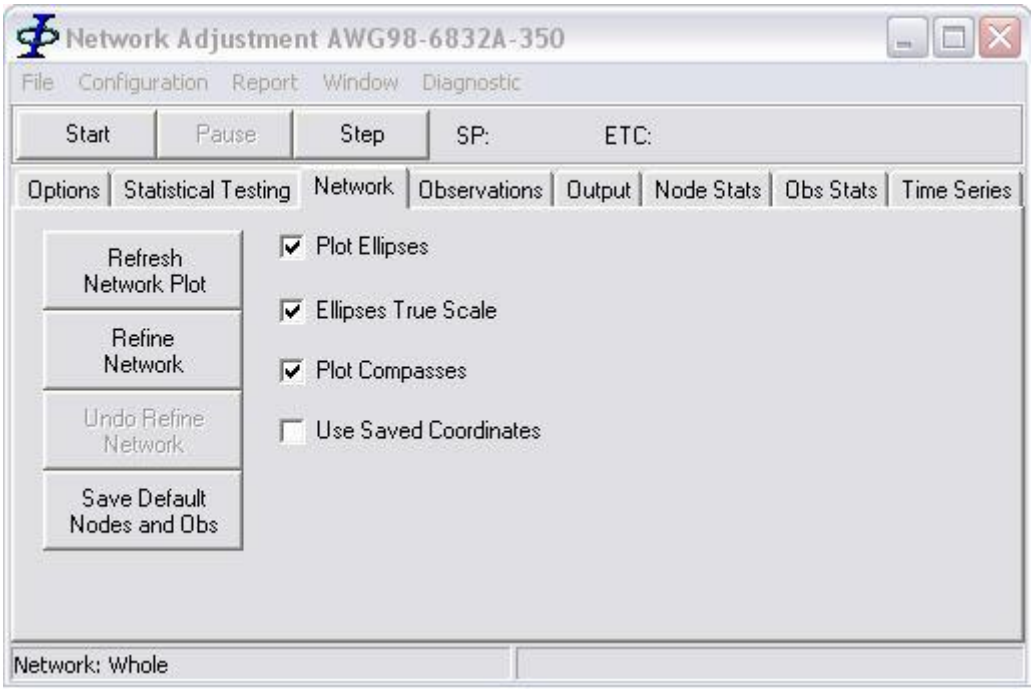


Figure 9-7

Plot Ellipses:	If checked, error ellipses will be displayed on the network diagram. The default is on.
Ellipses True Scale:	When checked error ellipses will be plotted true to scale. The default is off.
Plot Compasses:	If checked, streamer compasses will be displayed on the network diagram. The default is on.
Use Saved Coords:	If checked the adjustment uses for the initial estimate node coordinates computed in a previous adjustment.
Refresh Plot:	Re-draws the network diagram.
Refine Network:	Removes redundant nodes from the network (see section 9.3.1 Redundant Nodes).
Undo Refine:	Reverts network node and observation definitions to their status prior to invoking *Refine Network*. network (see section 9.3.1 Redundant Nodes).
Save Default Nodes & Obs:	Saves the current node and observation database tables as the defaults for use in subsequent lines.

9.9.4 Observations

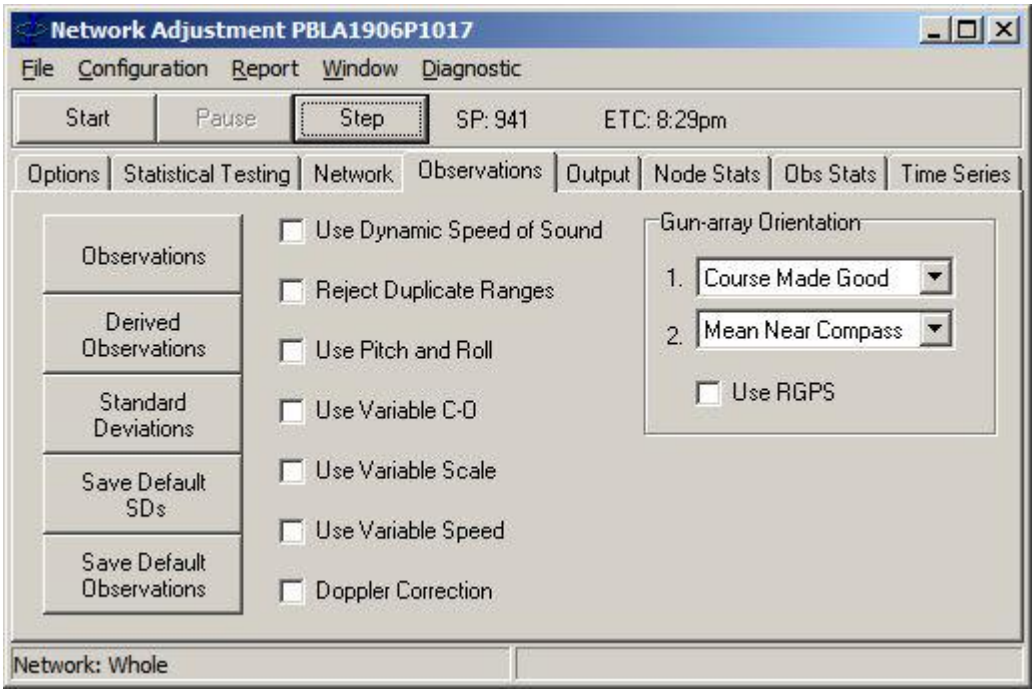


Figure 9-8

9.9.4.1 Normal Observations

Click on the *Observations* button to display the observation list as shown in Figure 9-9.

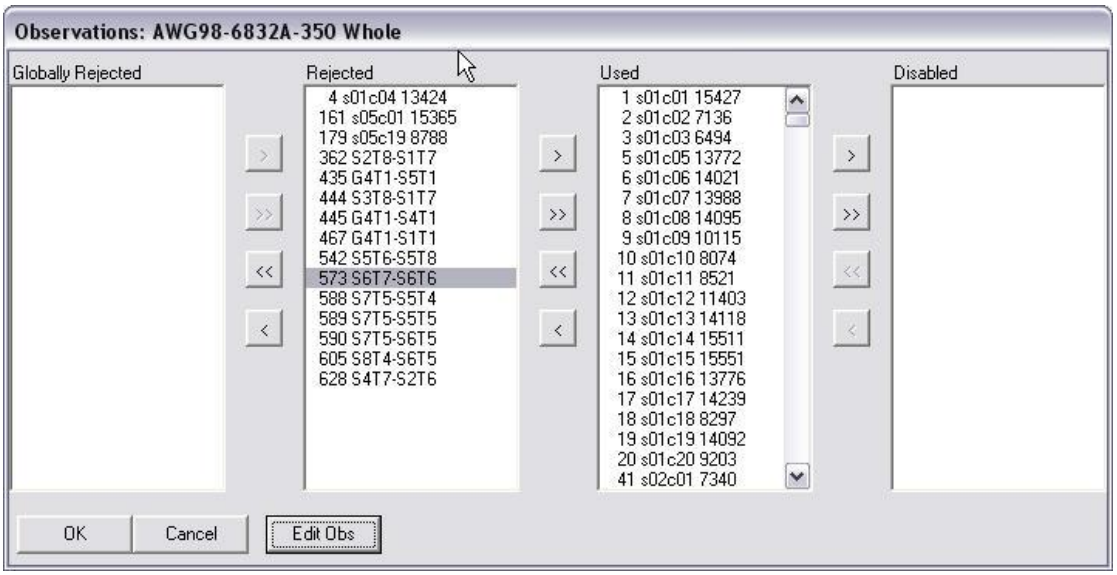


Figure 9-9

Only the observations for which nodes are part of the current network appear in the lists. The *Used* and *Disabled* lists contain all observations which have not been manually rejected in any other SeisPos module.

To include observations which have been previously rejected, move them to the *Used* list.

To reject observations for the current line only move them to the *Rejected* list.

To reject observations for all lines subsequently input into the project, move them to the *Globally Rejected* list, click on the *OK* button then click on the *Save Default Observations* button in the Network Adjustment control panel Observations tab.

The *Disabled* list contains observations which have been temporarily disabled during the adjustment (see Statistical Testing). This list is updated each time the *Observations* button is clicked.

When moving observations from one list to another these observations, and no other, remain highlighted so that they can be moved again without having to be re-selected.

By clicking on the *OK* button the accept/reject status is applied to the adjustment and saved to the database. Clicking the *Cancel* button will close the window without making any changes. Observations can be accepted or rejected with or without the adjustment in progress and are effective from the next shotpoint to be computed.

9.9.4.2 Observation Dialog

Click the *Edit Obs* button to display the Observation Dialog as shown in Figure 9-10.

Changes made to the observation attributes will be saved to the database when the *Save Button* is clicked.

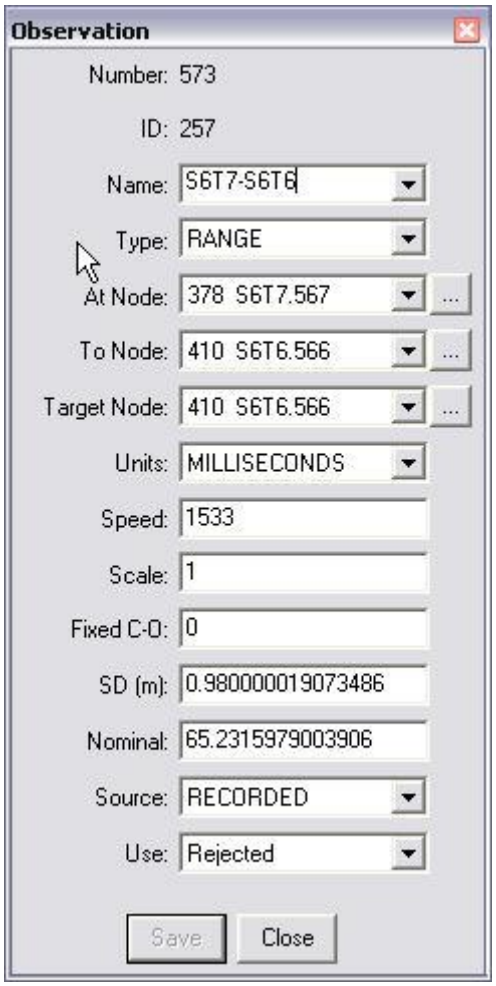


Figure 9-10

9.9.4.3 Manual Observations from Compass

If manual observations sourced from recorded streamer compass observations are present, and there is no data from the source, then the manual observation will automatically switch to using the next or previous compass observation on the same streamer, and a warning will be logged.

9.9.4.4 Derived Observations

Click on the *Derived Observations* button to display the derived observation list as shown in Figure 9-11.

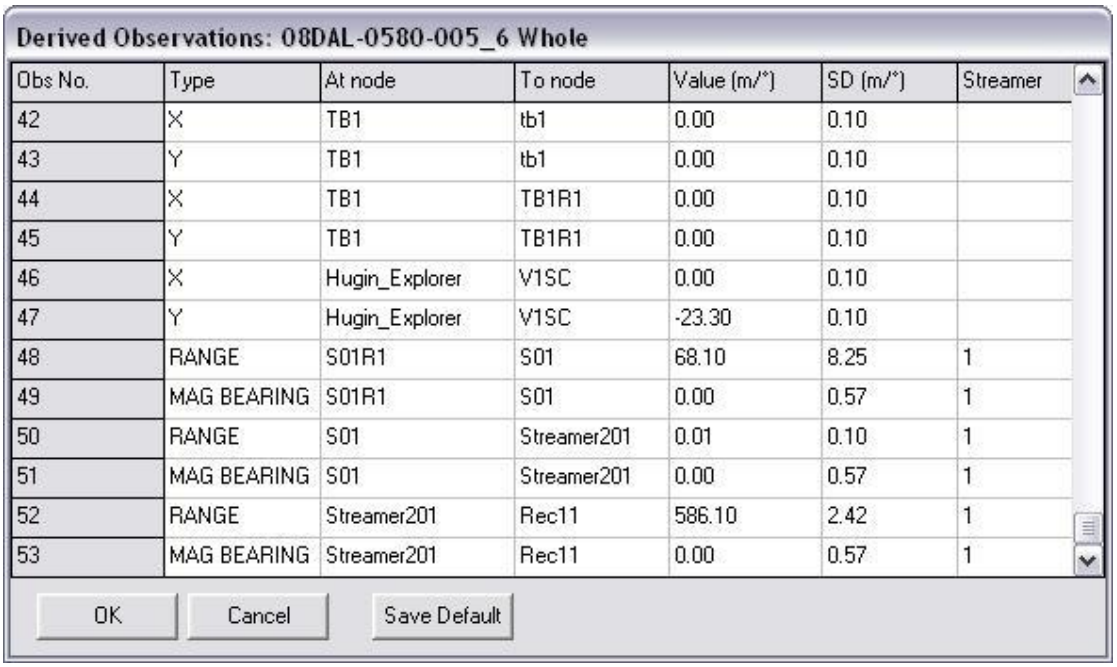
Derived observations are automatically created. Apart from this, they are treated in the same way in the adjustment as normal observations, with the exception that they cannot be rejected.

The values and standard deviations of derived observations are automatically computed. To change a value enter the new value and click on the *OK* button. Changing the standard deviation of an observation also disables auto-weighting of

that observation if auto-weighting is implemented.

When the *OK* button is clicked, changes to derived observation SDs are saved to the database for that line only, and will automatically be applied for subsequent adjustments of that line.

When the *Save Default* button is clicked the changes will be saved and applied to all lines in the database.



Obs No.	Type	At node	To node	Value (m/*)	SD (m/*)	Streamer
42	X	TB1	tb1	0.00	0.10	
43	Y	TB1	tb1	0.00	0.10	
44	X	TB1	TB1R1	0.00	0.10	
45	Y	TB1	TB1R1	0.00	0.10	
46	X	Hugin_Explorer	V1SC	0.00	0.10	
47	Y	Hugin_Explorer	V1SC	-23.30	0.10	
48	RANGE	S01R1	S01	68.10	8.25	1
49	MAG BEARING	S01R1	S01	0.00	0.57	1
50	RANGE	S01	Streamer201	0.01	0.10	1
51	MAG BEARING	S01	Streamer201	0.00	0.57	1
52	RANGE	Streamer201	Rec11	586.10	2.42	1
53	MAG BEARING	Streamer201	Rec11	0.00	0.57	1

Figure 9-11

There are 4 types of derived observations:

X: Distance, computed from nominal offsets, along the x-axis of the local coordinate frame from the *At Node* to the *To Node* located on the same vessel, buoy or gun array. The observation values are constant.

Y: Distance, computed from nominal offsets, along the y-axis of the local coordinate frame from the *At Node* to the *To Node* located on the same vessel, buoy or gun array. The observation values are constant.

RANGE: Chord distance, computed from nominal offsets, from the *At Node* to the *To Node*. The observation values are variable.

MAG BEARING: Magnetic bearing, computed from streamer compass data, from the *At Node* to the *To Node*. The observation values are variable. The standard deviations are computed from the individual compass standard deviations.

X/Y observations and *RANGE/MAG BEARING* observations are always in pairs between the same pair of nodes.

X/Y observations will be created between all pairs of nodes which have a *FIXED* relation.

RANGE/MAG BEARING observations will be created between adjacent nodes on the same streamer which are of type *STREAMER*, *NETWORK* or *BUOY* and have a relation *STREAMER*.

In the case of streamers without compasses, MAG BEARING observations will not be created.

9.9.4.5 A Priori Standard Deviations

Click on the *Standard Deviations* button to display the standard deviations list as shown in Figure 9-12.

The units of standard deviation are metres for distances and radians for angles and bearings. To change the standard deviation of observations, select the observations in the list, type in the new value in the *SD* edit box, and click on *Apply* or press the *Enter* key. The *SD* edit box supports single operation basic arithmetic functions. The example in Figure 9-12 will compute the standard deviation of a tailbuoy bearing given a cross-line standard error of 2m and a range of 5500m from the vessel.

To disable or enable auto-weighting of observations, select the observations in the list and click on the *Fixed* or *Variable* button respectively.

If auto-rejection is used instead of auto-weighting then setting an observation to *Fixed* will prevent it from being auto-rejected.

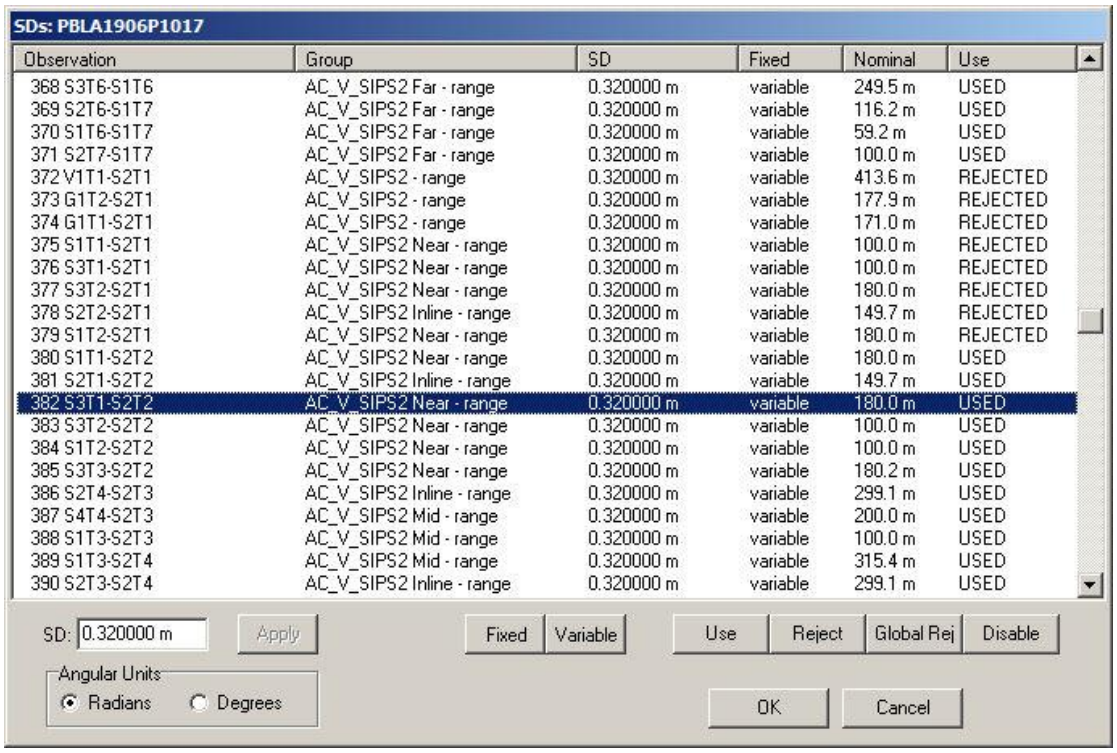


Figure 9-12

The list may be sorted according to any of the attributes shown by clicking on the column header. This is useful when wanting to apply the same SD to all observations in a group.

Click on the *OK* button to submit all changes and close the window, or the *Cancel* button to close the window without any changes. Changes can be made with or without the adjustment in progress and are effective immediately. However, if changes are made to the observation use status then it is advised to pause the adjustment and wait until the current shot has finished being computed before clicking the *OK* button.

To save the current standard deviations to the default observation file click on the *Save Default Standard Deviations* button. If the default file does not exist it will be created with the current observation attributes. Refer to section 4. Database for details of default observations.

9.9.4.6 Gunarray Orientation

This specifies the observation(s) used to rotate the *X* and *Y* derived observations from sensors on the gun floats to the source centre. Two different observations may be selected from the following, and the average of the two is used. The default is Course Made Good. RGPS may be used in place of this selection.

Course Made Good: The course made good of the *VESSEL* node computed for the last shot.

Mean Gyro: The mean of all gyrocompasses enabled.

Mean Near Compass: The mean of the nearest good compass on each streamer.

Use RGPS: If checked then any gun float with two or more RGPS targets at least 3m apart will result in the computed azimuth between the RGPS targets being used for that gunarray's orientation. This over-rides the above selection. If there are insufficient RGPS data for any shotpoint then the orientation will revert to the above selection for that shotpoint.

9.9.4.7 Dynamic Speed of Sound

Data from velocimeters can be recorded in user defined records in the P2 raw data file. SeisPos attempts to recognise this data based on the observation name. If found, the observation is designated type SPEED OF SOUND with units METRES/SEC.

If the *Dynamic Speed of Sound* checkbox is checked then the mean of all good observations of the above type will be used to apply to all network observations of type RANGE and units MILLISECONDS. If dynamic speed of sound data is bad or has been rejected for a shotpoint then the observation speed as defined in the database for each observation will be used.

9.9.4.8 Duplicate Ranges

By checking he checkbox *Reject Duplicate Ranges,* for each shotpoint all RANGE type observations are checked for duplicates and any duplicates found are not used for that shotpoint.

A *duplicate range* is defined as a RANGE type observation for which a *previous* RANGE type observation between the same two nodes has been found, is flagged for use and has "good" data i.e. valid data output by the Precondition module.

The first range between any two nodes is never rejected as a duplicate. Therefore, in the case of acoustic networks when 2-way observations are defined before their corresponding 1-way observations, the 1-way observations will only be used in the absence of a 2-way observation with "good" data.

Important: *The software does not detect 2-way or 1-way acoustic observations. It is the operator's responsibility to verify that the 2-way observations are defined before 1-way observations in the configuration*.

When a range for which duplicates exist is auto-rejected during the adjustment, *all* duplicate ranges for that range are enabled for the next iteration. These are then treated in the usual manner, i.e. it is possible that some or all of these may also be subsequently auto-rejected.

9.9.4.9 Pitch and Roll

If pitch and roll observations are present then checking the *Use Pitch and Roll* checkbox will enable the pitch and roll measurements to be applied to all GPS antennas, i.e. nodes of type SATELLITE, which are located on the same vessel as the pitch and roll observations. If more than one pitch or roll observation is available for a particular vessel then the average value is used.

9.9.4.10 Variable C-O, Scale and Speed

The checkboxes corresponding to variable C-O, scale and speed refers to data which has been recorded in the E54 and T54 records. Leave the respective checkboxes unchecked to prevent the data from being used.

9.9.4.11 Doppler Correction

When checked, acoustic ranges will be corrected for Doppler according to the direction of travel of the transmitted signal, its speed of propagation and the speed of the vessel computed from the last two shots (or the first two in the case of the first shotpoint).

9.9.4.12 Residual Report and Precondition

Each time the adjustment is stopped a new set of reports are generated, with an incremental name. In the example shown in Figure 9-13 the report is the 22nd.

The reports are accessible from the *Report* menu. The latest report is displayed.

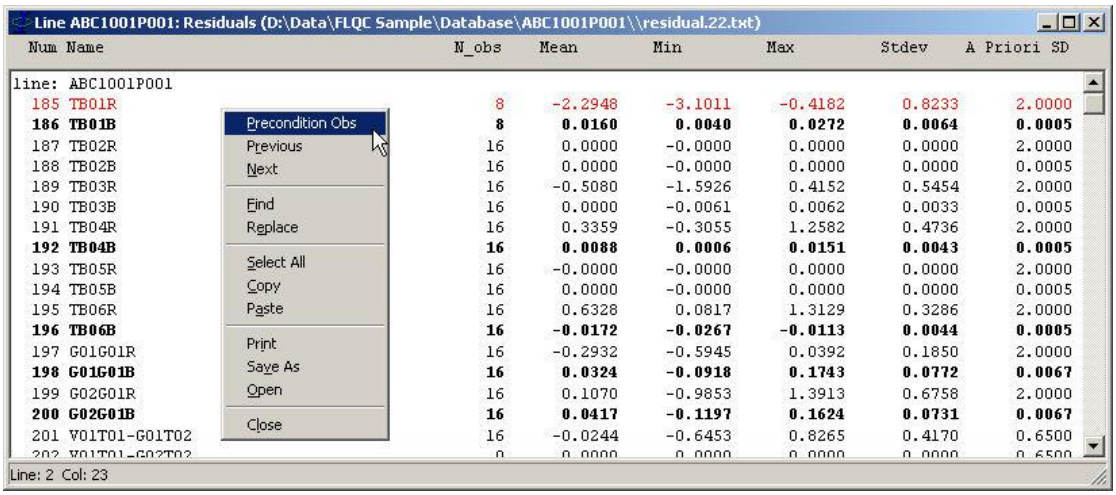


Figure 9-13

In the residual report the observation with the highest mean residual appears in red, and each observation whose mean residual exceeds twice it's a priori standard deviation appears in bold.

In the normalised residual report the observation with the highest mean normalised residual appears in red, and each observation whose mean normalised residual exceeds 1 appears in bold.

The observation residual and normalised residual reports support the additional feature, accessible from the popup menu, of allowing the observation at the cursor to be edited in the precondition module. Any edits or changes in precondition parameters are applied to the database immediately. These is no need to exit either the Precondition or the Network Adjustment module in order for the changes to be applied.

9.9.5 Output

The output options determine what data is written to the database. This is the data used in the Quality Control and Output (P1/90) modules.

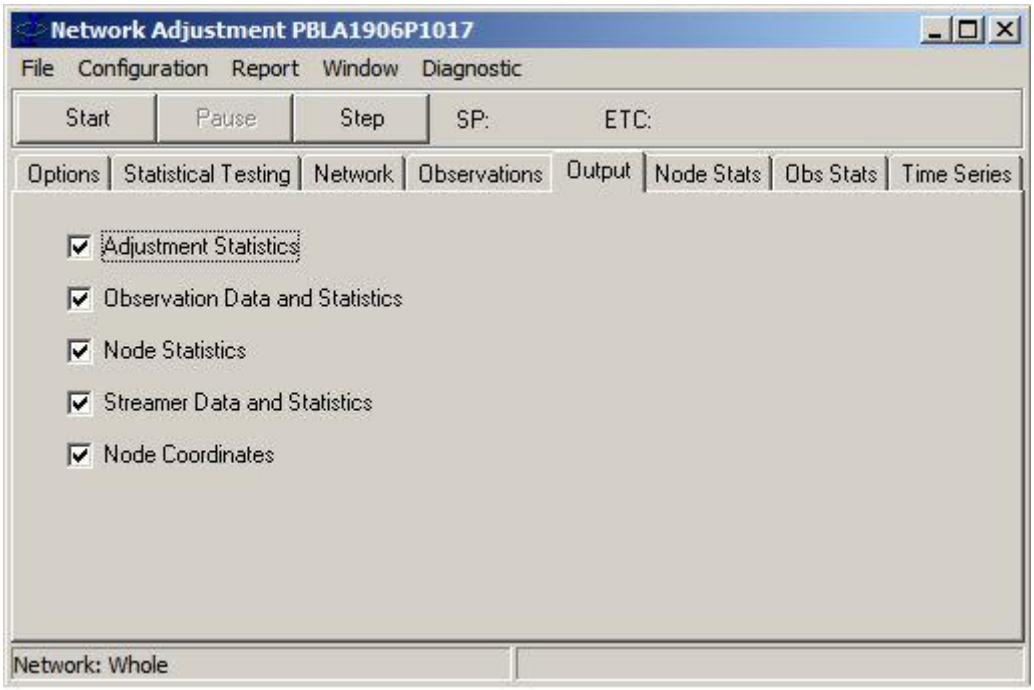


Figure 9-14

To avoid overwriting data that already exists in the database, uncheck the appropriate checkbox. All output is enabled by default. The types of output data are:

Adjustment: Number of iterations.
Degrees of freedom.
Variance factor.

Observation: Value, corrected for: scale factor, propagation velocity, C-O, grid convergence or scale factor, streamer rotation or stretch.
Residuals.
Normalised residuals.
Marginally detectable errors.
A priori standard deviation.

Node: Semi-major axis of the 95% probability error ellipse.
External reliability, $\sqrt{\left(\delta E^2 + \delta N^2\right)}$, where δE and δN are the respective East and North components of maximum external reliability.
Number of observations to/from the node.

Streamer: Rotation.
Stretch.
Feather.

Coordinates: Node Eastings and Northings.
Streamer shape data if streamer compasses are present.

With the exception of *VESSEL* type nodes, all output node coordinates are written relative to the vessel. This enables re-computation of vessel coordinates alone at a later stage if required without requiring a full network adjustment.

Note: The output options are not saved to the parameter file and all outputs are always enabled by default each time the Network Adjustment module is started.

9.9.6 Node Statistics

Node statistics are updated after each shotpoint is computed and displayed in the *Node Statistics* page. The node for which statistics are displayed can be changed by clicking on the node in the Network Diagram, or selecting from the dropdown list.

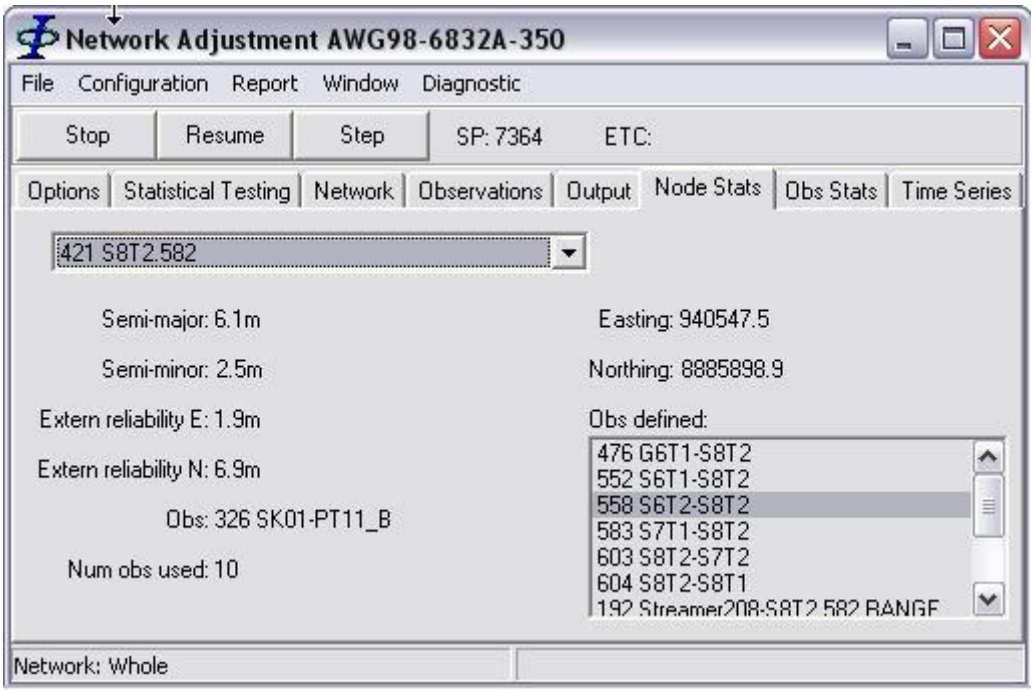


Figure 9-15

The following information is displayed:

- Node number and name.
- Semi-major axis of the 95% probability error ellipse.
- Semi-minor axis of the 95% probability error ellipse.
- Grid Easting in metres.
- Grid Northing in metres.
- External reliability of Easting and Northing.
- The observation number and name from which the highest external reliability is derived.
- The list of observations connected to this node. Clicking on an observation will display it in the *Observation Statistics* page.

9.9.7 Observation Statistics

Observation statistics are updated after each shotpoint is computed and displayed in the *Observation Statistics* page. The observation for which statistics are displayed can be changed by clicking on an observation in the Network Diagram or the *Node Statistics* page, or by clicking on one of its nodes in the Network Diagram, or selecting from the dropdown list.

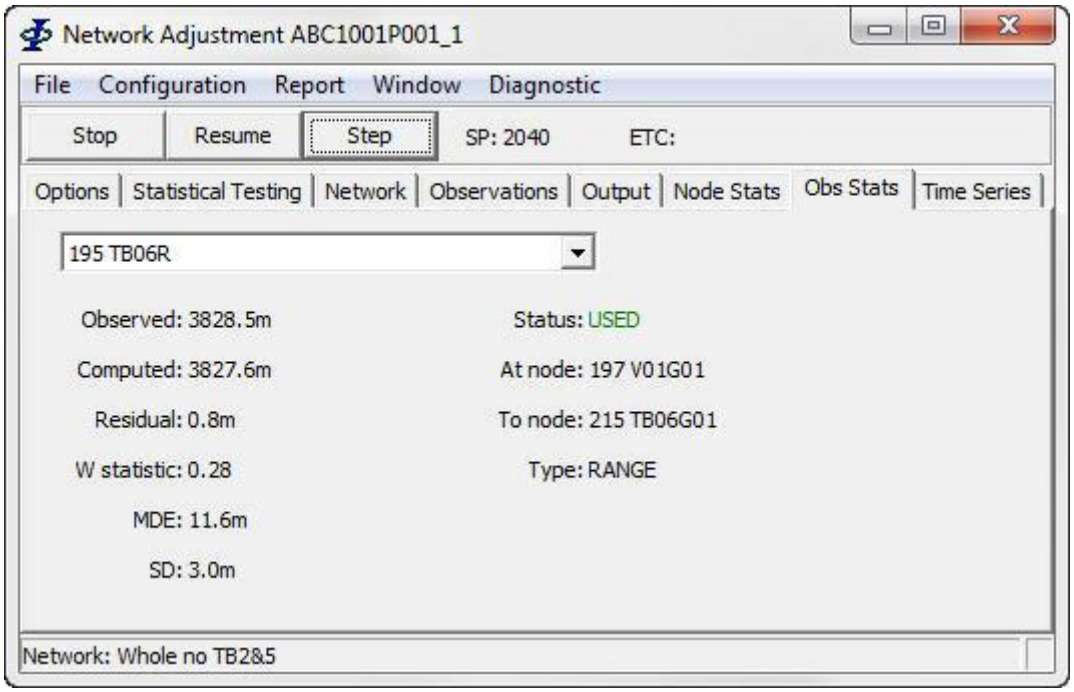


Figure 9-16

The following information is displayed:

Observation number and name.
Observed value in metres or radians.
Computed value in metres or radians.
Residual in metres or radians.
Normalised residual.
Marginally detectable error.
Use/reject status.
At node.
To node.
A priori standard deviation.

9.9.8 Time Series Plots

Adjustment, Streamer, Node and Observation attributes can be displayed as time series plots, dynamically updated as the adjustment progresses. Only one plot from each of these four categories can be displayed at one time.

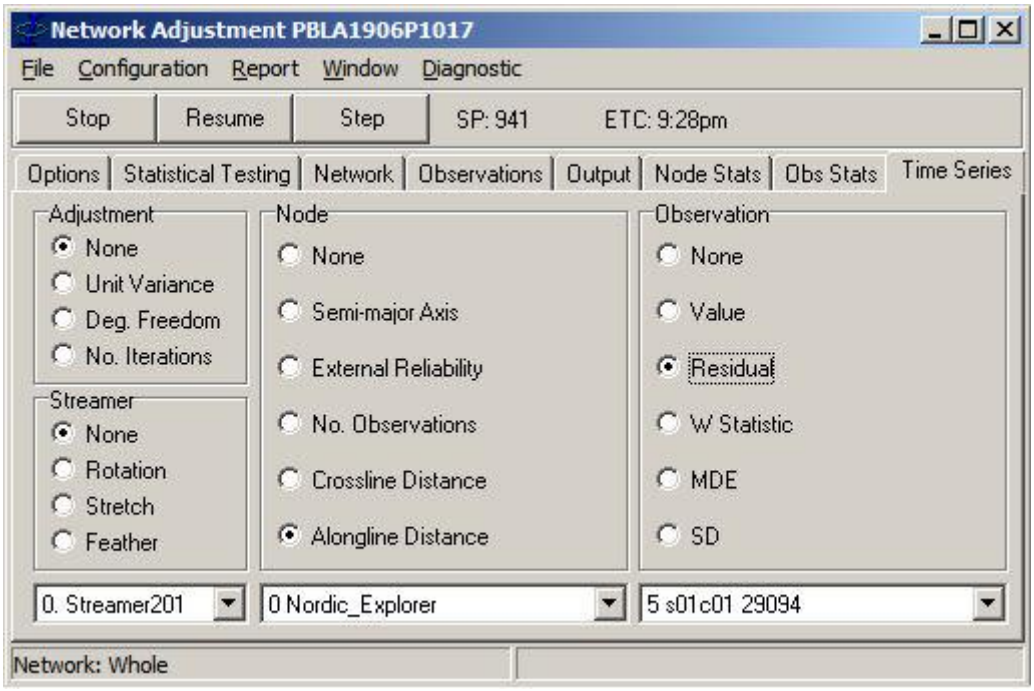


Figure 9-17

For each category select the attribute to plot. The plot window, as shown in Figure 9-18, will appear at the bottom left of the screen. For node and observation attribute plots select the node and observation from the dropdown lists.

Nodes and observations can be selected either from the dropdown lists or by clicking on a node in the network display. Each time a node is clicked on the observation displayed is scrolled to the next observation to or from that node.

The following attributes are available:

Adjustment:

- Unit variance.
- Degrees of freedom.
- Number of iterations.

Streamer:

- Rotation
- Stretch
- Feather

Node:

Semi-major axis of the 95% confidence error ellipse.

External reliability, $\sqrt{(\delta E^2 + \delta N^2)}$, where δE and δN are the respective East and North components of maximum external reliability.

Number of observations at and to the node.

Crossline distance of the node from the defined line.

Observation:

Value.

Residual.

Normalised residual (W statistic).

Marginally detectable error.

A priori standard deviation.

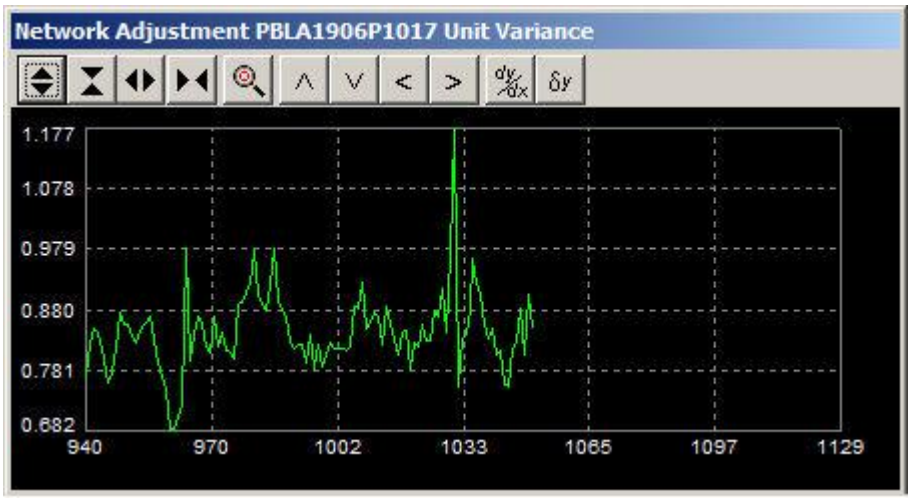


Figure 9-18

The shotpoint number and data value at the vertical cursor position is displayed at the top of the plot.

The plot X-axis is initially scaled to the full range of shotpoints specified for the adjustment. The Y-axis is initially automatically scaled to the maximum and minimum data values.

To expand or contract the vertical and horizontal scales use the zoom buttons on the left of the toolbar.

To zoom in on an area of the plot use the left mouse button to draw a rectangle defining the required zoom area. This will also disable automatic scaling.

To shift the plot vertically and horizontally use the single arrow buttons on the right of the toolbar.

Zooming or shifting vertically will disable automatic vertical scaling. Zooming or shifting horizontally will disable automatic horizontal scaling.

To zoom out, click on the *Zoom Original* button.

Toggle the *Rate of Change* and *Delta* buttons to display the rate of change or the shot to shot difference respectively. To revert to the normal plot toggle either of these buttons off.

To close a plot select *None* in the plot category.