

Particle Physics Division, Technical Centers, Alignment and Metrology Operating Procedure

Procedure Name : Leica DNA03 Level Procedure (long form) Revised on Date: May 7, 2009

Written by: Stu Lakanen, Glenda Adkins

Reviewed by: Gary Coppola

Purpose of This Procedure: The purpose of this procedure is to define the methods to be used for collecting differential level observations on indoor runs using a uniform manner designed to eliminate systematic errors that may otherwise contaminate the integrity of the data. This procedure specifically addresses using: ¹⁾ the DNA03 electronic digital level, ²⁾ the AMG generated *Levels Program*, ³⁾ the “BluePort-XP” connection technology, ⁴⁾ a hand held Bar Code Reader.

Tools: DNA03 electronic digital level (confirm calibration date is valid), a laptop computer with *Levels Program* installed (Latitude D800 or the HP laptop computer), two Carbon fiber rod(s), at least two 60 cm. bar coded scales (confirm calibration date is valid), 2 meter rods (if needed), miscellaneous stic mic equipment (as needed), scale bubble(s), BluePort-XP connection equipment (two pieces, BluePort Firefly and BluePort RS232 connector), hand held bar code reader, halogen lamps or strip light lighting system.

Personal Protective Equipment: PPE is typically environmentally dependent: refer to local Hazard Analysis, and Radiological Worker Permits (RWP), as well as compliance to **all local signage**. Since the halogen lamps produce a considerable amount of heat, cotton, plastic dot gloves or leather gloves are recommended for handling.

References: Interim FGGS Specifications and Procedures to Incorporate Electronic Digital/Barcode Leveling Systems and the WILD DNA03 instrument manual, AMG005 Electronic Leveling Procedure, and AMG034 Peg Test.

Detailed Procedure:

1. At the beginning of each day as a first operation before beginning a Level Run, always perform a Peg Test as per AMG034.
2. For the highest accuracies, the telescopes complete field of view should cover the staff. This is known as image processing with the maximum amount of code information.
 - a) The one percent rule states the effective staff length is determined by reducing the useable length of the staff by 1% of the distance to the staff from both the top and the bottom of the scale.

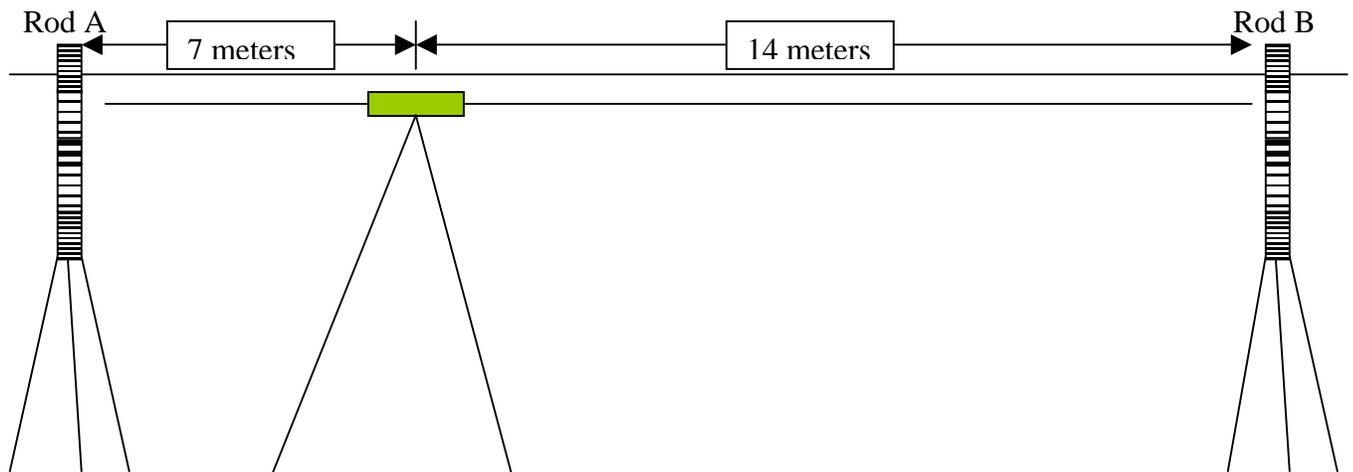
10m Dist	Maximum	Minimums
60cm Scale	0.50m	0.10m
2m Rod	1.90m	0.50*

20m Dist	Maximum	Minimums
60cm Scale	0.40m	0.20m
2m Rod	1.80m	0.50*

30m Dist	Maximum	Minimums
2m Rod	1.70m	0.50*

*The 2-meter rod is usually not read within 50 cm of the ground or floor.

- b) For maximum accuracy the field of view must be clear of obstructions.
 - c) For all indoor measurements, the scales must be illuminated with the portable halogen bulb lamps or LED type strip lights. **CAUTION:** The metal housings of the halogen lamps get very hot; when handling, use handles and wear gloves as needed. Scales and rods should be illuminated on an angle. (DNA03 will not measure if the light is too intense or shadowed.)
 - d) The instrument will accurately measure to a staff skewed to the line of sight.
3. Tripod stability is vital. Before each run check the tripod legs, head, and feet for tightness; any motion can adversely affect measurements. At each setup, ensure that the feet and legs are secure and unmoving.
 4. The level Rod bubbles must be checked each week or as required. (If one is dropped, calibration should be checked.)
 5. Forstner Procedure Peg test will be performed at the start of each day that levels are run.
 - a) The collimation error will be stored in accordance with Procedure AMG-022, NA3000 collimation procedures.
 - b) Turn on the instrument by pressing and releasing the red oblong shaped button on the bottom left side of the instrument. The instrument opens in “Measure & Record” mode.
 - c) Press the “Prog” oval button in the first row of buttons on the right side of the eyepiece.
 - d) Use the yellow arrow shaped buttons on the left side of the eye piece (the bottom “Pg Dn”) arrow down three times to the number 4 “CHECK & ADJUST”, then press the red right angle shaped button at the bottom and right side (this is a “return/enter” button).
 - e) To set the job, press the “return” key at the number 1. Job. The job indicated may be continued by using the arrows to select the <QUIT> or <SET> at the bottom of the screen. To change the name of the job, use the yellow arrows to move to <NEW> and select by pressing the enter button. The “New Job” screen is displayed; enter the job name (i.e. 06MAR07), operator name, and comments, then arrow to the <SET> selection and press the return button. (Note: pressing the shift key before pressing the number/letter keys toggles the keypad between alpha and numeric.)
 - f) Next in the “Check & Adjust” window the 2 “Set Method” must be selected using the return button.



- g) The method should be A x x B (this method requires two instrument stations at 1/3 the distance from the two scales). Entering the staff identification is not required. Arrow down to the <SET> and press the enter key

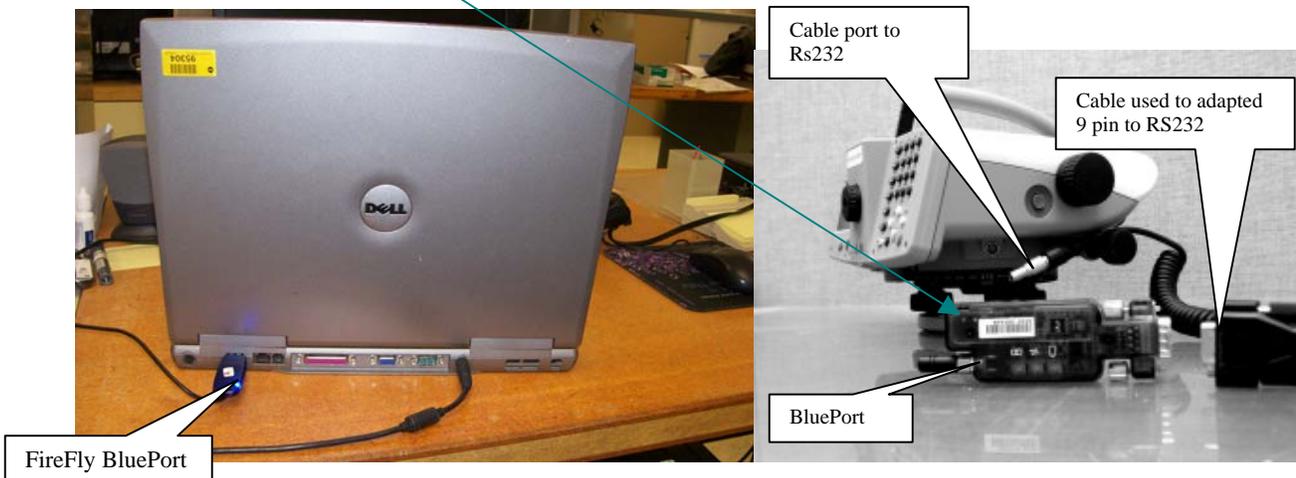
- h) Two leveling rods or scales will be used at approximately 21 meters. At the “Check & Adjust” screen, 3 “START” is selected: press the return button. Determine the distance between the two scales; the first instrument should be 1/3 the distance from Scale “A” and between the two scales.
 - i) Sight scale “A”, and press the measure button (the round red button on the left side of the instrument).
NOTE: if the instrument is not level or is incorrectly focused an error message will occur and necessitate rectification before the measurement will be accepted.
 - j) After the measurement is taken, press the return key to continue.
 - k) Sight the “B” scale, and press the measure button (the round red button on the left side of the instrument). After the measurement is taken, press the return key to continue.
 - l) Move the instrument to the second instrument station, approximately 1/3 of the distance from scale “B”.
 - m) Sight scale “B”, and press the measure button.
 - n) After the measurement is taken, press the return key to continue.
 - o) Sight scale “A” and press the measure button.
 - p) After the measurement is taken, press the return key to continue.
 - q) The screen will now display the collimation computation. Note the difference number. Press the return key to set the collimation correction, if the difference is outside the +2 to -2 range, the peg check must be repeated.
- 6) Two leveling rods or scales will be used.
 - 7) It is absolutely imperative that an even number of setups be used for every level run. The rods must leap frog during the elevation runs, resulting with the level rod or scale used on the beginning benchmark is the rod or scale used on the ending benchmark **in every instance**. (If “G” scale is used on the first benchmark, it should be used on the last benchmark as well.)
 - 8) Double runs are required between all benchmarks with the reversal of the direction of the run occurring each half day whenever possible.
 - 9) The minimum ground clearance is 0.5 meters.
 - 10) The maximum sight distances shall not exceed 25 meters.
 - 11) The Delta Stadia (imbalance in distance between the foresight and back sight of any given setup) shall not exceed 2 meters.
 - 12) The accumulation of the Delta Stadia between two benchmarks shall not exceed 5 meters for each run. The accumulated stadia imbalance displayed by the DNA03 will be positive (+) if the back sights are long and negative (-) if the foresights are long.

Part Two

How to operate DNA03 levels program

Preparation:

1. Using the AMG Elevation Data Base, download an elevation query file in meters relevant to the level run area preserving the Data Base format and save it as a comma delimited file (.csv). Place this control file in c:\levels\DataBase Elevations.<filename>. Ensure that the file c:\Levels\Corrections\ScaleCorrection.csv exists and that the file has the scale corrections for the scales to be used. (This file can be obtained from the task manager or downloaded from the Alignment Web page.)
2. Connect the FireFly BluePort to a USB port on the computer. (The BluePort and the FireFly BluePort are a matched set. There are two sets: they have a small sticky label with a number 1 (uses HP laptop computer) or a number 2 (uses Dell Latitude D800 laptop) on them. They will not work if you use one number 1 and one number 2). Connect the BluePort to the level using the RS-232 adapter cable as shown below; using the slide switch turn the BluePort on.
3. The BluePort RS-232 version has an onboard rechargeable battery. The slide switch has to be in the on position to during charging of the unit.

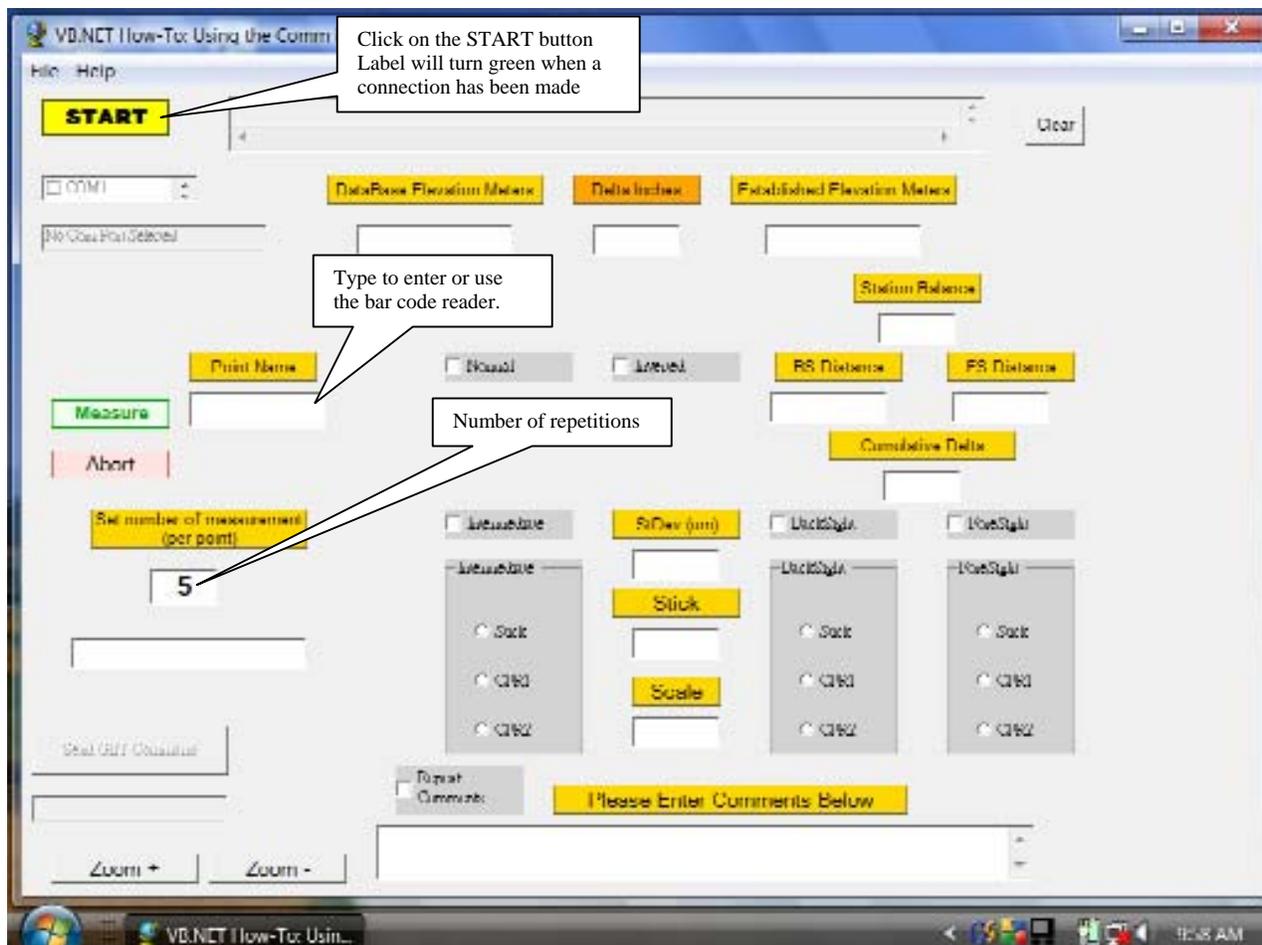


4. Lay out the level run by marking the instrument stations centering them between the points to be measured. The centering needs to be accurate to less than one-meter difference from the instrument to each, the backsight and the foresight.
5. It is absolutely imperative that an even number of setups be used for every level run. The rods must leap frog during the elevation runs, resulting with the level rod or scale used on the beginning benchmark is the rod or scale used on the ending benchmark **in every loop**. (If “G” scale is used on the first benchmark, it should be used on the last benchmark as well.)
6. A **loop** is a level run from one benchmark through the points to be measured, then through the same points in exact reverse order. A loop is to be completed in the morning before lunch and a second loop in the afternoon.

How to operate DNA03 levels program

AMG Levels Program User Guide :

- 1) Start the levels program using the shortcut on your desktop (or navigate to C:/MyConsole/ConsoleApplication/bin/VB>NET How-To Using the Comm Port.exe and double click). The instrument can be off, the program will turn on the instrument, or the instrument can be turned on, but if the instrument is in sleep or standby mode, the program will not be able to open a port.
- 2) First the program displays a communication window reminding you how to connect the BluePorts and to ensure that you are using a matched set. (The BluePort and the FireFly BluePort are a matched set. There are two sets: they have a small sticky label with a number 1 (to be used on the HP laptop computer) or a number 2 (to be used on the Dell Latitude D800 laptop) on them. They will not work if you use one number 1 and one number 2). Ensure that the BluePort is turned on. Click OK.
- 3) Then VB.NET How-To: Using the Comm Port window opens. This is the main window from which the program the user will interact with the program.



4. At the bottom of the user interface window is a scrollable input box labeled “Please Enter Comments Below”, the comments will be attached to the next point measured. A “Repeat Comments” check box may be used to associate the comment with several points and must be unchecked to discontinue.
5. The measurement process can now be started. Set the instrument in the middle of the first two points to be measured. Using the bull’s-eye bubble, level the instrument then point the instrument at the BackSight and focus. NOTE: if the instrument is not level, is incorrectly focused, or the lighting is inadequate an error message will occur and necessitate rectification before the measurement will be accepted.
6. Click the START button in the upper left corner of the window. A communication window opens allowing the user to select the vertical control file for the program to use. Click OK.
7. A navigation window will open, locate and select the file to be used. Click the open button in the window.
8. A communications window, notifies the user that the program will be loading the scale correction file : C:/Levels/Corrections/ScaleCorrection.csv. Click OK.
9. The Start button box turns green; the program initializes the instrument connections, turns on the instrument, and sets parameters in the instrument. Caution if the instrument is in “sleep mode” the program will not connect; you must have the instrument on or off for the program to connect properly.
10. The default for the program upon boot-up is to select the “Normal” checkbox and “Backsight” checkbox. If the backsight is inverted select this checkbox first. At any time, alternating between Normal and Inverted selections necessitates re-entering stick and scale corrections.
11. Click in the point name box and enter the name using the bar code reader or by typing it in. When using the bar code reader first click onto the point name textbox then read the code with the bar code reader. If the point name does not appear in the textbox make sure you have a connection with the bar code reader and the PC (see systems manger for details). A point name must be entered to continue, it can be any name using alphanumeric characters. (NOTE: occasionally the barcode reader will insert an incorrect name.) If the point name exists in the file loaded by the program at START, the Elevation will be displayed in the “DataBase Elevation Meters” box. If this point is not in the Elevation Control file, a communications window will inform the user and ask if this name is to be used. Followed by another information window asking for a starting elevation. The default of 100.000 meters is used on a point without an assigned elevation.
12. Selecting the number of measurements per point: the program default is 5 (which is typical for precise level runs). A communications window will inform the user that the program will accept 3 to 25 measurements modifiable at any time during the level run. An error window will allow the user to make the selection. Click OK. This number will be retained until the user chooses to change it.
13. Selecting the stick, carbon fiber rod, and scale correction: This selection may be made in three ways. Click on the radio buttons labeled Stick, CFR1 or CFR2 or click in the stick box or press measure before entries are made. A communications window opens requesting input: 1 to enter stick correction, 2 to enter the correction for CFR1 and 3 to enter the correction for CFR2. (The two CFR’s individual corrections will be incorporated with the scale correction and entered in the Stick box.) **NOTE: When using the two or three meter rods, select stick of 0.75” for the half size of the 1.5” ball, which represents the height of an SMR, the scale would be left blank.**
14. The next window will require the user to input a stick value if one exists, if none enter 0 (zero). This input could accommodate any other type of correction as well (i.e. tierod thickness). The stick correction is entered as a positive number; the program will adjust it accordingly.
15. Another window will require the letter of the scale on the point; this letter is found as a label on the back of the scale. Scales labels range from A through M. Selected scale letter will appear in the Scale box.
16. **NOTE: the correction in the Stick box is a combination of the scale correction and the stick correction combined.**
17. Using the bull’s-eye bubble, level the instrument then point the instrument at the BackSight and focus. Click the Measure button. The instrument will collect the designated number of measurements on the

backsight and beep 2 times on completion. The command line scroll window between the START button and the NEW LINE button will scroll through the number of measurements. Note the length of the string, if it is truncated or scrambled this indicates that the battery in the level is getting too low to communicate with the program.

The measurement status box indicates the measurements as they are taken.

The “StDev (um)”, standard deviation of the number of measurements, field will be calculated and displayed after measurements are collected. The program has a default setting of 100 microns for this statistic and will not accept a measurement that exceeds the default. Attempt to measure up to three more times, and then seek ways to mitigate. Several problems may cause this: air currents, lighting issues, benchmarks too far apart, etc.

After this measurement is collected, the program will change to foresight mode indicated by the back color of the foresight section turning green and the backsight section changing to grey.

17. Turn the instrument to the foresight and focus. NOTE: if you have balanced your backsight and foresight well, very little change in focus will be required.
18. Normal is the default selection for the scale orientation and will remain until the user changes it. Change as needed. Upon change, the stick and scale are cleared and must be reentered, after the measurement is taken, the information window will require stick and scale to be reentered. Click OK.
19. A communications window opens requesting input: 1 to enter stick correction, 2 to enter the correction for CFR1 and 3 to enter the correction for CFR2 for the foresight. Click OK. The program will continue to loop until the user enters input.
20. The next window will require the user to input a stick value if one exists, if none enter 0 (zero). Click OK.
21. Another window will require the letter of the scale on the point; this letter is found as a label on the back of the scale. Note the change in the Stick value. As you alternate, from the backsight and foresight the current scale correction will change the stick correction value.
22. Using the bull’s-eye bubble, level the instrument then point the instrument at the foresight and focus. Click the measure button.
23. After the foresight measurement is completed, the statistics in the Station Balance and the Cumulative Delta will be displayed. For a precise level run, the station balance should stay under 2 meters; the Cumulative Delta should be less than 5 meters. These balances can be adjusted only between setups. A negative number must be adjusted by making the backsight longer than the foresight on the next setup. Conversely, a positive number is corrected by making the foresight longer on the next setup. NOTE: these numbers are meters not feet. Always check and correct for station imbalance as this affects the adjustment on the run. It is best to make these adjustments in small increments keeping the changes small as opposed to making one large change in one setup. If these two statistical defaults are exceeded, the user has the option to override the default and accept the measurement, but the deficits still should be corrected in future setups. As long as these statistics continue to exceed the default maximum the program will continue to display the information window notifying the user.
24. The StDev (um), standard deviation of the number of measurements, field will be calculated and displayed. This statistic has a default maximum of 100 um and if exceeded will halt the measurements.
25. The program has changed into Backsight mode, retaining the point number and the stick and scale selections from the last station, adjust as needed.
26. Move the instrument to the next station centering it between the current backsight and the next foresight, adjust the backsight distance and foresight distance to correct for the station imbalance, level the instrument, rotate the scales as needed, adjust lighting, sight the scale and focus. Normal is the default selection for the scale orientation and will remain until the user changes it. Change as needed. Upon change, the stick and scale are cleared and must be reentered, after the measurement is taken, the information window will require stick and scale to be reentered. Click measure. (If too much time has elapsed the instrument may go into “sleep mode”, the information window will inform the user that the

“scale may be blocked or inverted or has insufficient light”. Check for these issues, turn the instrument off or on and re-measure.)

27. NOTE: Always double-check your stick and scale entries before pressing the measure button.
28. Continue alternating backsight and foresight until the user decides to start the return run (remember all level loops consist of a forward run and a reverse run). Reverse run can only be started on a “Backsight”. Click the “Reverse Run” check box.
An information window will notify the user that “the control file has been updated with the new point”. Click OK.
29. The foresight stick/scale settings will be retained, adjust as needed, and the program will switch to backsight. Adjust the instrument as needed and measure.
30. Information windows will inform the user of the next point number for the foresight.
31. Check and/or adjust the stick and scale corrections as needed.
32. The information windows will continue to guide the user in reverse order through all the points. After the last point is measured, the information window informs the user that the reverse run is finished.
Then the program asks the user for the decision to start a new level loop (line).
Yes, clears out all of the old information and statistics then asks the user for stick/CFR decisions. Selecting No returns to the main user window retaining all of the calculated statistics.
During the reverse run, the program will be comparing elevations between the forward run and the reverse run. In the event that elevations do not match, an information window will inform the user of the issue, displaying the stick used on this station’s backsight and foresight. This allows the option to re-measure adjusting the incorrect stick. Yes, will dump this station’s data, and allow it to be re-measured. An information window will allow the user a second chance to decide. No, keeps the station data and the Delta Inches box will display the discrepancy between the forward and return runs.
34. Close the program in the usual manor; select exit under the file menu or click the “X” in the upper right corner of the main window.
35. On the main interaction window, to the left of the Stick and Scale input boxes, is the option for Intermediate measurements. This is not typically used in a level loop since every point in a loop is a significant point or monument requiring double measurements between all points. The Intermediate measurement is used to collect one or more measured points from one instrument station (using one instrument height) typically used in level runs that will be adjusted by bundle method or perhaps a check elevation to a lesser significant point. Once the Intermediate check box is selected it remains until the user de-selects it so several points can be measured in succession. The Intermediate option can only be used after a backsight has been measured and an instrument height established.
36. New Line: This option is available at any time. Functionally, it clears out all statistical data and inserts a new line starting point for a reverse run.
37. The program creates three data files during operation. One file is an operational file only (c:/Levels/DataBase Elevations/Level Control_<today’s date>); the other two are the data files for the run, which must be logged at the office at the end of the day and or job. The two data files are c:/Levels/Run/LevelRun.txt and c:/Levels/Run/LevelRunCrew.txt. The operational file may be deleted when the run is completed. Each run, data will be appended to the data files. Each day, the c:/Levels/Run/LevelRun.txt and c:/Levels/Run/LevelRunCrew.txt data files may have the data from past runs cleared to avoid confusion and keep the files current. NOTE: when clearing out the data of these two files do not delete or clear the headers! Do not move the files or change the names.