Calibration Base Lines

Instrument Station Setup At The Corbin Calibration Base Line
500 Meter Point

What Is A Calibration Base Line?

- **A series of stable monuments (marks) in a straight line (to within 2 arc minutes) whose published mark-to-mark distances and horizontal distances between all marks compare favorably with the National Standard of Unit Length.**
- **The National Standard of Unit Length is determined by the National Institute of Standards and Technology (NIST).**
- **NIST calibration services link the makers and users of precision instruments to the basic and derived units of the International System (SI) of measurements.**
- **For more information see http://www.nist.gov/public_affairs/guide/**

The NIST Reference on Constants, Units, and Uncertainty

www.physics.nist.gov/cuu/Units/meter.html

International System of Units (SI)

Return to Units home page

Units Topics:
Introduction
Units
Prefixes
Outside
Rules
Background

Units Bibliography

Constants, Units & Uncertainty home page

Historical context of the SI

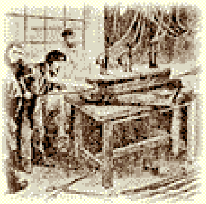
meter	kilogram	second	ampere	kelvin	mole	candela	history of SI

Unit of length (meter)

Abbreviations: CGPM, CIPM, BIPM

The origins of the meter go back to at least the 18th century. At that time, there were two competing approaches to the definition of a standard unit of length. Some suggested defining the meter as the length of a pendulum having a half-period of one second; others suggested defining the meter as one ten-millionth of the length of the earth's meridian along a quadrant (one fourth the circumference of the earth). In 1791, soon after the French Revolution, the French Academy of Sciences chose the meridian definition over the pendulum definition because the force of gravity varies slightly over the surface of the earth, affecting the period of the pendulum.

Thus, the meter was intended to equal 10^{-7} or one ten-millionth of the length of the meridian through Paris from pole to the equator. However, the first prototype was short by 0.2 millimeters because researchers miscalculated the flattening of the earth due to its rotation. Still this length became the standard. (The engraving at the right shows the casting of the platinum-iridium alloy called the "1874 Alloy.") In 1889, a new international prototype was made of an alloy of platinum with 10 percent iridium, to within 0.0001, that was to be measured at the melting point of ice. In 1927, the meter was more precisely defined as the distance, at 0°, between the axes of the two central lines marked on the bar of platinum-iridium kept at the BIPM, and declared Prototype of the meter by the 1st CGPM, this bar being subject to standard atmospheric pressure and supported on two cylinders of at least one centimeter diameter, symmetrically placed in the same horizontal plane at a distance of 571 mm from each other.



The 1889 definition of the meter, based upon the artifact international prototype of platinum-iridium, was replaced by the CGPM in 1960 using a definition based upon a wavelength of krypton-86 radiation. This definition was adopted in order to reduce the uncertainty with which the meter may be realized. In turn, to further reduce the uncertainty, in 1983 the CGPM replaced this latter definition by the following definition:

The meter is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second.

Note that the effect of this definition is to fix the speed of light in vacuum at exactly 299 792 458 $m \cdot s^{-1}$. The original international prototype of the meter, which was sanctioned by the 1st CGPM in 1889, is still kept at the BIPM under the conditions specified in 1889.

How Are the Distances on a Calibration Base Line Compared to this Standard?

- **The instruments used to establish the base line are traceable to the National Standard of Unit Length.**

- **Before and after a series of calibration base lines are established, the instruments are compared to the lengths on the Corbin Calibration Base Line located at the National Geodetic Survey's Instrumentation and Methodologies Branch at Corbin, Virginia.**

- **All lengths on Corbin base line were established with a series of calibrated 50 Meter Invar Tapes. These tapes were calibrated by the National Bureau of Standards (NBS), now the National Institute of Standards and Technology (NIST) and were directly compared to the National Standard of Unit Length.**

What Is The Purpose Of A CBL?

- **The purpose of a CBL is to check the accuracy of electronic distance measuring instruments (EDMI).**
- **Regular checks and documentation of EDMI calibration over a CBL provides surveyors with valid evidence of the proper function of their distance measuring equipment.**
- **To assure the measuring capabilities of an EDMI have not significantly deteriorated, known distances forming a calibration range or base line is required.**
- **EDMI observations made over a CBL provide a direct link to the National Standard of Unit Length.**

When Should An EDMI Be Checked At A CBL

- **When an EDMI is new and no previous measurements have been made at a CBL**
- **After a repair has been made**
- **Anytime there is a question to the accuracy of the EDMI**
- **When it is dictated by law, management authority, or policy**
- **When it is an agreement between the contractor and client**

How Are Calibration Base Lines Configured?

- **CBL monuments are set in a straight line on flat or even sloped terrain, or on terrain with a slight depression in the middle.**
- **Monuments are usually set at approximately 0 m, 150 m, 430 m and 1400 m.**
  - **The distance to the mark farthest from the 0 meter point must be 1000 meters or more.**
- **Some have a tape calibration monument (chaining mark) at 100 feet from 0 m point either along the base line or perpendicular to it.**
- **Elevations published on marks are usually NOT to be treated as benchmarks.**
  - **In North Carolina most CBL marks are also benchmarks**

CBL Monumentation

Without stable monumentation a calibration base line is worthless.

For this reason, a heavy, poured concrete monument is required.

The figure at right depicts this type of monument.

Experience has shown that monuments with significant mass placed in relatively undisturbed soil have the best long-term stability.

CALIBRATION BASE LINE MONUMENT

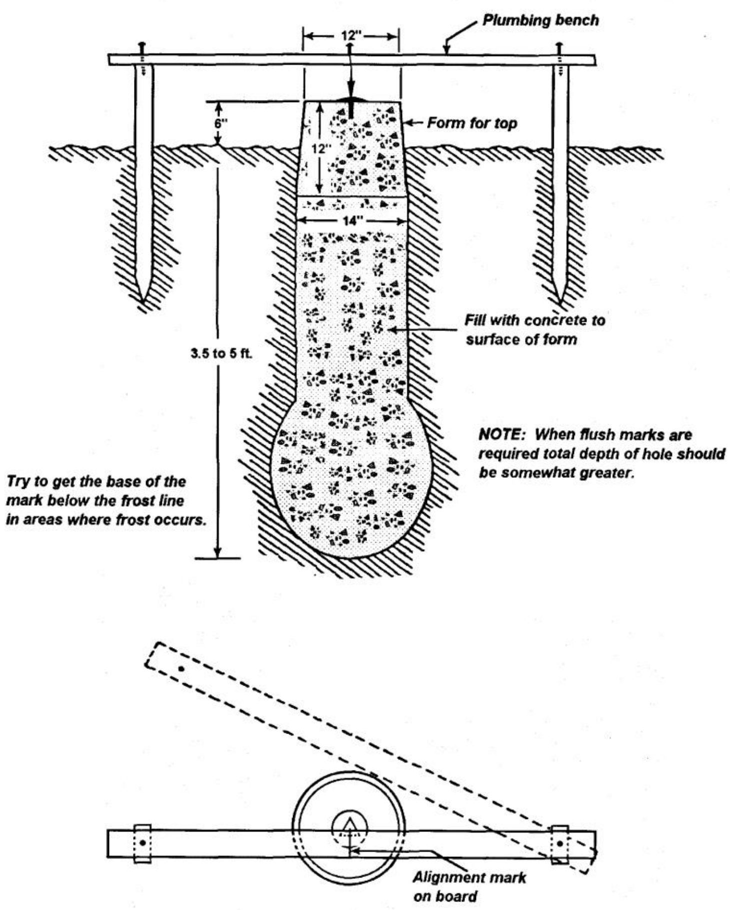
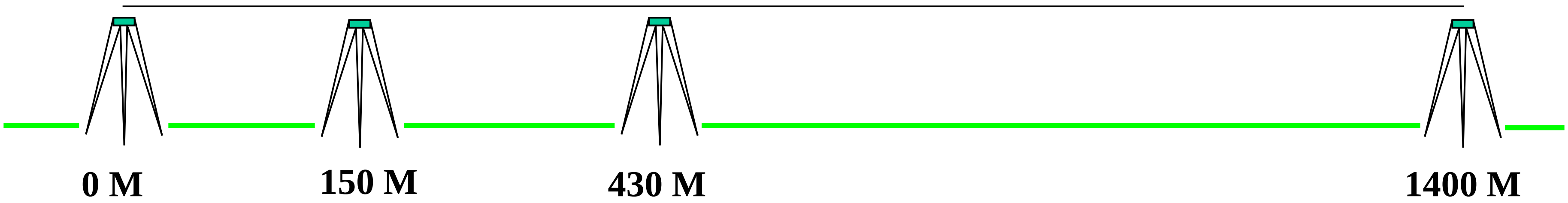
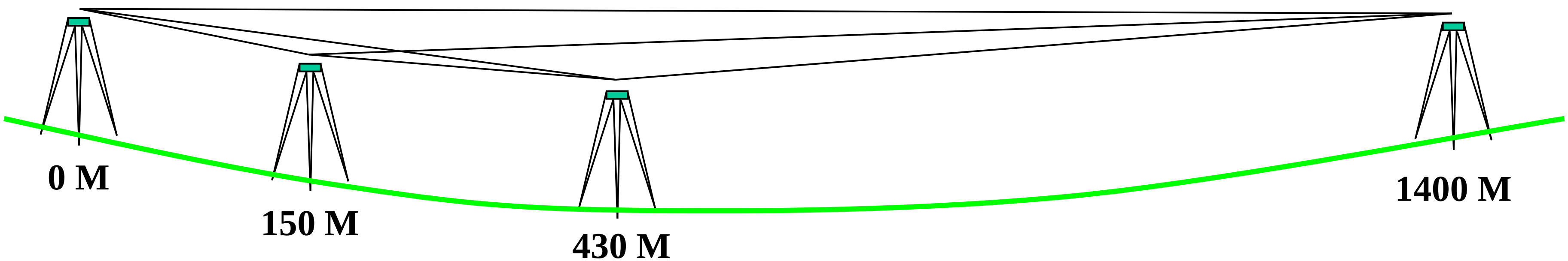


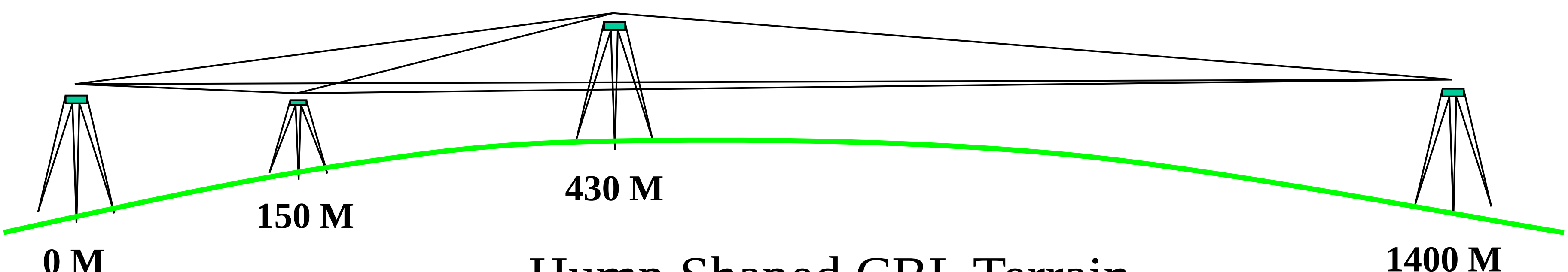
Figure 2. -- Diagram of installation of typical calibration baseline monument.



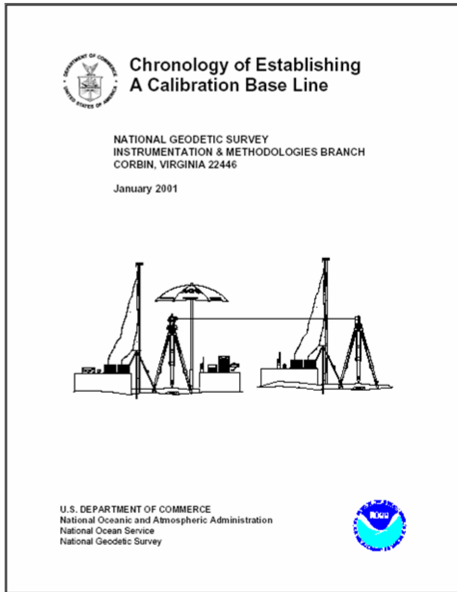
Flat CBL Terrain



Sag or “Dish” Shaped CBL Terrain



Hump Shaped CBL Terrain

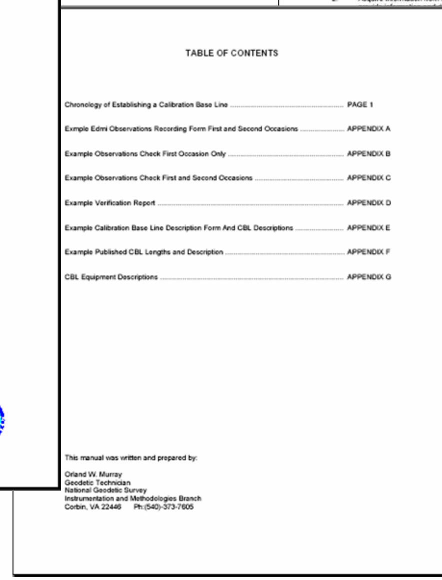


Chronology of Establishing A Calibration Base Line

NATIONAL GEODETIC SURVEY
INSTRUMENTATION & METHODOLOGIES BRANCH
CORBIN, VIRGINIA 22446

January 2001

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Service
National Geodetic Survey



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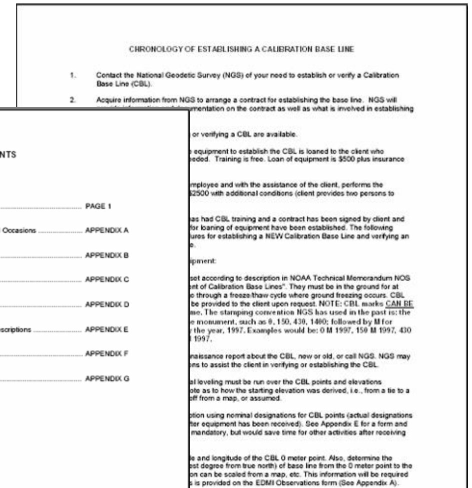
This manual was written and prepared by:

Orland W. Murray
Geodetic Technician
National Geodetic Survey
Instrumentation and Methodologies Branch
Corbin, VA 22446 Ph:(540)-373-7605



CHRONOLOGY OF ESTABLISHING A CALIBRATION BASE LINE

1. Contact the National Geodetic Survey (NGS) of your need to establish or verify a Calibration Base Line (CBL).

2. Acquire information from NGS to arrange a contract for establishing the base line. NGS will ...mentation on the contract as well as what is involved in establishing

... or verifying a CBL are available.

... equipment to establish the CBL is loaned to the client who ...eeded. Training is free. Loan of equipment is $500 plus insurance

...mployee and with the assistance of the client, performs the ...$2500 with additional conditions (client provides two persons to

...as had CBL training and a contract has been signed by client and ...for loaning of equipment have been established. The following ...lures for establishing a NEW Calibration Base Line and verifying an ...e.

...ipment:

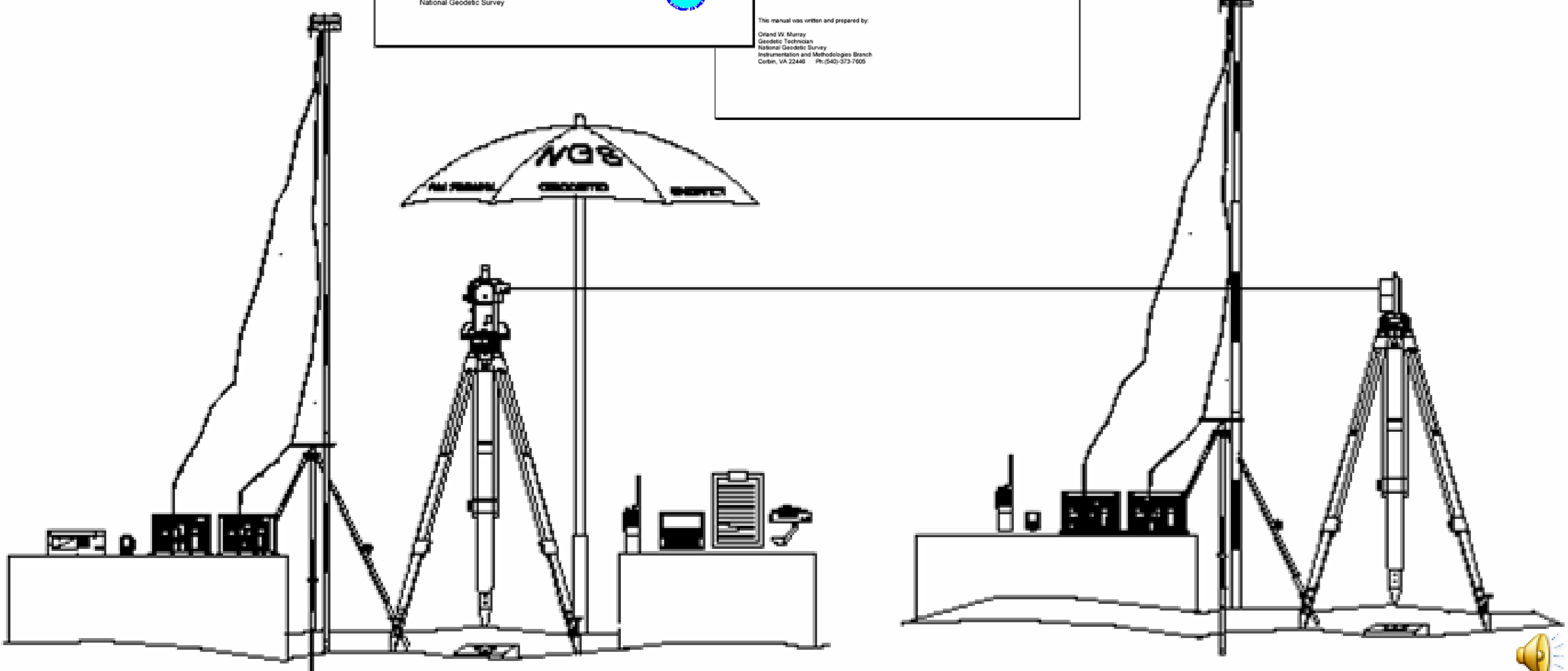
...set according to description in NOAA Technical Memorandum NOS ...nt of Calibration Base Lines". They must be in the ground for at ...o through a freeze/thaw cycle where ground freezing occurs. CBL ... be provided to the client upon request. NOTE: CBL marks CAN BE ...me. The stamping convention NGS has used in the past is: the ...e monument, such as 0, 150, 430, 1400; followed by M for ...the year, 1997. Examples would be: 0 M 1997, 150 M 1997, 430 ... 1997.

...naissance report about the CBL, new or old, or call NGS. NGS may ...ns to assist the client in verifying or establishing the CBL.

...al leveling must be run over the CBL points and elevations ...ote as to how the starting elevation was derived, i.e., from a tie to a ...off from a map, or assumed.

...tion using nominal designations for CBL points (actual designations ...ter equipment has been received). See Appendix E for a form and ... mandatory, but would save time for other activities after receiving

...e and longitude of the CBL 0 meter point. Also, determine the ...est degree from true north) of base line from the 0 meter point to the ...on can be scaled from a map, etc. This information will be required ...s is provided on the EDMI Observations form (See Appendix A).



Wild T2000 Electronic Theodolite (Figure 2) - The T2000 is used primarily as a support for the two EDMI instruments, but is also used for checking the alignment of the base line, performing trigonometric leveling, and establishing the 100 ft monument.

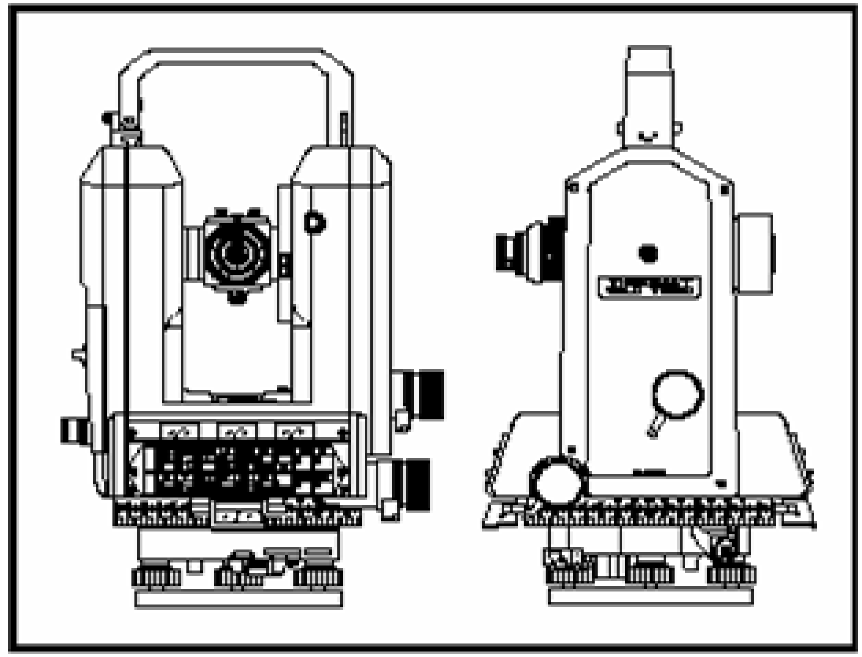


Figure 2 - Wild T2000 Tachymeter

Two Wild Lieca DI2002 EDMI (Figure 3) - The DI2002 is very accurate short range (2000 m) electronic distance measuring instrument. It's specifications are ±1 mm + 1 ppm. Two DI2002s are used to measure every segment of the base line in both directions on two different days. This is the primary piece of equipment for establishing the calibration base lines.

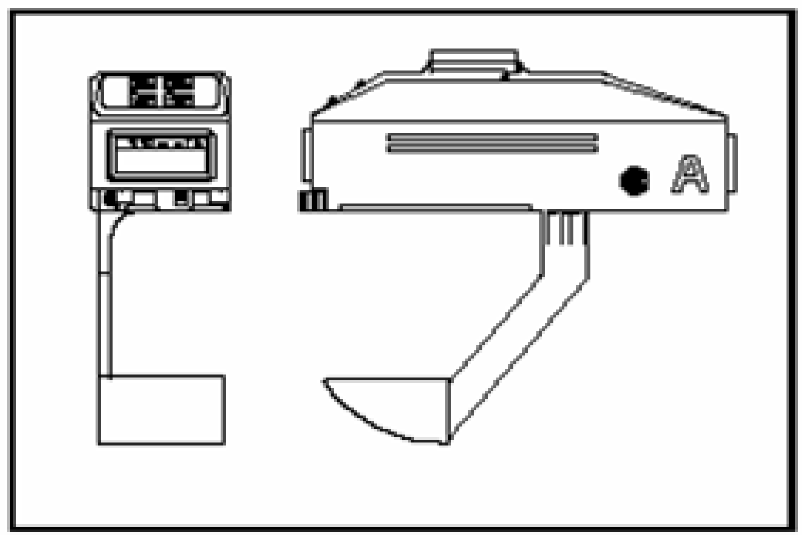


Figure 3 - Wild DI2002 EDMI


WILD
HEERBRUGG
DIST
TEST
CODE
COMP
DSP
STOP
OFF
ON
CE
ALL
REC
HZ
V
HZ V
REP
NR
SET
RUN


LEICA EDMI C
MODEL: DI2002
S/N: 180065 NOAA: 63743
CBL EQUIPMENT SET #1
C


NATL GEOD
SURVEY-

Wild Zenith/Nadir Collimator ZBL16 (Figure 12) - This little collimator is used during setup of the tripods and collimating the tribrachs. Since the GDF-23 tribrachs do not have optical plummets, it provides the means to collimate very closely before final collimating with the NL collimator.

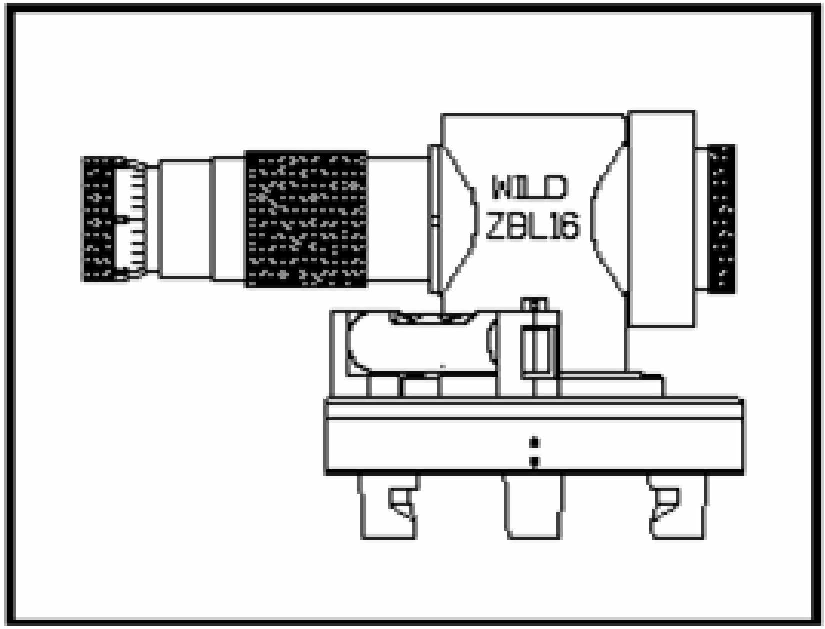


Figure 12 - Wild Zenith/Nadir Collimator

Wild NL Collimator (Figure 4) - The NL collimator is a self-leveling collimator that provides the ability to collimate (plumb) over a mark to withing 0.2-0.4 mm. It is used to assure that both the EDMI and the reflectors are plumbed over the base line marks as accurately as possible. This is very important when establishing a CBL and when calibrating an EDMI as well.

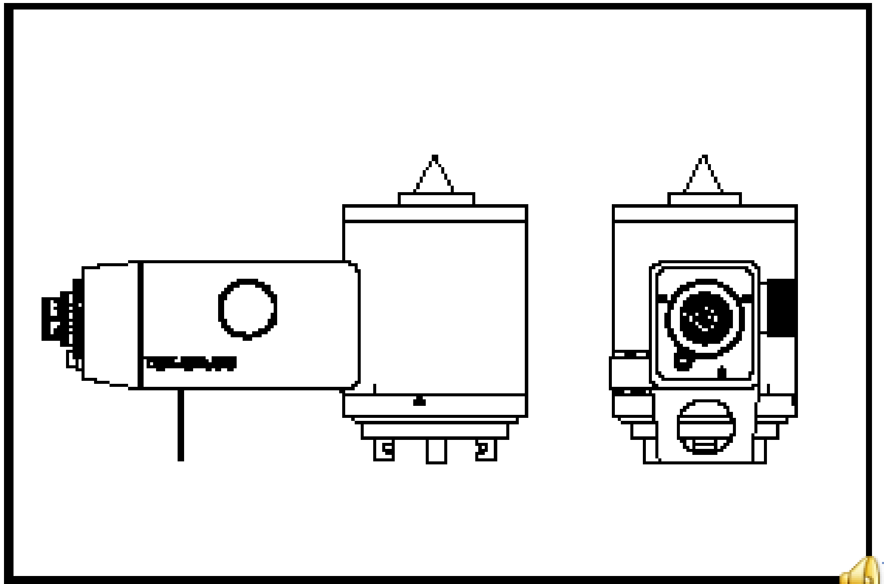
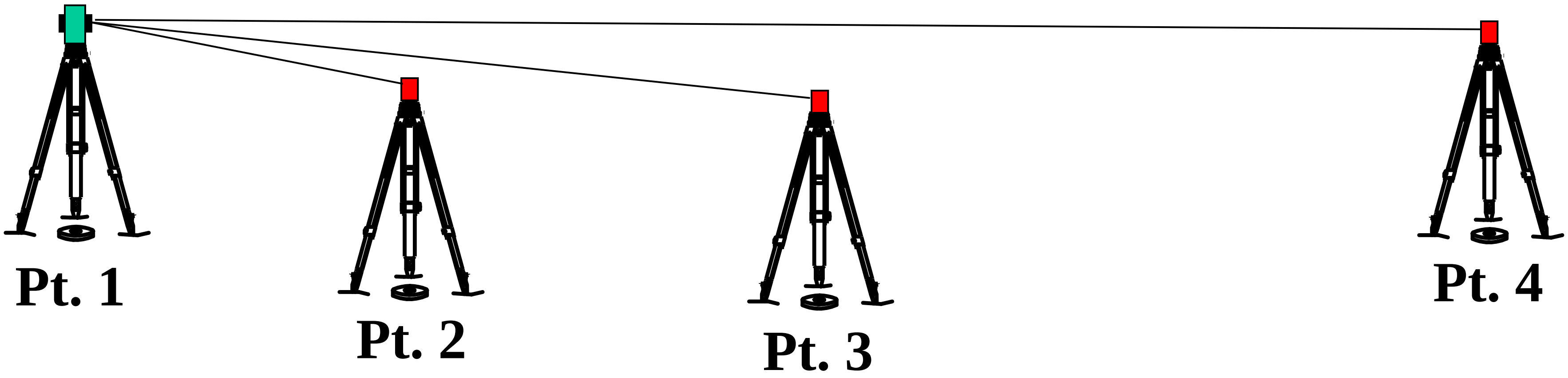


Figure 4 - Wild NL Collimator


HEERBRUGG SWITZERLAND

Day 1 – First Occasion



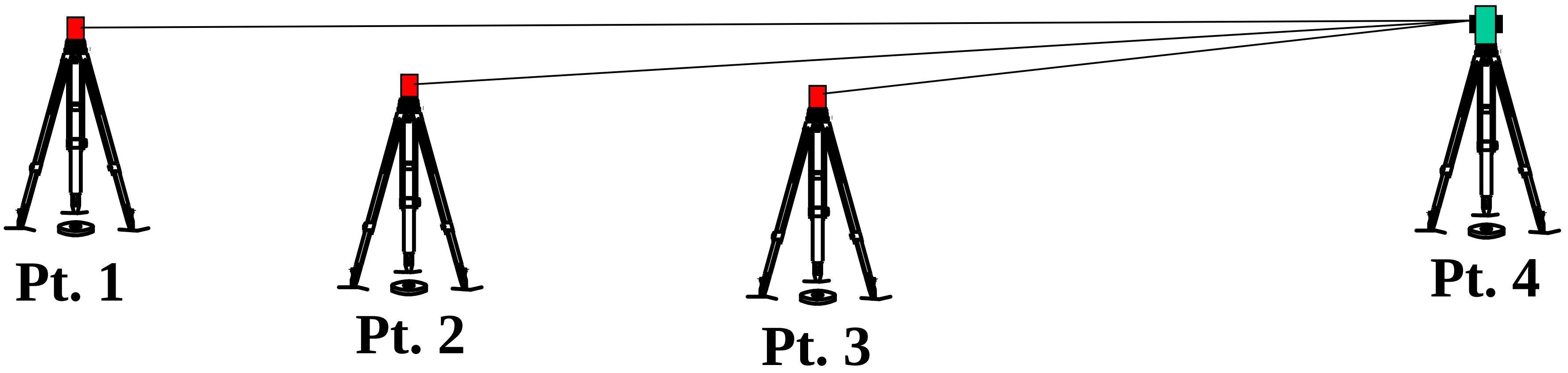
Instrument at Pt. 1 – Reflector starts at Pt. 2 Measure:

Pt. 1 to Pt. 2 - EDMI A then C; Observation AF1-2 and CF1-2

Pt. 1 to Pt. 3 - EDMI C then A; Observation CF1-3 and AF1-3

Pt. 1 to Pt. 4 - EDMI A then C; Observation AF1-4 and CF1-4

Day 2 – Second Occasion

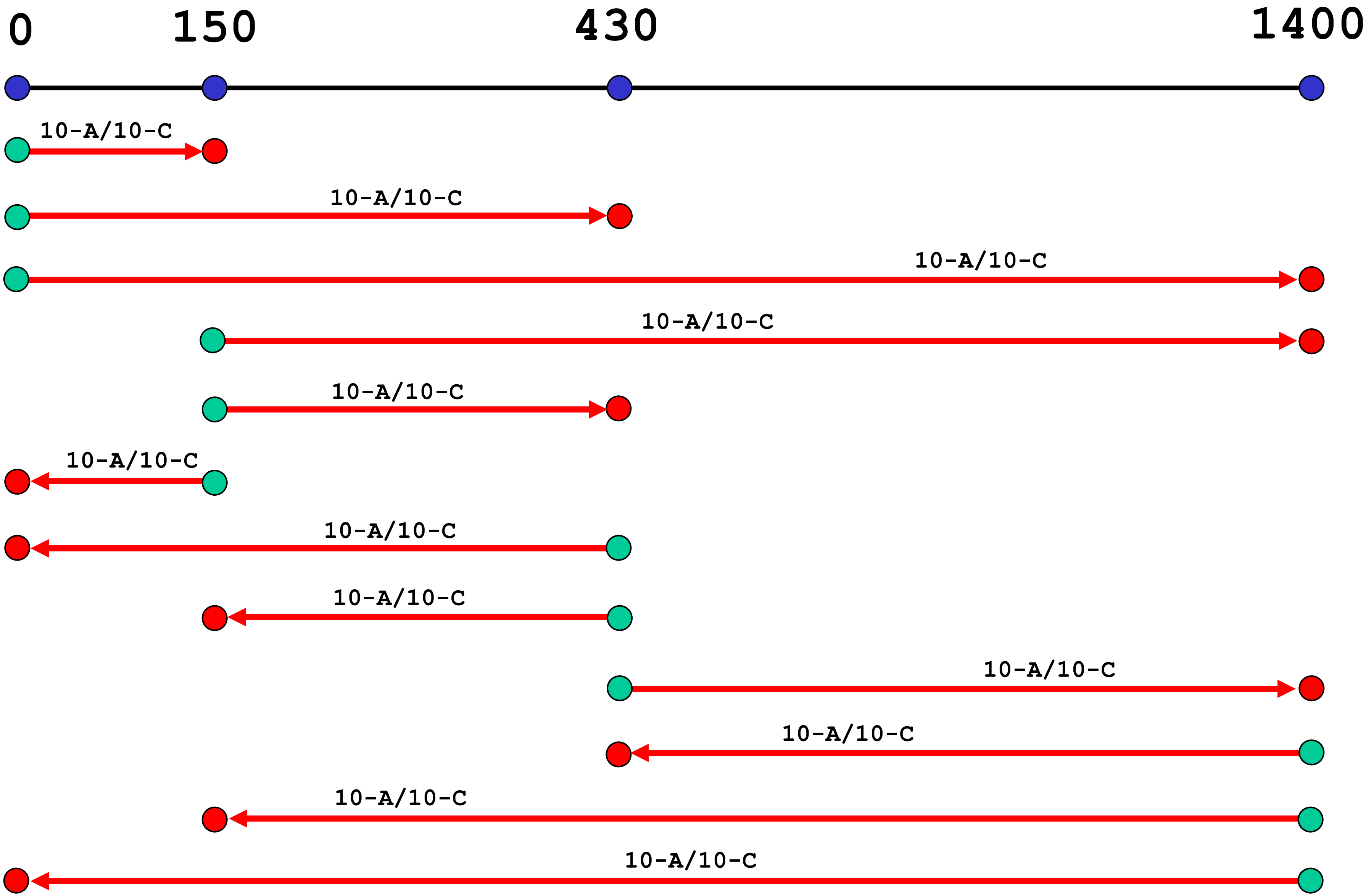


Instrument at Pt. 4 – Reflector starts at Pt. 3 Measure:

Pt. 4 to Pt. 3 - EDMI A then C; Observation AS4-3 and CS4-3

Pt. 4 to Pt. 2 - EDMI C then A; Observation CS4-2 and AS4-2

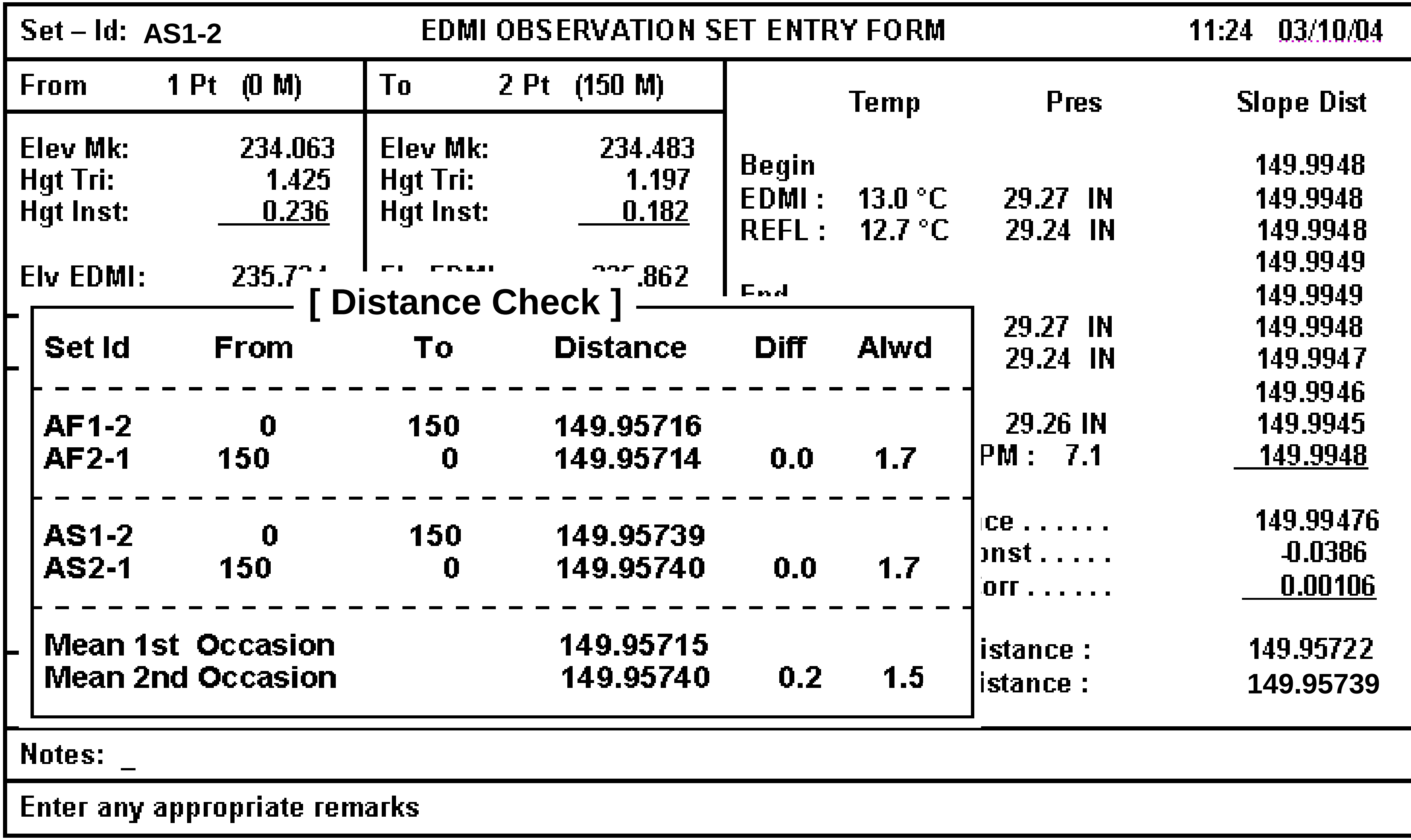
Pt. 4 to Pt. 1 - EDMI A then C; Observation AS4-1 and CS4-1



1^{st} Day – 120 EDMI A + 120 EDMI C = 240 Total Measurements

2^{nd} Day – 120 EDMI A + 120 EDMI C = 240 Total Measurements

Sample Data Collector Screen



Set – Id: AS1-2 | EDMI OBSERVATION SET ENTRY FORM | 11:24 03/10/04

From 1 Pt (0 M)		To 2 Pt (150 M)	
Elev Mk:	234.063	Elev Mk:	234.483
Hgt Tri:	1.425	Hgt Tri:	1.197
Hgt Inst:	0.236	Hgt Inst:	0.182
Elv EDMI:	235.7		.862

	Temp	Pres	Slope Dist
Begin			149.9948
EDMI :	13.0 °C	29.27 IN	149.9948
REFL :	12.7 °C	29.24 IN	149.9948
			149.9949
End			149.9949
		29.27 IN	149.9948
		29.24 IN	149.9947
			149.9946
		29.26 IN	149.9945
PM :	7.1		149.9948
ce			149.99476
nst			-0.0386
orr			0.00106
istance :			149.95722
istance :			149.95739

[Distance Check]

Set Id	From	To	Distance	Diff	Alwd
AF1-2	0	150	149.95716		
AF2-1	150	0	149.95714	0.0	1.7
AS1-2	0	150	149.95739		
AS2-1	150	0	149.95740	0.0	1.7
Mean 1st Occasion			149.95715		
Mean 2nd Occasion			149.95740	0.2	1.5

Notes: _

Enter any appropriate remarks

EDMI Error

- **Constant Error**
  - **Stated by the manufacturer as a fixed + or - value**
  - **Same in sign and magnitude regardless of length**
  - **Error is systematic (accumulative)**
  - **Number of measured distances added together, the error in the total equals the number of distances multiplied by the constant error value**

EDMI Error (Continued)

- **Scale Error**
  - **Proportional to length of the measured distance**
  - **Expressed as +/- parts per million (PPM)**
  - **Magnitude of error is equal to the length of the measured distance multiplied by the error in PPM times 10^{-6}**

Atmospheric Measurement Errors

- Distance errors caused by atmospheric measurements errors
  - 1 degree Celsius in air temperature = 1 PPM
  - 1/10 inch of mercury in barometric pressure = 1 PPM
  - 1 degree in wet or dry bulb temperature = 0.01 PPM

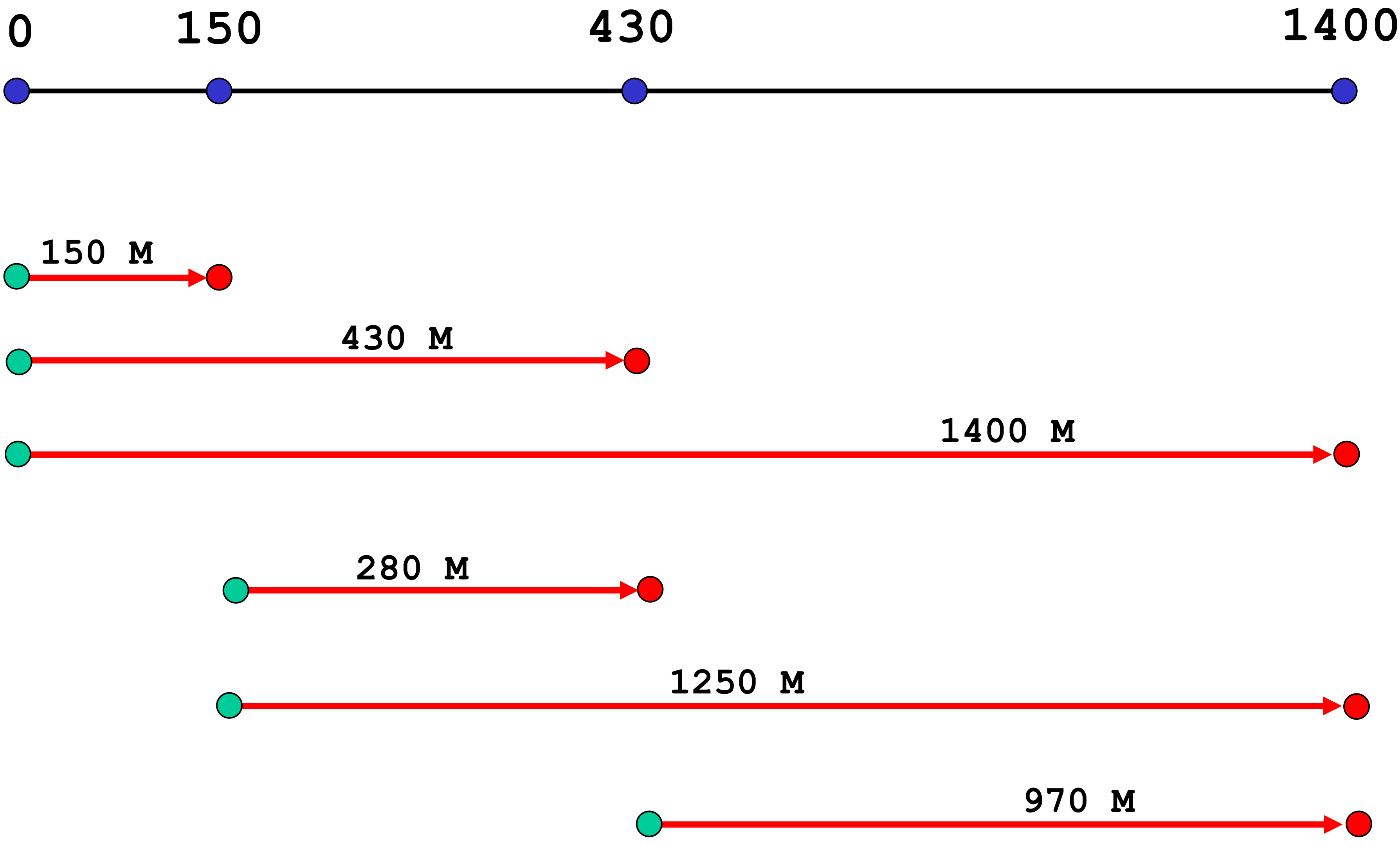
EDMI Measurement Error Sources

- Constant Error
  - Plumbing Errors
    - Cross Hairs out of adjustment
    - Level bubble out of adjustment
    - Prism constant error

EDMI Measurement Error Sources

- Scale Error
  - Error in measuring the atmospheric conditions that affect the velocity of light
    - Air temperature
    - Barometric pressure
    - Relative humidity

“Standard” Calibration Base Line



NC EDM CALIBRATION BASELINES

Smithfield EDM Calibration Baseline - Windows Internet Explorer

http://www.ncgs.state.nc.us/baselines/smithfield.html

Smithfield EDM Calibration Baseline

FROM STATION	TO STATION	HOR DIST (M)	MARK TO MARK (M)	STD ERROR (MM)
SMITH 000	SMITH 150	150.0008	150.0281	0.1
SMITH 000	SMITH 400	399.9772	400.0222	0.1
SMITH 000	JNX B	1100.0001	1100.0168	0.2
SMITH 150	SMITH 400	249.9764	249.9960	0.1
SMITH 150	JNX B	949.9991	950.0045	0.1
SMITH 400	JNX B	700.0226	700.0226	0.1

STATION	NGVD 29 ELEVATION IN METERS
SMITH 000	47.494
SMITH 150	44.631
SMITH 400	41.497
JNX B	41.431

THE BASE LINE IS LOCATED ABOUT 5.4 (3.4 MI) NORTHWEST OF SMITHFIELD, N. C. AND 13.1 KM (8.2 MI) SOUTH SOUTHEAST OF CLAYTON, N.C. AT THE JOHNSTON COUNTY AIRPORT (PERMISSION NEEDED FOR ACCESS SEE BELOW).

THE BASE LINE IS A NORTH-SOUTH LINE WITH THE 0-METER POINT ON THE NORTH END. IT CONSISTS OF THE 0, 150, 400 AND 1100 METER POINTS. THERE IS NO 100 FT. TAPE CALIBRATION MARK.

TO REACH THE 0-METER POINT FROM THE JUNCTION OF US HIGHWAY 70 BUSINESS AND STATE ROUTE 1501 (BUCKET JONES ROAD) LOCATED ABOUT 6.4 KM (4.0 MI) NORTHWEST OF SMITHFIELD, N.C., GO SOUTHWEST ON STATE ROUTE SR1501 FOR 1.0 KM (0.6 MI) TO THE ENTRANCE TO JOHNSTON COUNTY AIRPORT ON THE LEFT, TURN LEFT AND GO EAST ALONG ENTRANCE ROAD FOR 0.03 KM (0.05 MI) TO BRICK AIRPORT FACILITY BUILDING. PASS THROUGH GATE ON THE NORTH SIDE OF THE BUILDING AND GO SOUTHWEST FOR 0.3 KM (0.2 MI) ALONG THE TAXIWAY TO THE 0-METER POINT NEAR THE SOUTHWEST CORNER OF THE APRON.

THE 0-METER POINT IS A NCGS HORIZONTAL CONTROL DISK STAMPED "SMITH 000 1997" SET IN THE TOP OF A 30 CM (12 IN) DIAMETER CONCRETE CYLINDER FLUSH WITH THE SURFACE OF THE GROUND. IT IS: 112.8 M (370.0 FT) NORTHWEST OF THE CENTERLINE OF THE RUNWAY, 10.7 M (35.0 FT) NORTH NORTHEAST OF THE

Done | Internet | 100%

Shelby EDM Calibration Baseline - Windows Internet Explorer

http://www.ncgs.state.nc.us/baselines/shelby.html

Shelby EDM Calibration Baseline

US DEPARTMENT OF COMMERCE - NOAA
NOS - NATIONAL GEODETIC SURVEY
SILVER SPRING MD 20910

CALIBRATION BASE LINE DATA
BASE LINE DESIGNATION: SHELBY CBL
PROJECT ACCESSION NUMBER: 15482
NEAREST TOWN: SHELBY

QUAD: N350813
NORTH CAROLINA
CLEVELAND COUNTY

LIST OF ADJUSTED DISTANCES (7/20/2004)

FROM STATION	ELEV. (M)	TO STATION	ELEV. (M)	ADJ. DIST. (M) HORIZONTAL	ADJ. DIST. (M) MARK - MARK	STD. ERROR (MM)
CLEV 000 1998	256.730	CLEV 150 1998	257.659	149.9983	150.0012	.1
CLEV 000 1998	256.730	CLEV 400 1998	255.935	400.0068	400.0076	.1
CLEV 000 1998	256.730	CLEV 1000 1998	253.389	999.9981	1000.0037	.2
CLEV 150 1998	257.659	CLEV 400 1998	255.935	250.0085	250.0145	.1
CLEV 150 1998	257.659	CLEV 1000 1998	253.389	849.9999	850.0106	.1
CLEV 400 1998	255.935	CLEV 1000 1998	253.389	599.9914	599.9968	.1

DESCRIPTION OF SHELBY CBL
YEAR MEASURED: 2003
LATITUDE: 35 15 25
LONGITUDE: 81 35 55
AZIMUTH: 224
CHIEF OF PARTY: MARK BOOTHE

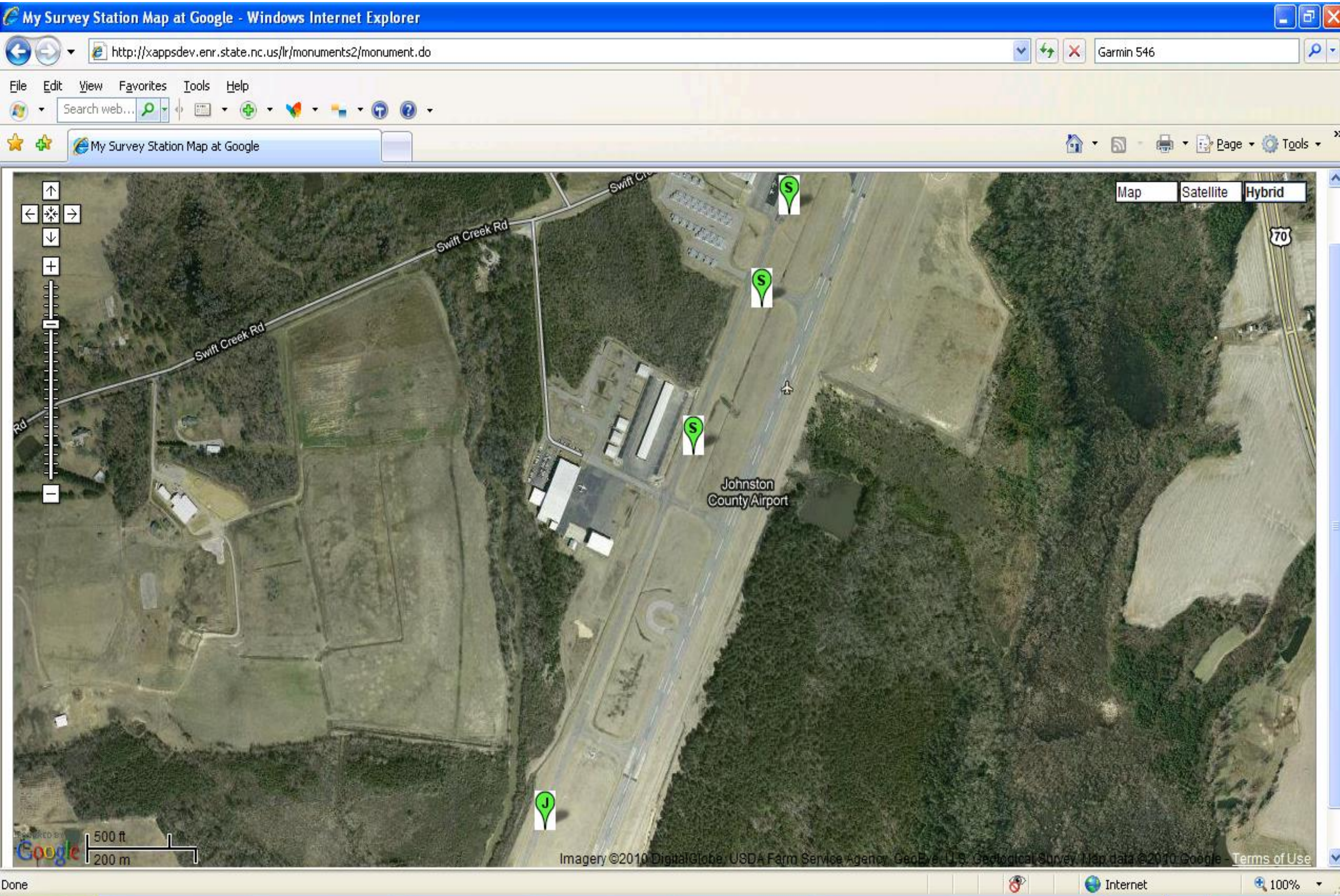
THE BASE LINE IS LOCATED ABOUT 6.8 KM (4.1 MI) WEST-SOUTHWEST OF SHELBY AT THE SHELBY MUNICIPAL AIRPORT. 6.5 KM (3.9 MI) EAST OF BOILING SPRINGS; 9.5 KM (5.7 MI) NORTH OF THE NORTH CAROLINA/SOUTH CAROLINA STATE LINE.

THE BASE LINE IS A NORTHEAST-SOUTHWEST LINE WITH THE 0-METER POINT ON THE NORTHEAST END. IT CONSISTS OF THE 000, 150, 400, AND 1000 METER POINTS.

TO REACH THE 0-METER POINT FROM THE JUNCTION OF NC 150 AND NC 18, LOCATED IN SOUTH SHELBY, GO WEST ON NC 150 FOR 3.25 KM (1.95 MI) TO THE JUNCTION OF THE AIRPORT ENTRANCE, TURN RIGHT AND GO NORTHWEST FOR 0.3 KM (0.2 MI) TO THE AIRPORT TERMINAL. CONTINUE NORTHWEST FOR 0.16 KM (0.1 MI) ACROSS THE PARKING APRON AND ALONG THE NORTHEAST TAXI RAMP TO THE TAXIWAY. TURN RIGHT AND GO NORTHEAST FOR 0.2 KM (0.12 MI) ALONG THE TAIWAY TO THE STATION ON THE LEFT IN THE GRASS MEDIAN BETWEEN THE TAXIWAY AND RUNWAY.

THE 0-METER POINT IS A STANDARD NCGS DISK STAMPED "CLEV 000 1998" SET IN THE TOP OF A 26 CM (10 IN) DIAMETER, SQUARE CONCRETE POST RECESSED 2.5 CM (1 IN) BELOW THE SURFACE OF THE GROUND. IT IS 47.9 M (157.0 FT) NORTHEAST OF THE CENTER OF A DROP INLET, 45.7 M (150.0 FT) SOUTHEAST OF THE CENTERLINE OF THE RUNWAY, 44.8 M (147.0 FT) WEST-SOUTHWEST OF THE CENTER OF A DROP INLET AND 30.1 M

Done · Internet · 100%


My Survey Station Map at Google - Windows Internet Explorer
http://xappsdev.enr.state.nc.us/lr/monuments2/monument.do
Garmin 546
File Edit View Favorites Tools Help
Search web...
My Survey Station Map at Google
Page
Tools
Map
Satellite
Hybrid
Swift Creek Rd
Swift Creek Rd
Rd
70
S
S
S
J
Johnston County Airport
500 ft
200 m
Imagery ©2010 DigitalGlobe, USDA Farm Service Agency, GeoEye, U.S. Geological Survey, Map data ©2010 Google - Terms of Use
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Internet
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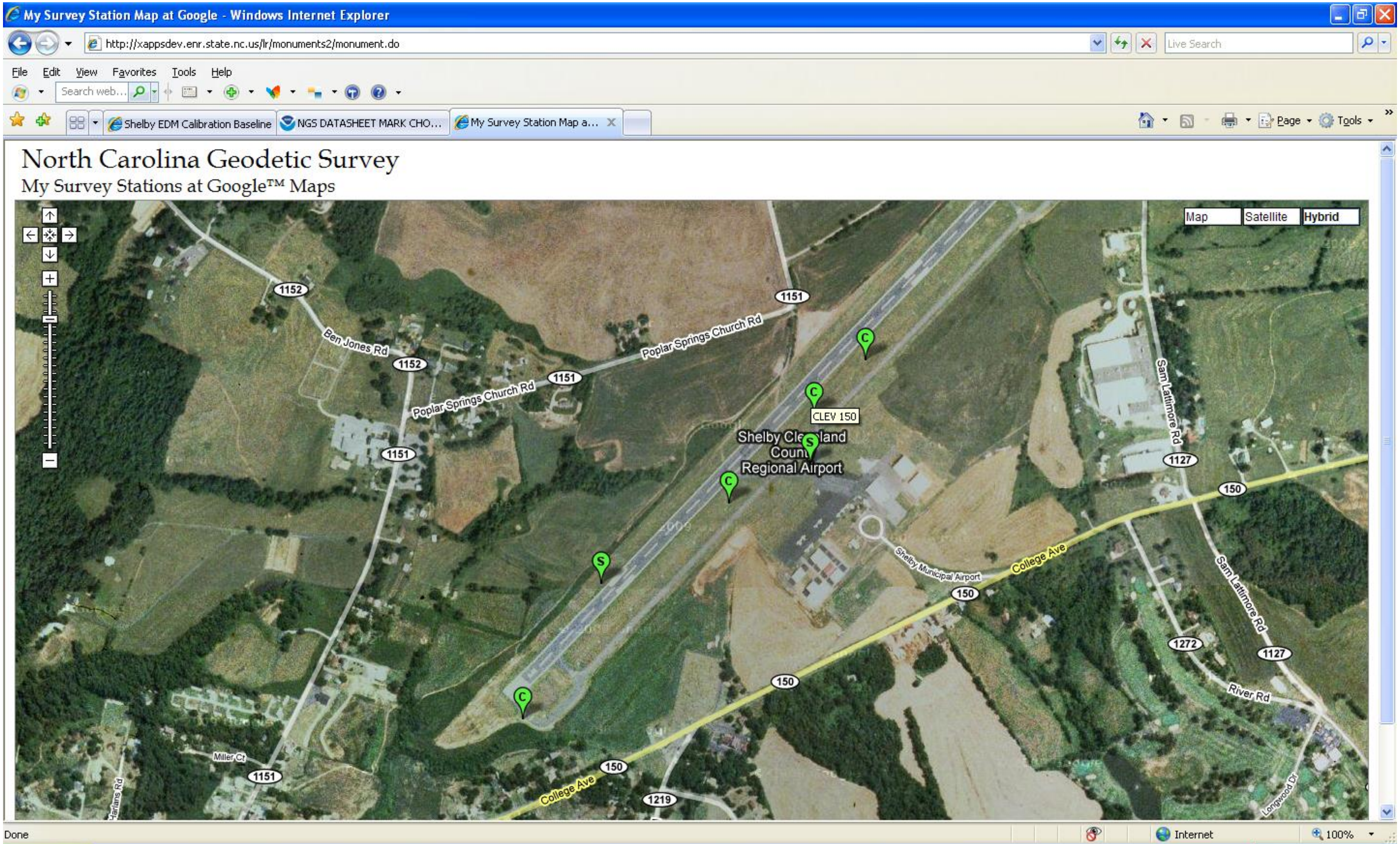
My Survey Station Map at Google - Windows Internet Explorer
http://xappsdev.enr.state.nc.us/lr/monuments2/monument.do
Shelby EDM Calibration Baseline
NGS DATASHEET MARK CHO...
My Survey Station Map a...
North Carolina Geodetic Survey
My Survey Stations at Google™ Maps
Map
Satellite
Hybrid
CLEV 150
Shelby Cleveland County Regional Airport
Poplar Springs Church Rd
Ben Jones Rd
Sam Lattimore Rd
College Ave
Shelby Municipal Airport
River Rd
Miller Ct
1151
1152
1127
150
1272
1219
Done
Internet
100%

National Geodetic Survey

PC Software Download - CALIBRAT

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CALIBRAT - Version 1.0

[April, 1992]

Description

This program is used to determine the scale and constant corrections for electronic distance measuring instruments by making measurements over previously determined base lines. The formulas used in the program are found in NOAA Technical Memorandum *NOS NGS-10: Use of Calibration Base Lines.*

- Download the PC executable
- View/Download the Turbo BASIC source code
- View the program documentation.

- ZIP'ed archive of entire CALBRAT distribution [82.8 KB]

RELATED SOFTWARE: **GETM2M11** can be used to facilitate the creation of the input constraint file for **CALIBRAT**.

- Download the PC executable

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THIS PROGRAM IS USED TO DETERMINE THE SCALE AND CONSTANT
CORRECTION OF ELECTRONIC DISTANCE MEASURING INSTRUMENTS BY MAKING
MEASUREMENTS OVER PREVIOUSLY DETERMINED BASE LINES.  THE FORMULAS
USED IN THE PROGRAM ARE FROM THE NOAA TECHNICAL MEMORANDUM NOS
NGS-10.  THE USE OF CALIBRATION BASE LINES.

ENCLOSED IS A DISK CONTAINING A COPY OF BOTH THE TURBO BASIC
SOURCE CODE (CALIBRAT.BAS) AND EXECUTABLE MODULE (CALIBRAT.EXE)
FOR THE CALIBRATING OF AN EDMI VIA A "LEAST SQUARED SOLUTION".

PROGRAM CONSTRAINTS:

     (1)  THE BASE LINE MEASURED MUST HAVE MORE THAN 2 POINTS AND
          LESS THAN 16 POINTS.
     (2)  THE NUMBER OF USER OBSERVATIONS MUST BE MORE THAN 2 AND
          LESS THAN 211.

THE PUBLISHED BASE LINE DISTANCES AND USER OBSERVATIONS ARE
INPUTTED VIA FILES RATHER THAN BY OBSERVATIONAL PROMPTS WITHIN
THE PROGRAM.  BOTH THE PUBLISHED BASE LINE DISTANCE FILE AND USER
OBSERVATION FILE (WHOSE FILENAMES AND LOCATIONS ARE TOTALLY UP TO
THE USER) MUST HAVE RECORDS OF THE FORM:

             FROM POINT NUMBER, TO POINT NUMBER, DISTANCE

THE RECORDS CAN BE IN ANY ORDER AND SEPARATED BY EITHER COMMAS OR
BLANKS.  THE POINT NUMBERS NEED ONLY TO BE UNIQUE; THEY DO NOT
NEED TO BE CONSECUTIVE. (I.E - YOU CAN USE POINT DESIGNATIONS FOR
THE POINT NUMBERS.)

EXAMPLE:
          150,800,650.2345
     OR   800 150 650 2345

FOR AN 'N' POINT BASE LINE, THERE ARE  N * (N - 1) / 2 SEGMENTS.

THE PROGRAM PROMPTS ARE SELF-EXPLANATORY.  HOWEVER A NULL
RESPONSE FOR EITHER THE PUBLISHED BASE LINE DISTANCE FILENAME OR
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EDM Calibration

________________ (Baseline)

________________ (Date)

EDM Owner: ________________

EDM Brand: ________________ **Model:** ________________

Temperature: _____ (F) **Barometric Pressure:** _____ . _____ (inches of mercury)

PPM Setting: _______ **Prism Offset:** _______

_____ to _____	_____ to _____	_____ to _____	_____ to _____
_____ . _____	_____ . _____	_____ . _____	_____ . _____
_____ . _____	_____ . _____	_____ . _____	_____ . _____
_____ . _____	_____ . _____	_____ . _____	_____ . _____
_____ . _____	_____ . _____	_____ . _____	_____ . _____
_____ . _____	_____ . _____	_____ . _____	_____ . _____
_____ . _____	_____ . _____	_____ . _____	_____ . _____

MANUFACTURER'S SPECIFICATIONS: +2 MM
+2 PPM

SCALE ERROR	=	+24.2216 PPM
STANDARD ERROR OF SCALE	=	+0.9907 PPM
CONSTANT ERROR	=	+0.0320 METERS
STANDARD ERROR OF CONSTANT	=	+0.0003 METERS
VARIANCE OF UNIT WEIGHT	=	+0.0487
COVARIANCE	=	+0.2704
CORRELATION	=	+0.8986

PUBLISHED (METERS)	OBSERVED (METERS)	DIFFERENCE (METERS)	RESIDUAL (METERS)
150.0268	149.9910	+0.0358	+0.0002
150.0268	149.9910	+0.0358	+0.0002
150.0268	149.9910	+0.0358	+0.0002
150.0268	149.9910	+0.0358	+0.0002
150.0268	149.9920	+0.0348	-0.0008
150.0268	149.9910	+0.0358	+0.0002
419.7585	419.7160	+0.0425	+0.0003
419.7585	419.7170	+0.0415	-0.0007
419.7585	419.7170	+0.0415	-0.0007
419.7585	419.7160	+0.0425	+0.0003
419.7585	419.7160	+0.0425	+0.0003
419.7585	419.7160	+0.0425	+0.0003

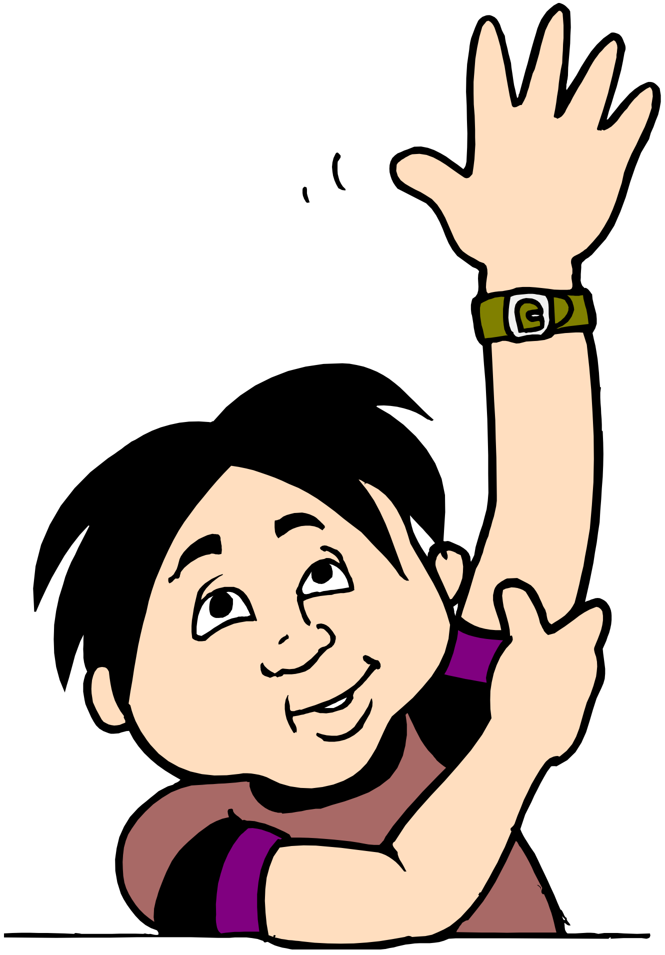
SCALE ERROR	=	+59.7154 PPM
STANDARD ERROR OF SCALE	=	+6.3246 PPM
CONSTANT ERROR	=	-0.0467 METERS
STANDARD ERROR OF CONSTANT	=	+0.0077 METERS
VARIANCE OF UNIT WEIGHT	=	+0.5808
COVARIANCE	=	+48.1133
CORRELATION	=	+0.9895

PUBLISHED (METERS)	OBSERVED (METERS)	DIFFERENCE (METERS)	RESIDUAL (METERS)
990.2270	990.2150	+0.0120	-0.0005
990.2270	990.2160	+0.0110	-0.0015
990.2270	990.2130	+0.0140	+0.0015
990.2270	990.2130	+0.0140	+0.0015
990.2270	990.2140	+0.0130	+0.0005
990.2270	990.2180	+0.0090	-0.0035
1259.9591	1259.9280	+0.0311	+0.0025
1259.9591	1259.9330	+0.0261	-0.0025
1259.9591	1259.9310	+0.0281	-0.0005
1259.9591	1259.9300	+0.0291	+0.0005
1259.9591	1259.9330	+0.0261	-0.0025
1259.9591	1259.9220	+0.0371	+0.0085
1409.9860	1409.9530	+0.0330	-0.0045
1409.9860	1409.9490	+0.0370	-0.0005
1409.9860	1409.9360	+0.0500	+0.0125
1409.9860	1409.9580	+0.0280	-0.0095
1409.9860	1409.9480	+0.0380	+0.0005
1409.9860	1409.9510	+0.0350	-0.0025

SCALE ERROR	=	-0.4533 PPM
STANDARD ERROR OF SCALE	=	+1.3473 PPM
CONSTANT ERROR	=	+0.0000 METERS
STANDARD ERROR OF CONSTANT	=	+0.0016 METERS
VARIANCE OF UNIT WEIGHT	=	+0.1041
COVARIANCE	=	+2.1597
CORRELATION	=	+0.9892

PUBLISHED (METERS)	OBSERVED (METERS)	DIFFERENCE (METERS)	RESIDUAL (METERS)
990.2270	990.2280	-0.0010	-0.0006
990.2270	990.2260	+0.0010	+0.0014
990.2270	990.2280	-0.0010	-0.0006
990.2270	990.2280	-0.0010	-0.0006
990.2270	990.2270	+0.0000	+0.0004
990.2270	990.2280	-0.0010	-0.0006
1259.9591	1259.9580	+0.0011	+0.0016
1259.9591	1259.9590	+0.0001	+0.0006
1259.9591	1259.9610	-0.0019	-0.0014
1259.9591	1259.9610	-0.0019	-0.0014
1259.9591	1259.9580	+0.0011	+0.0016
1259.9591	1259.9590	+0.0001	+0.0006
1409.9860	1409.9870	-0.0010	-0.0004
1409.9860	1409.9860	+0.0000	+0.0006
1409.9860	1409.9860	+0.0000	+0.0006
1409.9860	1409.9870	-0.0010	-0.0004
1409.9860	1409.9880	-0.0020	-0.0014
1409.9860	1409.9870	-0.0010	-0.0004

Questions?



denr.geodetic.questions@ncmail.net