Calibration Base Lines

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/**

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.

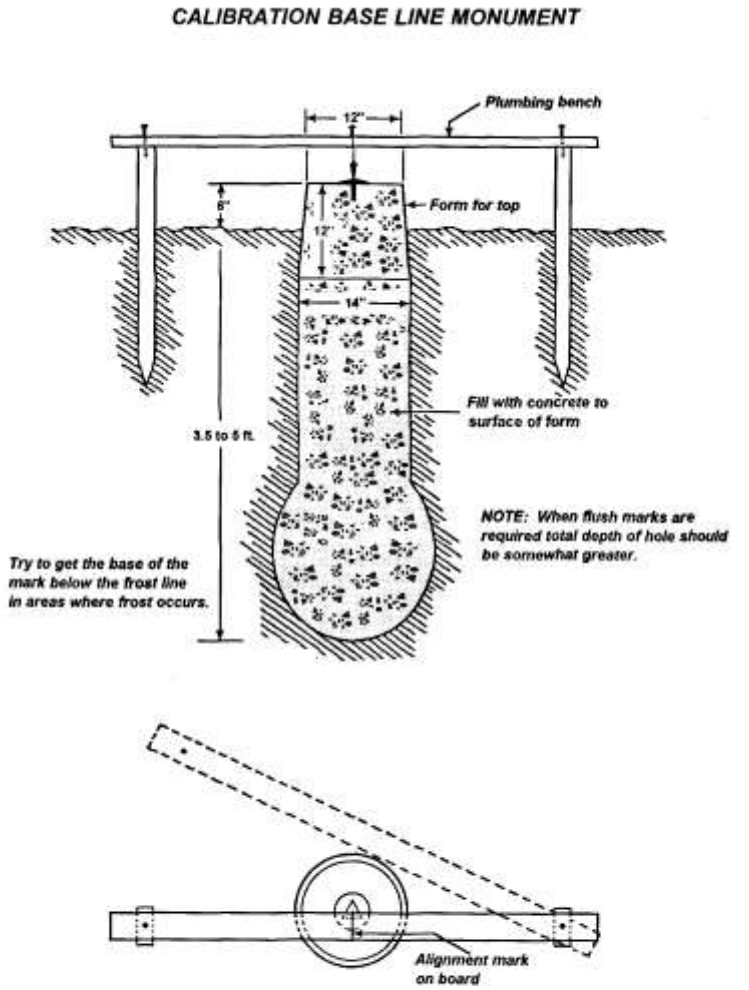
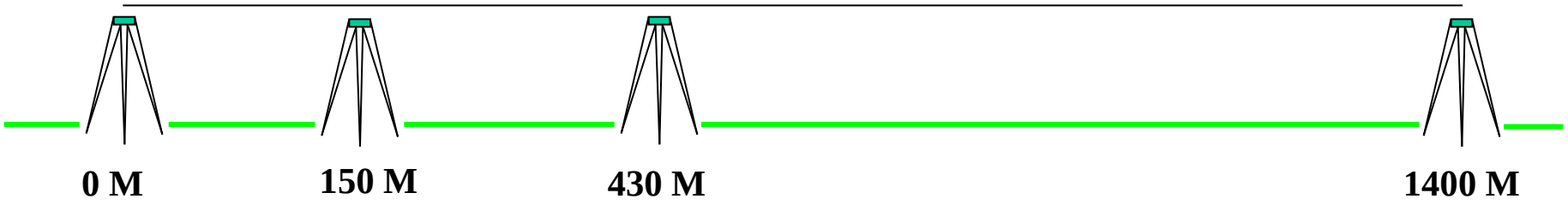
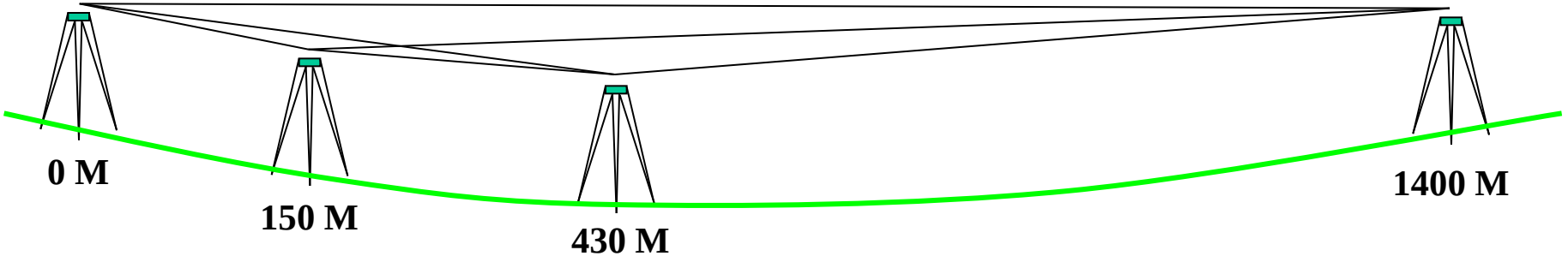


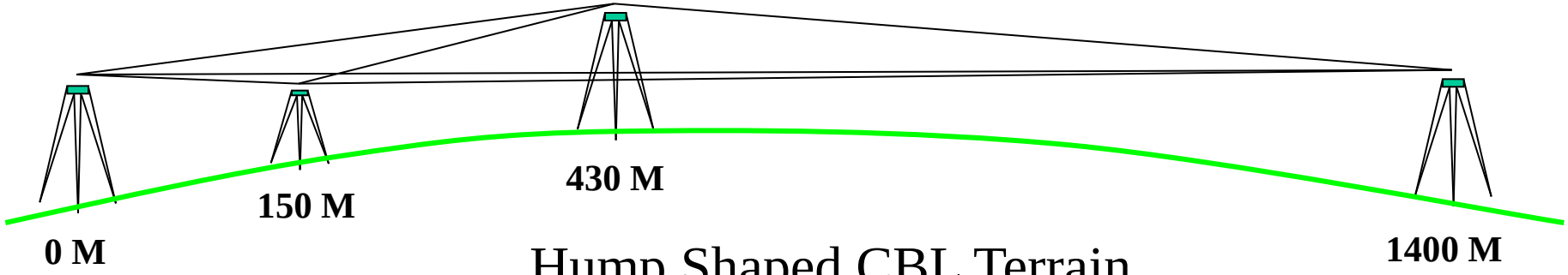
Figure 2. – Diagram of installation of typical calibration baseline monument.



Flat CBL Terrain

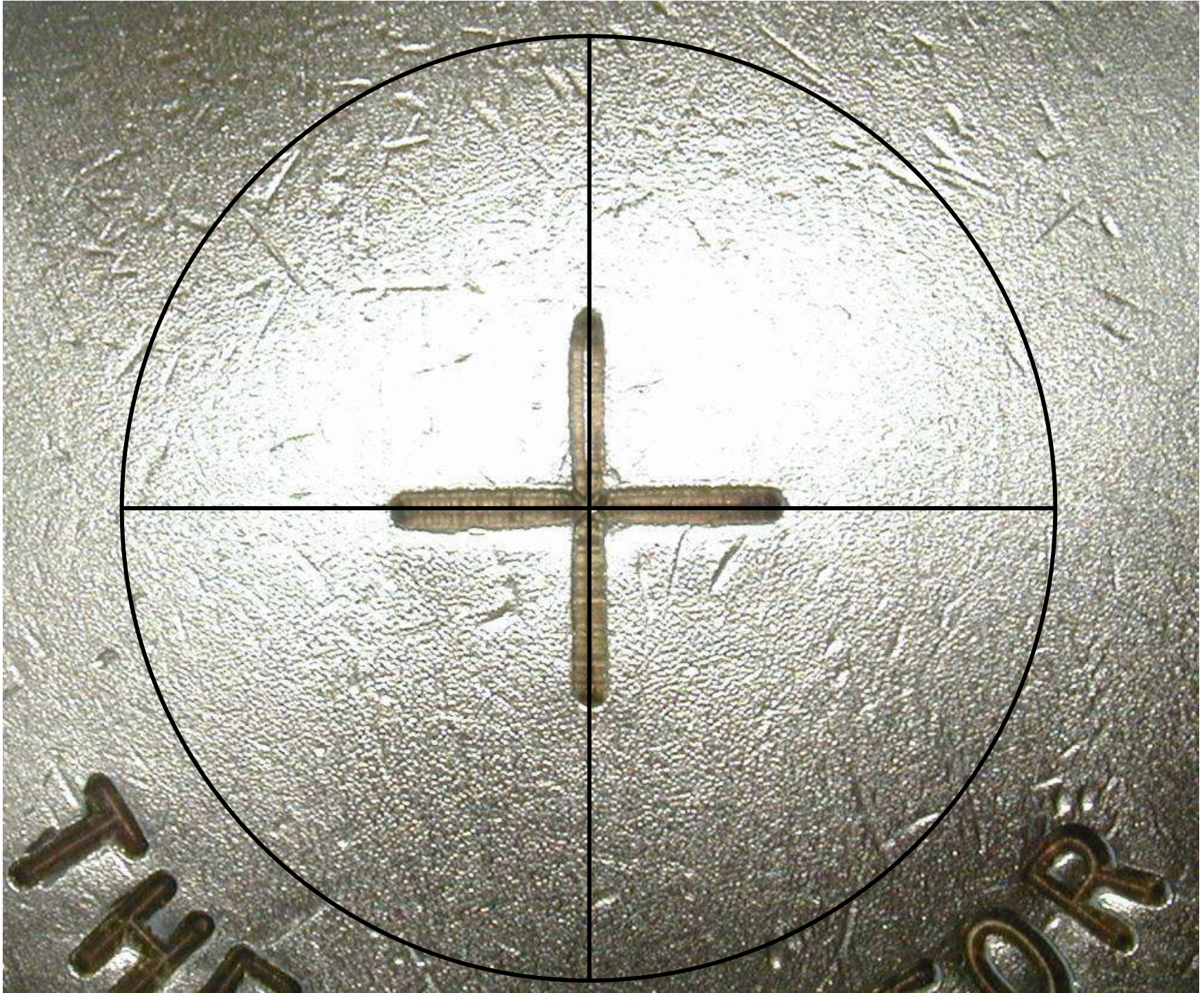


Sag or “Dish” Shaped CBL Terrain

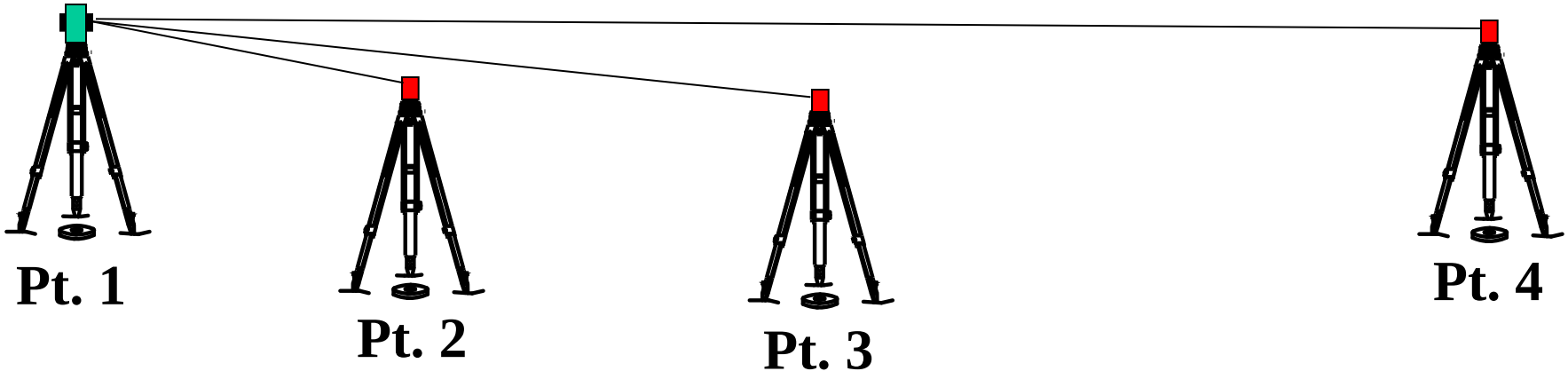


Hump Shaped CBL Terrain


HEERBRUGG
SWITZERLAND



Day 1 – First Occasion



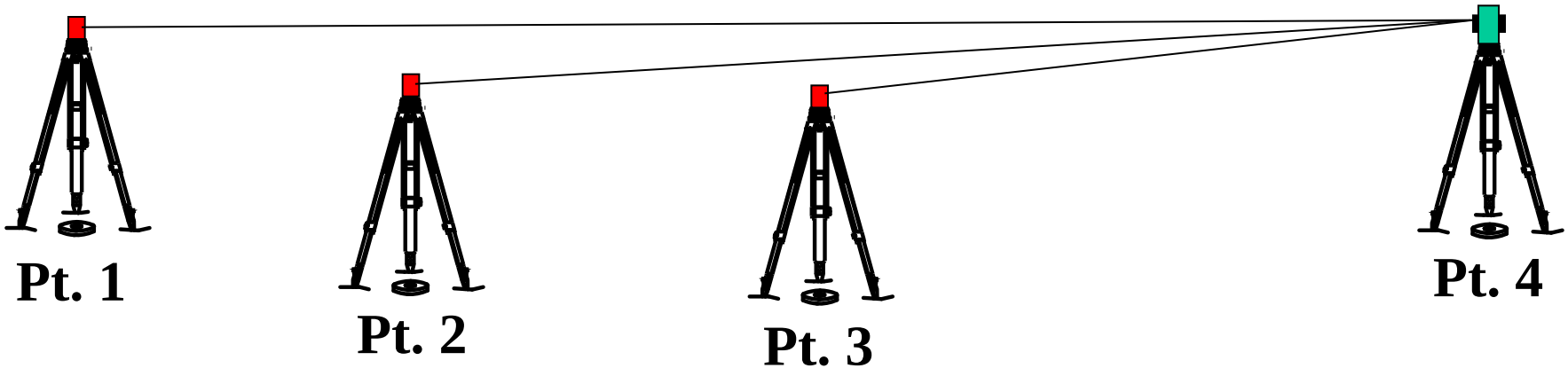
Instrument at Pt. 1 – Reflector starts at Pt. 2 Measure:

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

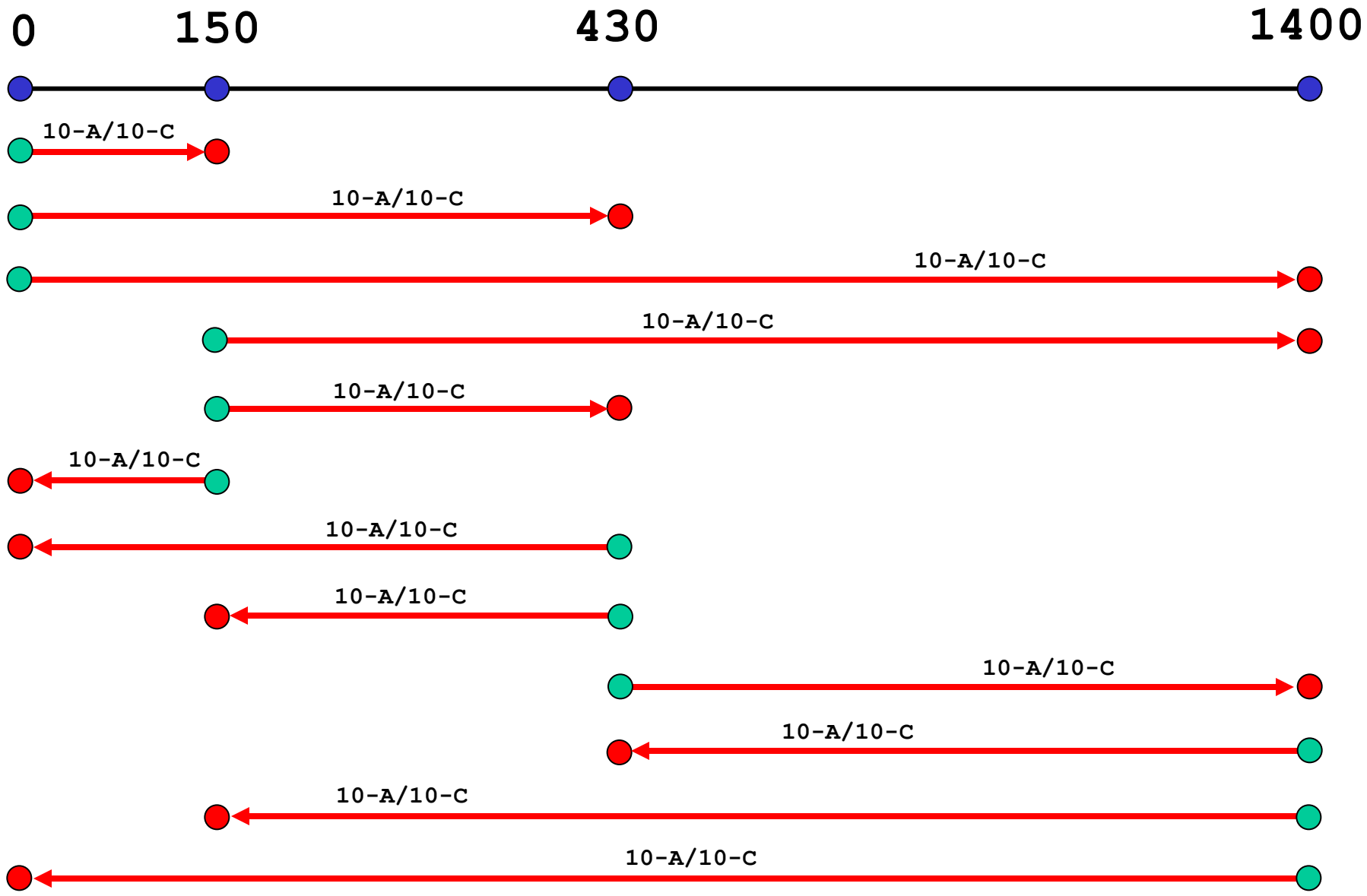


Instrument at Pt. 4 – Reflector starts at Pt. 3 Measure:

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



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

2nd 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: 235.724	Elv EDMI: 235.862

	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


07 28 2011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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

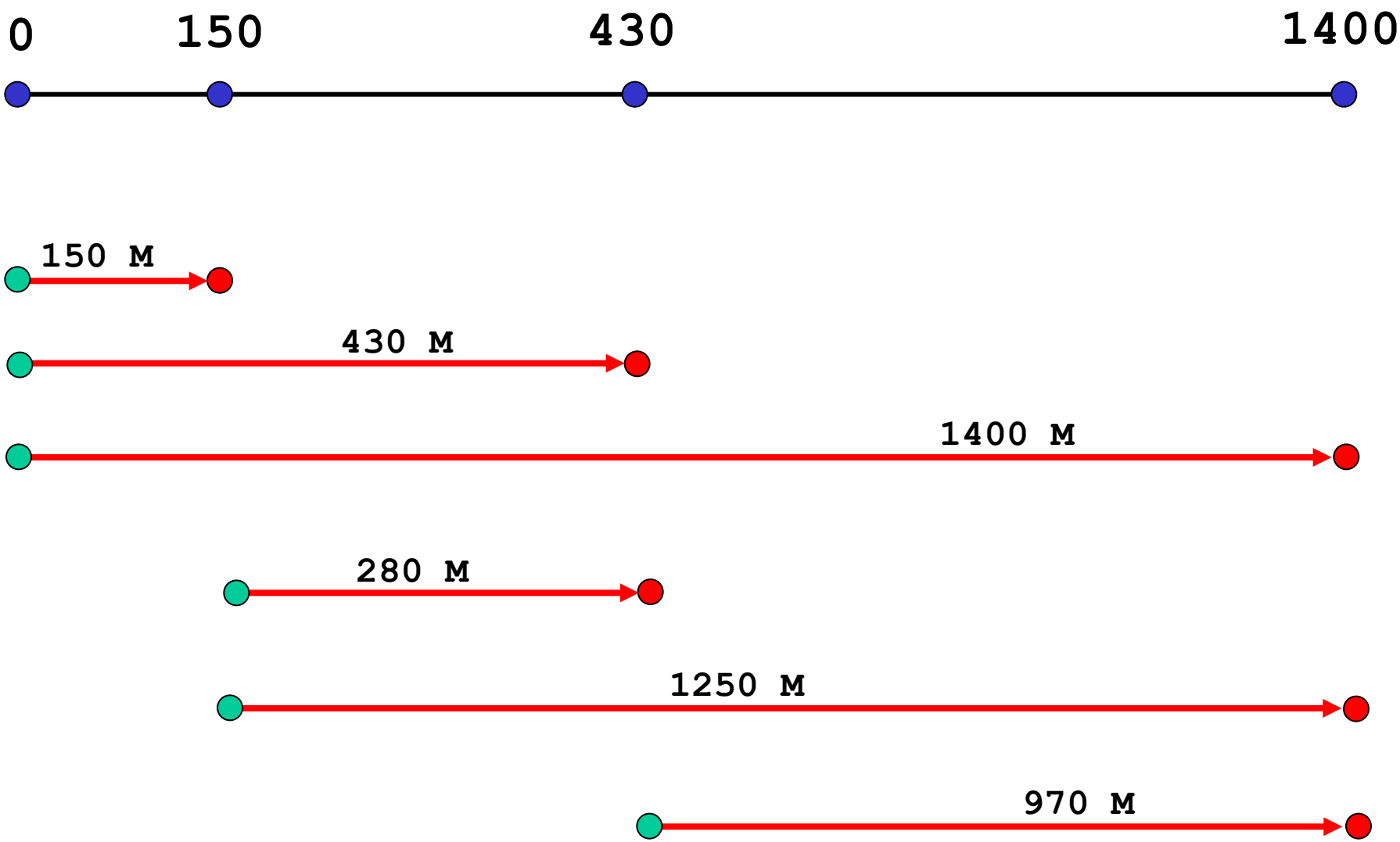
EDMI Measurement Error Sources

- 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

Franklin EDM Calibration Baseline

FROM STATION	TO STATION	ADJ. DIST.(M) HORIZONTAL	ADJ. DIST.(M) MARK - MARK	STD. ERROR(MM)
MACON 000 1998	MACON 150 1998	150.0268	150.0273	0.1
MACON 000 1998	FRANKLIN 410 1988	419.7585	419.7597	0.1
MACON 000 1998	FRANKLIN 1400 1988	1409.9860	1410.0528	0.2
MACON 150 1998	FRANKLIN 410 1988	269.7317	269.7353	0.1
MACON 150 1998	FRANKLIN 1400 1988	1259.9591	1260.0298	0.1
FRANKLIN 410 1988	FRANKLIN 1400 1988	990.2270	990.3365	0.1

STATION	NGVD 29 ELEVATION IN METERS
MACON 000 1998	614.609
MACON 150 1998	614.989
FRANKLIN 410 1988	613.606
FRANKLIN 1400 1988	628.332

DESCRIPTION OF FRANKLIN BASE LINE
YEAR MEASURED: 1999
LATITUDE: 35 13 19
LONGITUDE: 083 25 14
AZIMUTH: 69 DEGREES TRUE NORTH
CHIEF OF PARTY: JGG

THE BASE LINE IS LOCATED ABOUT 5.6 KM (3.5 MI) NORTHWEST OF FRANKLIN AT THE MACON COUNTY AIRFIELD WHICH IS 21.8 KM (13.1 MI) NORTH OF THE NORTH CAROLINA/GEORGIA STATE LINE AND 8.8 KM (5.3 MI) NORTHEAST OF CARTOOGECHAYE.

THE BASE LINE IS A SOUTHWEST-NORTHEAST LINE WITH THE 0 METER POINT ON THE SOUTHWEST END. THE BASE LINE CONSISTS OF THE 000, 150, 410, AND 1400 METER POINTS. THERE IS NO 100-FOOT TAPE CALIBRATION STATION LOCATED AT THIS BASE LINE.

TO REACH THE 0-METER POINT OF THE BASE LINE FROM THE JUNCTION OF NORTH CAROLINA STATE HIGHWAY 28 (NC 28) AND U.S. BUSINESS 441 IN FRANKLIN, GO NORTH ON NC 28 FOR 4.5 KM (2.7 MI) TO THE JUNCTION OF STATE ROUTE 1434 (AIRPORT ROAD). TURN LEFT AND GO WEST ON STATE ROUTE 1434 FOR 2.0 KM (1.2 MI) TO A SIDE ROAD RIGHT. TURN RIGHT AND GO NORTH ON THE SIDE ROAD FOR 0.25 KM (0.15 MI) TO GATE AT AIRPORT TERMINAL. TURN RIGHT AND GO NORTHWEST ON TAXI RAMP "D" FOR 0.13 KM (0.08 MI) TO THE JUNCTION OF RUNWAY AND THE 0-METER POINT ON THE LEFT ALONG THE SOUTH EDGE OF THE RUNWAY.

THE 0 METER POINT IS A STANDARD NORTH CAROLINA GEODETIC SURVEY DISK, STAMPED "MACON 000 1998", SET IN THE TOP OF A 26 CM (10 IN) ROUND CONCRETE POST RECESSED 2.5 CM (1.0 IN) BELOW THE SURFACE OF THE GROUND. IT IS 41.9 M (137.5 FT) WEST SOUTHWEST OF THE CENTERLINE OF THE TAXI RAMP "D", 29.1 M (95.5 FT) NORTHWEST OF WINDSOCK IN FRONT OF TERMINAL, 20.4 M (67.0 FT) SOUTH

NCDENR - NCGS Database - Windows Internet Explorer

http://portal.ncdenr.org/web/lr/geodetic/database

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NCDENR - NCGS Database

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Division of Land Resources

HOME LAND QUALITY GEOLOGICAL SURVEY GEODETIC SURVEY

Search DENR ... - Text +

Display distances in Meters

Monument search | My Folder | Inverse Calculator | Data Export | Station Recovery | Contact NCGS

Station name

PID

County All

Order All

Search Radius 2000

Latitude 35 ° 13 ' 18.84136 " N

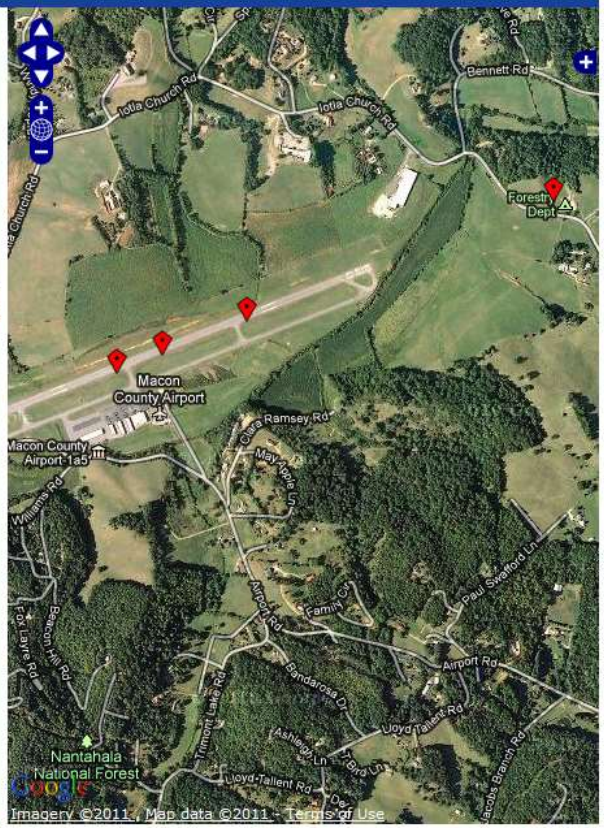
Longitude 083 ° 25 ' 14.40236 " W

Find monuments Clear search form

Showing 1 to 9 of 9 monuments << prev next >>

County	Name	PID	Type	Condition
Macon	1A5 A	AJ3424	Disk	Good
Macon	AIRPORT	FB3509	Disk	Not found
Macon	FRANKLIN CBL 000	FB4103	---	---
Macon	FRANKLIN CBL 1400	FB4104	Disk	Good
Macon	FRANKLIN CBL 150	FB4105	---	---
Macon	FRANKLIN CBL 410	FB4106	Disk	Good
Macon	MAC 1	AJ3419	Disk	Good
Macon	MACON CBL 000 2	AJ3417	Disk	Good
Macon	MACON CBL 150 2	AJ3418	Disk	Good

Add to My Folder



feedback

Done Internet 100%

PC Software Download - CALIBRAT

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]

Disclaimer

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

- Download the PC executable

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	=	-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

Runway Incursion

Any occurrence at an airport involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of separation with an aircraft that is taking off, intending to take off, landing or intending to land (within 1 mile).

Conditions at Time of Runway Incursions

Not Familiar with the Airport

Airport Diagram Not Used

Unfamiliar with Airport Signage

Failed to Follow Instructions

Inexperienced at Towered Airports (Phraseology)

Unfavorable Environmental Conditions

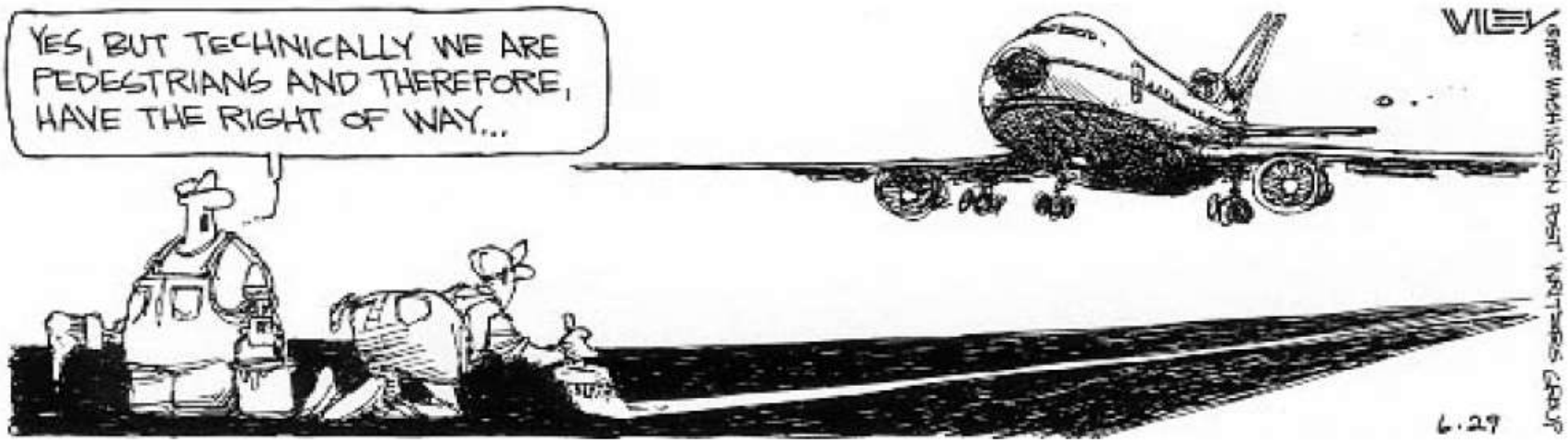
Clearance Not Read Back

HUMAN ERROR

What can you do to help prevent Surface Incidents?

- Meet with and inform the appropriate officials of your visit
- Be familiar with the Airport Layout
- Use current charts/diagrams
- Be familiar with airport signs and markings
- Be familiar with ATC phraseology and what to do if you become confused. (Stop and Ask)
- Use accepted radio techniques/phraseology
- Do not take shortcuts. Maintain high standards!!!
- Attend information/training meetings
- Maintain a high level of situational awareness

http://www.aopa.org/lms/courses/runway-safety/


YES, BUT TECHNICALLY WE ARE PEDESTRIANS AND THEREFORE, HAVE THE RIGHT OF WAY...
WILEY
6.29
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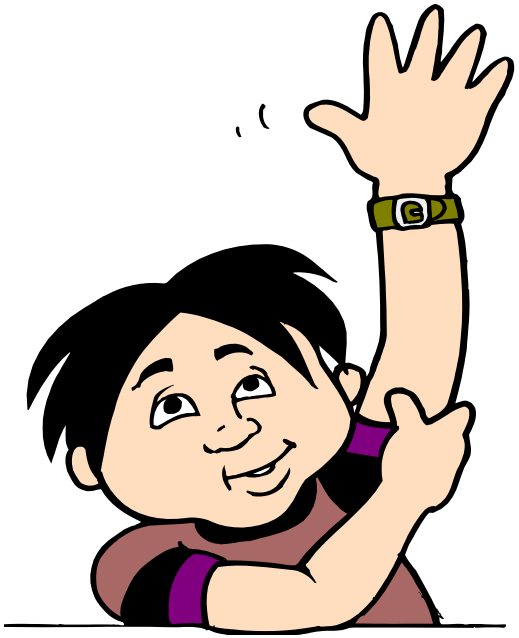
Questions?



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