U.S. Army Corps of Engineers
Sacramento District

Structural Monitoring Surveys

Argonaut Mine Dam Inspection and Site support
Amador County, California

EPA / USACE Superfund Program
Work Authorization Assignment No.04
Revision No. 05 11-18-2014

Report Date: 11-19-2015

Engineering Support Branch Quality Control Record

Project Name: Argonaut Mine Dam   Project Manager: Kay Chang

Organization USACE CE SPK-ED-SG

Technical Products: Monitoring Surveys   Actual Completion Date: 11-19-2015

PREPARER – I have prepared the above the products in accordance with the Quality Management Plan.

Preparer: MELLO.DAVID.SAMUEL.1225304544 Digitally signed by MELLO.DAVID.SAMUEL.1225304544 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MELLO.DAVID.SAMUEL.1225304544 Date: 2015.11.19 14:32:04 -08'00'   date: 11-19-2015

Signature

REVIEWERS – I have reviewed the product noted above and find it to be in accordance with the Quality Management Plan meeting project requirements, standards of the profession and Corps of Engineers policies and standards.

Lead Peer Reviewer: MARINO.JOSEPH.NEIL.1272301006 Digitally signed by MARINO.JOSEPH.NEIL.1272301006 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MARINO.JOSEPH.NEIL.1272301006 Date: 2015.11.19 14:35:12 -08'00'   date: 11-19-2015

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Lead QC Reviewer: OLIVER.JAMES.MAILON.1258611850 Digitally signed by OLIVER.JAMES.MAILON.1258611850 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=OLIVER.JAMES.MAILON.1258611850 Date: 2015.11.19 14:39:55 -08'00'   date: 11-192015

Signature

ITR Chair Reviewer: ______________________   date: __________

*If needed

Signature

PREPARER – I have incorporated or resolved all review issues in accordance with the Quality Management Plan.

Preparer: MELLO.DAVID.SAMUEL.1225304544 Digitally signed by MELLO.DAVID.SAMUEL.1225304544 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=MELLO.DAVID.SAMUEL.1225304544 Date: 2015.11.19 14:46:26 -08'00'   date: 11-19-2015

Signature

Resource Providers– I have reviewed and resolved all critical and technical issues. I agree that all project requirements and standards of the profession and Corps of Engineers policies and standards have been met.

Section Chief: OLIVER.JAMES.MAILON.1258611850 Digitally signed by OLIVER.JAMES.MAILON.1258611850 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=OLIVER.JAMES.MAILON.1258611850 Date: 2015.11.19 14:40:29 -08'00'   date: 11-19-2015

Signature

Branch Chief: KELLY.SUSAN.JANE.1458989652 Digitally signed by KELLY.SUSAN.JANE.1458989652 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=KELLY.SUSAN.JANE.1458989652 Date: 2015.11.19 15:14:18 -08'00'   date: __________

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Division Chief: KELLY.SUSAN.JANE.1458989652 Digitally signed by KELLY.SUSAN.JANE.1458989652 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=KELLY.SUSAN.JANE.1458989652 Date: 2015.11.19 15:14:47 -08'00'   date: __________

*If needed

Signature

Prepared:

US Army Corps of Engineers
Sacramento District
GIS and Mapping Section
1325 J Street
Sacramento, Ca. 95814
916-557-7763

I. Site Location and Access

a. Site Location

The Argonaut Mine site is comprised of approximately 64.8 acres of largely undeveloped land located in Jackson, CA. (Image 1) The site is located in an alluvial valley and consists of open space characterized by soil and tailings impounded behind several dams. The site (Image 2) is abutted by a relatively new single-family residential development (i.e. houses) to the northwest, northeast, and east, City of Jackson offices and a public high school on the west side, and open undeveloped areas on the north, south, and southeast sides.

Directions:

From downtown Sacramento, Take CA-16 East towards Jackson, Ca. Right on to CA-49 South, Right Sutter Street. Dam is on the Left side of Sutter Street. Approximate distance from USACE SPK Office: 50 miles. 1hr 15min.

It is recommended that prior arrangements be made with the EPA Representative before accessing the site.

Image 1.

Image 2. Approx Lat/Long location of Structure: N38-21-10 , W120-46-57

b. Site and Dam Access.

The dam access is made from either the left or right abutment. (Image 3)

Access to the Right abutment is a steep path along a barbed wire fence near the intersection of Sutter Stree and Argonaut Drive. Care should be taken using this route especially in wet weather conditions.

Access to the Left abutment is made through a gate in a barbed wire fence. The route is level ground from the street and across the upstream side of the dam. Vegetation in the area creates numerous tripping hazards.

The area is subject to flooding, access could be obstructed during weather events.

The crest of the concrete structure is a fall hazard and fall protection is required for USACE survey activities.

Image 3.

II. Project Planning and Installation

The GIS and Mapping Section of the Sacramento District was tasked under the EPA/USACE super fund program, work assignment No.04, Revision 05 to support the development and implementation of a dam safety monitoring and inspection program for the Argonaut Dam in Sept 2015.

At the time of this survey there was no information available for previous monitoring programs. USACE, Sacramento District (SPK) GIS and Mapping Section is creating a new survey monitoring plan.

The project scope of services as outlined to the USACE SPK GIS and Mapping Section was to create a Structural Monitoring Plan to monitor movement of the structure in both a Horizontal and Vertical direction. The proposed monitoring plan would only be required for a short duration time period of no more than two years.

The Monitoring plan was developed to meet the US Army Corps of Engineers Manual EM 1110-2-1009, Section 2-2, Accuracy Requirement for Performing Deformation Surveys.

Accuracy Requirements for structure Target Points (95% RMS).

Long-Term Movement for Concrete Structures:

Horizontal Movement is +/- 5-10mm (0.016’-0.0328’)
Vertical Stability and Settlement +/- 2mm (0.00656’)

Several measuring methods were evaluated:

1. Collimation line method – Line of Sight
2. GPS – Global Positioning System
3. Conventional angular and distance – Total Station Instrument

The Conventional angular and distance method was selected because of the high accuracy, repeatability and speed. This method also gives the field technician immediate results that can be verified and compared to previous measurement sessions while in the field at the project site. Because of the restricted lines of sight and the short distances being measured, the measurement are being made from a single location.

The collimation line method was discussed. The site conditions and design of the structure would have exposed two (2) of the USACE Survey technicians to the fall hazard by standing at the edge of each pier on the structure for an extended period of time.

The GPS method of monitoring would require extended occupation times to meet the measurement accuracy requirements for a concrete structure per the USACE manual. Obstructions due to vegetation would have limited the number of Piers that could be measured affectively to those in the center of the structure. This method also requires post processing of the collected data back in the office and would not allow for immediate evaluation of the data at the project site.

Once the Conventional Angular and Distance method was selected, the SPK Sacramento District survey staff completed an office evaluation of the available equipment and preformed an office simulation using assumed location data Google Earth, and performed a pre-analysis of the proposed monitoring plan using the Starnet Least Squares Adjustment Software.

Once the office pre-analysis was completed, the USACE Survey Unit moved to a field Mock up of the plan and performed four (4) separate measurement sessions to simulate the field activities using two different Leica 1201 Total Station Instruments. The first measurement session was held as a simulated baseline. The subsequent three (3) sessions were then compared to the baseline to confirm the methods and procedures met the US Army Corps of Engineers Manual EM 1110-2-1009, Section 2-2, Requirement for Positional Accuracy.

The installation of fixed measurement points commenced in September of 2015. Eleven (11) of the SECO Product (www.surveying.com) Part no. 5-114-150 a 5/8” rebar with a swiss-style system adaptors (Image 4) were installed at the top of each of the Eleven (11) Piers on the structure. The twelfth exposed Pier (left end of structure, closest to the road) is damaged and no measurement point was installed. (Installation examples - Images 5-8)

Image 4.

Image 5.

Image 6.

A one (1") inch hole was drilled approximately six (6") inches deep into the top of each Concrete Pier (Image 7.) and the Seco Measurement Point rebar was affixed into place with Anchor Cement/Epoxy (Image 8.)


Image 7.


Image 8.

III. Horizontal and Vertical Survey Control

a. Project Horizontal Survey Control / Coordinate Listing

Image 9.

Control Pnt	Type	Northing	Easting	Elevation
401 (Image 9.)	Brass Disk	5000.000	10000.000	1000.000
401A Ref	Brass Disk	5010.086	9960.368	
401B Ref	PK Nail	5049.064	9967.695	
401C Ref	Brass Disk	5062.773		
402	Brass Disk	4538.676	10000.000	
402A Ref	Brass Disk	4384.200	10213.302	
402B Ref	PK Nail	9976.031	9976.031	
402C Ref	PK Nail	4497.387	9941.006	
402D Ref	Brass Disk	4595.816	9977.582	

(Per survey 10/19/2015)
(Project Coordinates and Elevations are Assumed)

b. Coordinate System and Vertical Datum

The Horizontal Coordinate System for this survey is assumed.

The Vertical Datum for this project is assumed.

c. Basis of Bearing

The Basis of Bearing is assumed.

Azimuth of 180° was held between Point 401 and 402.

Point	Northing	Easting	Elevation	Description
401	5000.000	10000.000	1000.00	Brass Disk set in top of Curb

Azimuth 180° / Horizontal Distance 461.324

Point	Northing	Easting	Elevation	Description
402	4538.676	10000.000		Brass Disk set in top of Curb at Catch Basin

d. Required Equipment

1” Second or Better Total Station Instrument
Leica GRP111 or GRP121 Prisms with Swiss Style Connector or equivalent
Leica DNA10 Digital Level or equivalent
Trimble TSC3 Data Collector or equivalent
Trimble TBC Software or equivalent

e. Units

Units: US Survey Feet, Ground Distances.

f. Reference Points

The horizontal position for both the primary control point (401) and the back sight (402) control point should be validated for position for movement prior to commencement of a monitoring session.

Brass Disks (Image 10) and PK Nails with Shiners have been placed as Reference points at both primary survey control locations. (Images 11)

The horizontal distances listed were measured as part of the baseline survey 10-19-2015:

401 Reference Points	Horizontal Distance
401 to 402	461.324
401 to 401A	40.895
401 to 401B	58.744
401 to 401C	64.370

(Per Field Survey 10/19/2015)

402 Reference Points	Horizontal Distance
402 to 402A	263.365
402 to 402B	67.822
402 to 402C	72.006
402 to 402D	61.380

(Per Field Survey 10/19/2015)

Image 10.


Control Scheme
Legend
Argonaut Dam
Feature 1
Feature 2
Untitled Path
401C
401B
401
401A
Argonaut Dr
402D
402A
402
402B
402C
Argonaut Dam
Survey
Google earth
100 ft
N
Image 11.

g. Survey Procedures / Final Pier Coordinates and Elevations

1. The Horizontal Survey for the Argonaut Structure begins by attaching a standard Leica or equivalent swiss style prism to the measurement points at each of the Eleven Piers. (Image 12).

(Safety and Fall Protection plan should be created for this site prior to commencing work on or around the structure).

Image 12.

2. A one second (1”) or better Total Station Surveying Instrument is set up at point 401, back sighting point 402 holding an Azimuth of 180°.

3. Five (5) sets of direct and reverse angles and distances are turned to each prism at Piers 1 through 11. (Image 13)

Twelve (12) points including the Back sight point 402 make up the scheme for the survey. (Image 14)

(12 points x 2 (direct and reverse measurements) x 5 sets = 120 measurements for the survey.

Using the USACE SPK Survey Units 1” Leica Model 1201 Total Station Instrument, the measurement session was completed in approximately 30 minutes.

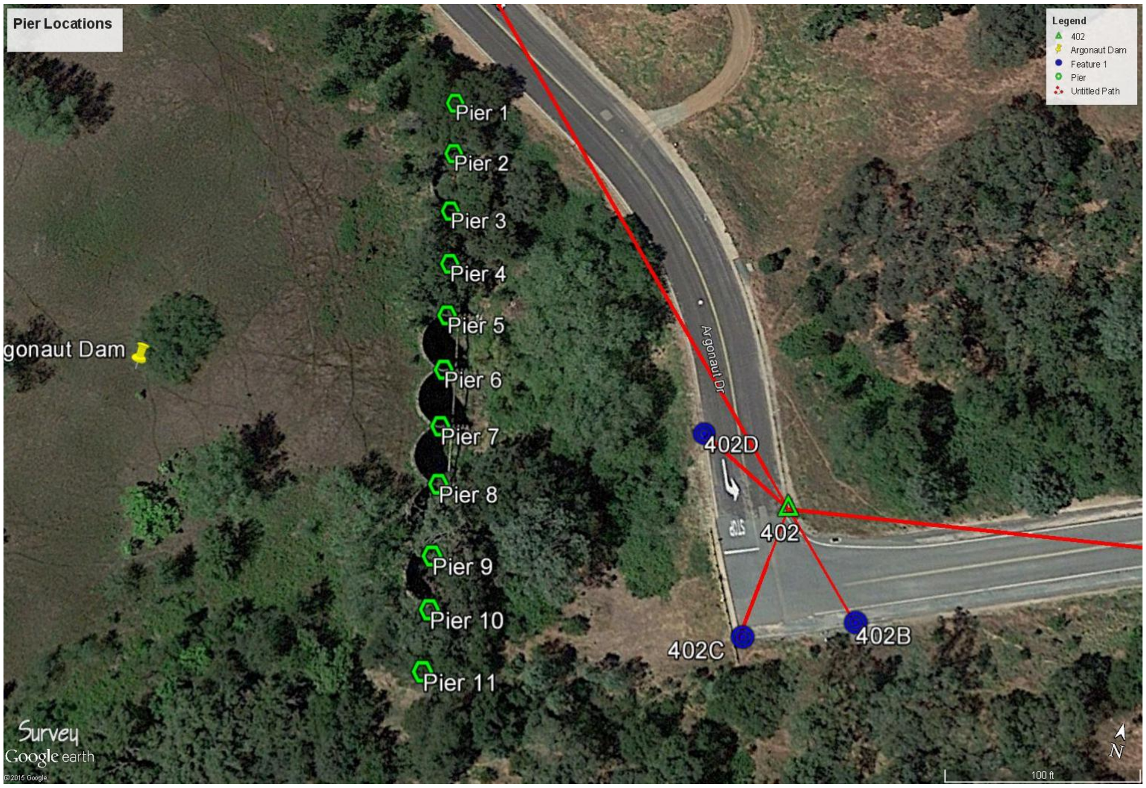


Image 13.

Image 14.

Final Horizontal Coordinates (Per survey 10/19/2015)

Pier	Northing	Easting
1	4838.142	9943.732
2	4810.316	9927.792
3	4782.977	9911.638
4	4755.119	9895.517
5	4727.676	9879.418
6	4700.215	9863.311
7	4672.268	9847.210
8	4644.599	9831.366
9	4616.815	9815.404
10	4589.558	9799.268
11	4561.919	9783.360

4. Primary Vertical Survey commences at Point 401. The assumed elevation of 1000.00 feet is held.

The initial baseline survey leveling run/loop was made by using the BF (Backsight Foresight) method. Pier Points 1 through 11 are measured as intermediate side shot points as the leveling loop is run across the upstream side of the dam.

All measurements are taken on top of the Measurement Points.

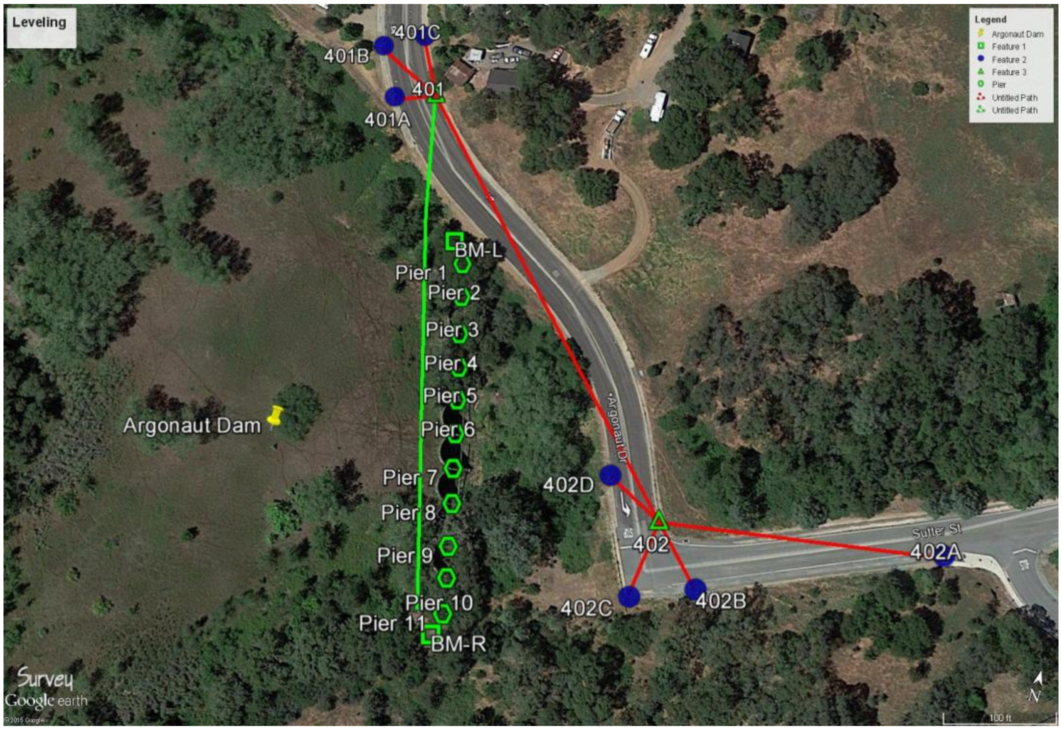


Image 15. Main Dam Leveling Route

The leveling route commences at Point 401 then runs to BM-L. Points 1 through 7 are measured as intermediate side shots. A turn is made at a point, and Points 8-11 are made as intermediate side shots, a turn is then made at BM-R. The leveling loop then returns to the commencement Point 401.

Final Elevations Baseline Survey (per Survey 10/20/2015)

Dam Pier Point	Type	Record Elevation (Elevations are Assumed)
401	Brass Disk	1000.000 Assumed
BM-L	Brass Disk	988.835
1	Rebar	988.996
2	Rebar	989.176
3	Rebar	989.072
4	Rebar	989.172
5	Rebar	989.122
6	Rebar	989.192
7	Rebar	989.133
8	Rebar	989.217
9	Rebar	989.308
10	Rebar	989.158
11	Rebar	989.046
BM-R	Brass Disk	988.747

(Per survey 10/19/2015)

h. Reporting

The Horizontal displacement portion of the survey is reported in two methods:

1. Positional (Coordinate YX Value)

2. Deflection / Tangential (Station and Offset)

The positional portion of the report is a comparison between the baseline surveyed coordinates (YX values, obtained on 10/19/2015) for each individual Pier measurement point and the subsequent Re-Surveys.

	POSITIONAL					
	Baseline Northing	Baseline Easting	Present Northing	Present Easting	**Δ N USFT**	**Δ E USFT**
1	4838.142	9943.732	4838.146	9943.731	**0.004**	**-0.001**
2	4810.316	9927.792	4810.319	9927.791	**0.003**	**-0.001**
3	4782.977	9911.638	4782.981	9911.637	**0.004**	**-0.001**
4	4755.119	9895.517	4755.120	9895.519	**0.001**	**0.002**
5	4727.676	9879.418	4727.678	9879.419	**0.002**	**0.001**
6	4700.215	9863.311	4700.218	9863.311	**0.003**	**0.000**
7	4672.268	9847.210	4672.273	9847.208	**0.005**	**-0.002**
8	4644.599	9831.366	4644.602	9831.363	**0.003**	**-0.003**
9	4616.815	9815.404	4616.817	9815.403	**0.002**	**-0.001**
10	4589.558	9799.268	4589.563	9799.263	**0.005**	**-0.005**
11	4561.919	9783.360	4561.923	9783.357	**0.004**	**-0.003**

Figure 1. Example from Baseline survey 10/19/2015 and second survey performed on 10/20/2015.

2. Deflection / Tangential

The Deflection / Tangential Values are based on an assumed alignment. (At the time of the survey on 10/19/2015, the historical design alignment was not available.) The assumed alignment was created by holding the azimuth between the surveyed coordinate values for Pier Points 1 and 11 obtained on 10/19/2015.

The calculated Alignment is being called "Argo Alignment 1" and is defined by the following coordinates.

Point	Northing	Easting	Station
A1	4842.4661	9946.2425	0+00.000
A2	4557.5949	9780.8495	3+29.403

[A1] 210° 08'20.3" 329.403' [A2]

The reported values for the Deflection are based on the perpendicular distance from the current surveyed coordinate to the assumed alignment. A Negative valve represents a Downstream Movement.

	DEFLECTION		
Pier No.	Offset Baseline	Offset Present	**"-" = D/S USFT**
1	0.000	0.003	**0.0031**
2	-0.187	-0.184	**0.0023**
3	0.057	0.060	**0.0029**
4	0.011	0.010	**-0.0007**
5	0.154	0.155	**0.0004**
6	0.296	0.298	**0.0019**
7	0.188	0.192	**0.0044**
8	-0.002	0.001	**0.0037**
9	-0.148	-0.147	**0.0012**
10	0.120	0.127	**0.0072**
11	0.000	0.005	**0.0052**

Figure 2. Examples of comparison. Survey 10/20/2015.

The Tangential value is based on the Alignment Stationing for the measured point along the assumed "Alignment Argo 1". A positive difference would show movement of the Pier to the Right when looking down stream.

TANGENTIAL			
Pier No.	Station Baseline	Station Present	"+" = RT. USFT
1	5.000	4.998	**-0.0020**
2	37.068	37.066	**-0.0020**
3	68.821	68.818	**-0.0030**
4	101.008	101.006	**-0.0020**
5	132.824	132.822	**-0.0020**
6	164.660	164.657	**-0.0030**
7	196.913	196.910	**-0.0030**
8	228.797	228.796	**-0.0010**
9	260.840	260.838	**-0.0020**
10	292.513	292.511	**-0.0020**
11	324.403	324.401	**-0.0020**

Figure 3. Examples of comparison. Survey 10/20/2015.

The below example is the final measured position for Pier 10 on 10/20/2015 and its relationship to the “Argo Alignment 1”.

Pier 10 final calculated position Station 2+92.511, The offset (Perpendicular distance) being 0.127’ feet. Figure 4.

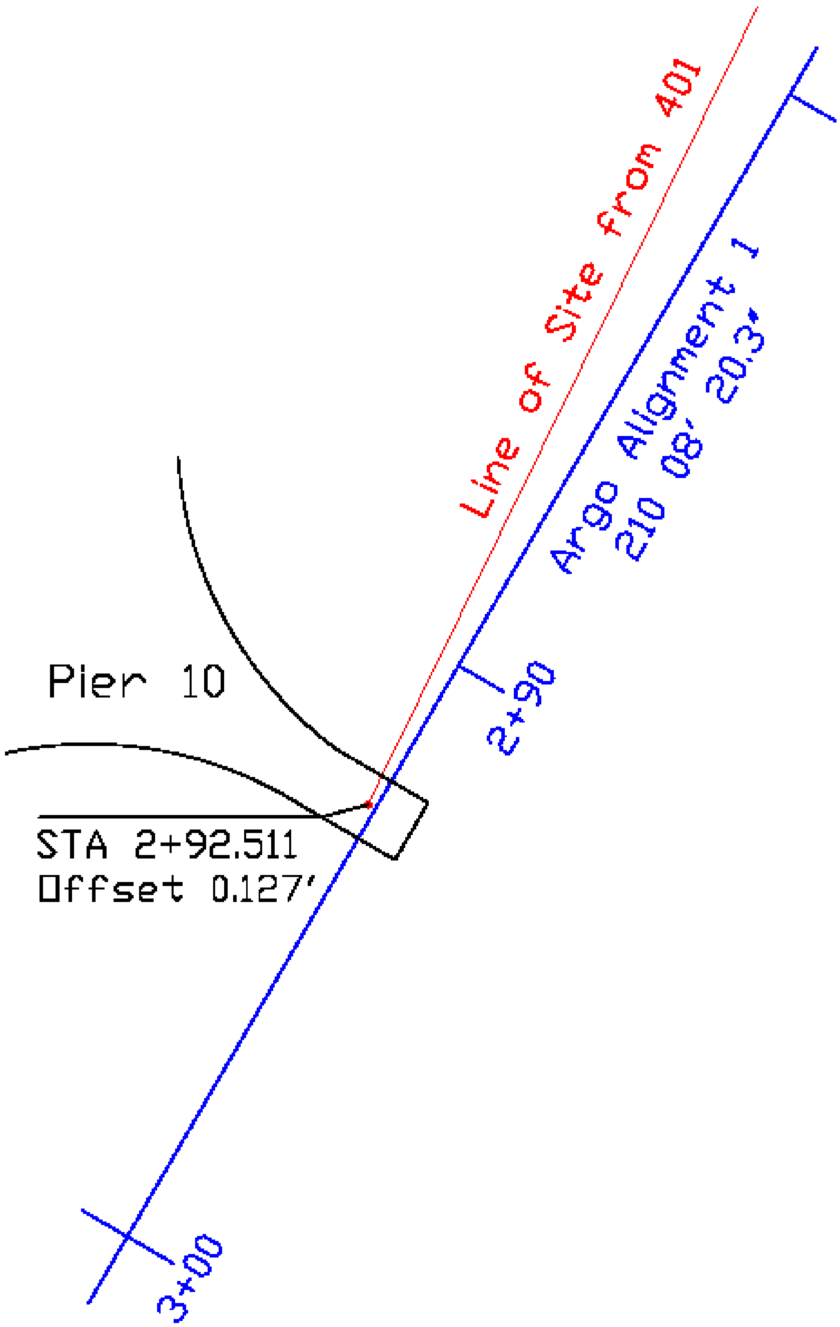


Figure 4.

Vertical Reporting

The Vertical Elevation Values of the measured points are shown by comparing the vertical displacement between the original baseline survey elevations and the current surveyed elevations. Figure 5.

		VERTICAL	
Pier No.	Baseline	Present	**"+" = Up USFT**
1	988.996	988.997	**0.001**
2	989.176	989.173	**-0.003**
3	989.072	989.072	**0.000**
4	989.172	989.174	**0.002**
5	989.122	989.125	**0.003**
6	989.192	989.193	**0.001**
7	989.133	989.137	**0.004**
8	989.217	989.222	**0.005**
9	989.308	989.314	**0.006**
10	989.158	989.163	**0.005**
11	989.046	989.051	**0.005**

Figure 5.

ARGONAUT DAM -- EXTERNAL MOVEMENT DATA

DEFLECTION -- TANGENTIAL -- VERTICAL

Baseline Survey 10-19-2015 OBSERVER(S) : Erickson DATE : 10/19/2015
vs.
Field Survey 10-20-2015 RODMAN : Mello AIR TEMP. : 60 °F
PRESURE: 29.87

	DEFLECTION			TANGENTIAL			VERTICAL		
PIER NO.	Offset Baseline	Offset Present	"-" = D/S USFT	Station Baseline	Station Present	"+" = RT. USFT	Baseline	Present	"+" = Up USFT
1	0.000	0.003	**0.0031**	5.000	4.998	**-0.0020**	988.996	988.997	**0.001**
2	-0.187	-0.184	**0.0023**	37.068	37.066	**-0.0020**	989.176	989.173	**-0.003**
3	0.057	0.060	**0.0029**	68.821	68.818	**-0.0030**	989.072	989.072	**0.000**
4	0.011	0.010	**-0.0007**	101.008	101.006	**-0.0020**	989.172	989.174	**0.002**
5	0.154	0.155	**0.0004**	132.824	132.822	**-0.0020**	989.122	989.125	**0.003**
6	0.296	0.298	**0.0019**	164.660	164.657	**-0.0030**	989.192	989.193	**0.001**
7	0.188	0.192	**0.0044**	196.913	196.910	**-0.0030**	989.133	989.137	**0.004**
8	-0.002	0.001	**0.0037**	228.797	228.796	**-0.0010**	989.217	989.222	**0.005**
9	-0.148	-0.147	**0.0012**	260.840	260.838	**-0.0020**	989.308	989.314	**0.006**
10	0.120	0.127	**0.0072**	292.513	292.511	**-0.0020**	989.158	989.163	**0.005**
11	0.000	0.005	**0.0052**	324.403	324.401	**-0.0020**	989.046	989.051	**0.005**

	POSITIONAL						Reference Points		
	Baseline Northing	Baseline Easting	Present Northing	Present Easting	Δ N USFT	Δ E USFT	Orginal Ref Dist	Current Ref Dist	Diff
1	4838.142	9943.732	4838.146	9943.731	**0.004**	**-0.001**	**401-402** 461.324		
2	4810.316	9927.792	4810.319	9927.791	**0.003**	**-0.001**			
3	4782.977	9911.638	4782.981	9911.637	**0.004**	**-0.001**	**401-401A** 40.895		
4	4755.119	9895.517	4755.120	9895.519	**0.001**	**0.002**			
5	4727.676	9879.418	4727.678	9879.419	**0.002**	**0.001**	**401-401B** 58.744		
6	4700.215	9863.311	4700.218	9863.311	**0.003**	**0.000**			
7	4672.268	9847.210	4672.273	9847.208	**0.005**	**-0.002**	**401-401C** 64.370		
8	4644.599	9831.366	4644.602	9831.363	**0.003**	**-0.003**			
9	4616.815	9815.404	4616.817	9815.403	**0.002**	**-0.001**	**402-402A** 263.365		
10	4589.558	9799.268	4589.563	9799.263	**0.005**	**-0.005**			
11	4561.919	9783.360	4561.923	9783.357	**0.004**	**-0.003**	**402-402B** 67.822		
							402-402C 72.006		
							402-402B 61.380		

COMMENTS: Example
1. 10-19-2015 Clear Windy
2. Heavy Rains Previous 7 Days
3. Pressure measured from Sherpa Instrument

Weather: 10-19-2015 Clear, Warm, Windy
10-20-2015 Clear, Warm, Calm
Event: Baseline Survey and Survey No.1

Project Safety

General safety notes:

- The Argonaut Dam contains a significant Fall Hazard Site, and fall protection is required when near the top of the structure for USACE survey team members.
- The Argonaut Dam Site is closed to the public. The site is secured by a three strand barbed wire fence. Care should be taken in areas of public access, close gates and secure all vehicles and equipment.
- Depending on the time of year, the subsequent surveys might be performed in extreme temperatures conditions. Survey team members should be aware of heat or cold related injuries.
- The area is known to have viper related snakes, i.e. rattle snakes.
- Tripping Hazards exist on site, brush and vegetation near the top of the structure.
- Parasites such as ticks exist in large numbers at the site and surrounding areas.
- Poison Oak is abundant at the site and surrounding areas.
- Primary Horizontal and Vertical survey points are set in the top of the curbs of Sutter Street. Care should be taken in Traffic Areas. Traffic Signs and cones should be used.
- A plan for and emergency egress, and the rescue of injured personnel from the site should be discussed and understood by all team members prior to the entry of the site.

Location and contact information for Emergency Services

911

Jackson Fire Department
10600 Argonaut Drive
Jackson, Ca. 95642
209-223-9039

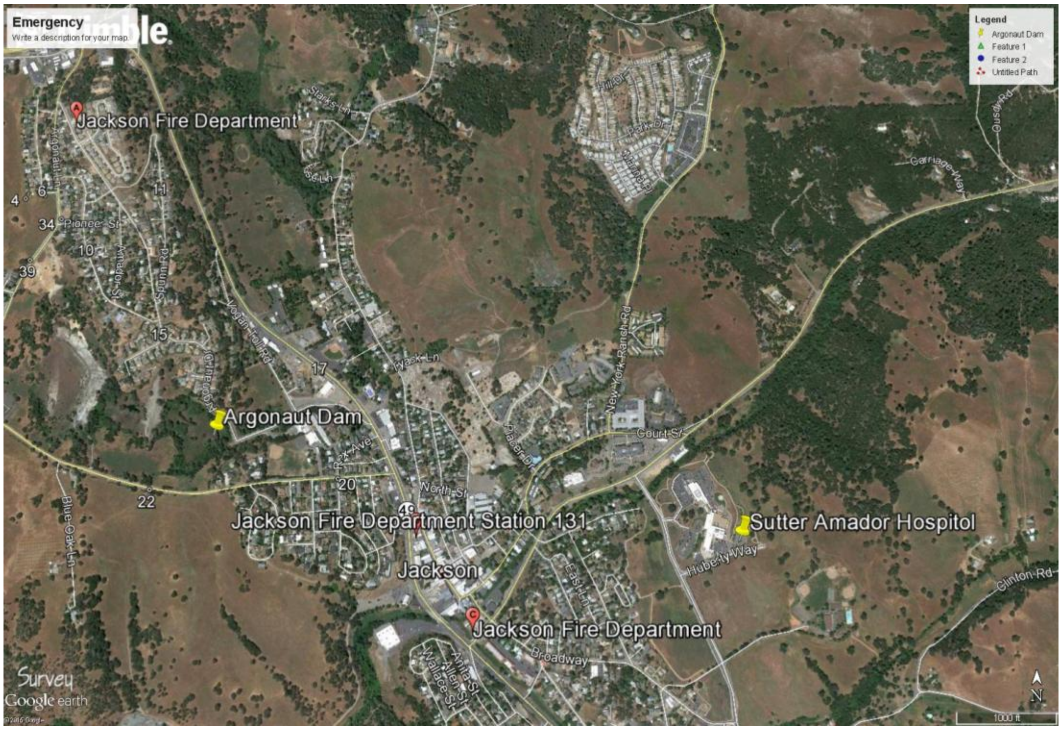
Jackson Fire Department
175 Main Street
Jackson, Ca. 95642
209-223-2147

Jackson Fire Dept
33 Broadway
Jackson, Ca. 95642
209-223-9039

Sutter Hospital
200 Mission Blvd.
Jackson, Ca. 95642
209-223-7500

Emergency Service Locations

Local hospital is located off Alpine State Way and Mission Blvd. 200 Mission Blvd, Jackson, CA.



VIII. Appendices

a. Field Work Sheets
- Cover Sheet – Overview of Workflow
- Example Field Work Sheet / Notes
- Blank Field Work Sheet
- Completed Field Work Sheet / Baseline Survey 10-19-2015
- Prism Log for Baseline Survey 10-19-2015
- Field Report from Trimble Business Center Software / Baseline Survey 10-19-2015
- Vertical Leveling Comparison and Listing / Baseline Survey 10-19-2015
- Final External Movement Report (excel spreadsheet) / Baseline Survey 10-19-2015
- Blank External Movement Form

b. Starnet Least Square Adjustment Report
- Baseline Survey 10-19-2015
- Secondary Survey 10-20-2015

c. Horizontal MTA Reports (Mean Turned Angle)
- Field Monitoring Report MTA / Baseline Survey 10-19-2015
- Field Monitoring Report MTA / Baseline Survey 10-20-2015

d. Vertical Leveling Sheets
- Field Notes Vertical Leveling / Baseline Survey 10-19-2015
- Field Notes Vertical Leveling / Baseline Survey

e. Equipment Technical Data Sheet and Specifications
- Seco Product 5-114-150 150mm Rebar - Installed Measurement Point
- Leica Prism Specification
- Leica Tribrach Specification
- Leica Prism Offset Technical Data Sheet
- Leica TSP1201+ Total Station Instrument Technical Data Sheet
- Leica DNA10 Digital Level Technical Data Sheet

Appendices a. Field Work Sheets

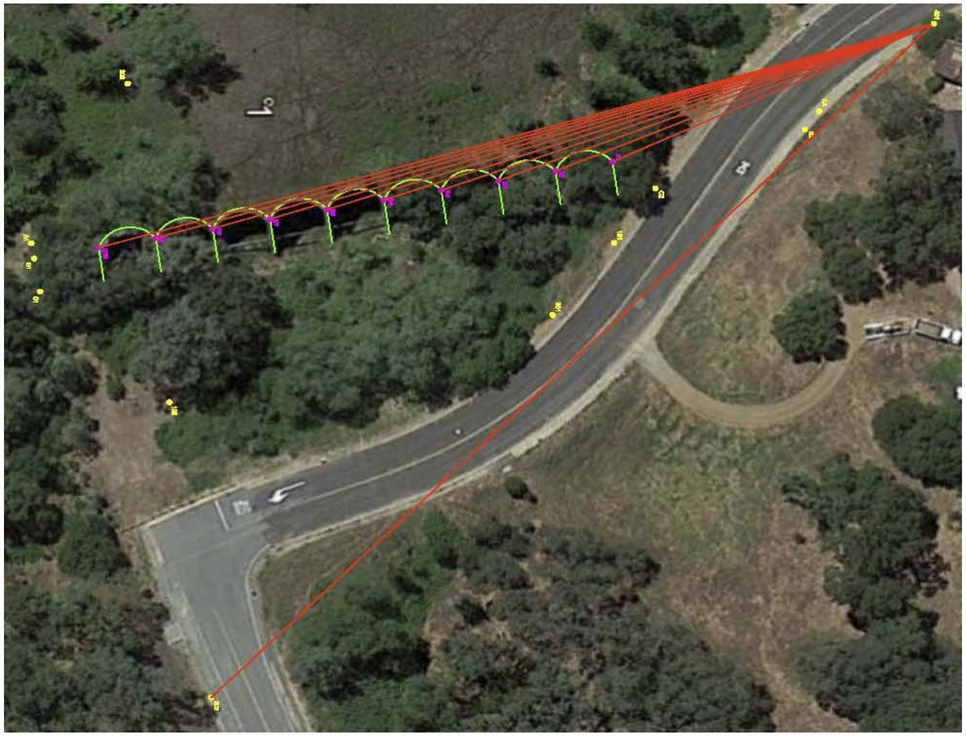
ARGONAUT Dam Structural Monitoring Fied Procedures

Event TEST 1

Date: 9/4/2015

Field

1. Contact EAP or other requested representatives prior to site visit.
2. Review Safety and Fall Protection plan, go over check list of safety procedures and recover plan.
3. Measure Reference Points at Back Sight (Station 402) for Movement
4. Measure Reference Points at Primary (Station 401) for Movement
5. Using Safety and Fall Protection Plan install Prisms on Structure
6. Measure Structure, compare preliminary Field Report
7. Using Safety and Fall Protection Plan Remove Prisms from Structure
8. Using Safety and Fall Protection Plan Begin Leveling Survey for Vertical , Compare Results
9. Return to Office
10. Reporting



Reporting

1. Fill in Field Work Sheet
2. Import Corridor Report from TBC
3. Import Levels from Starnet
4. Review Final Report

Argonaut Dam Structural Monitoring				USACE Surveying Section (SPK)			
Event TEST2	Starting Time	Ending Time	Duration		Starting Time	Ending Time	Duration
Session 1.	9/4/15 10:41 AM	9/4/15 11:04 AM	0:23	Session 2.	9/4/15 11:17 AM	9/4/15 11:40 AM	0:23
Temp (F)	72	73	1	Temp	74	75	1
Pressure	28.35	28.35	0	Pressure	28.35	28.35	0
PPM	24	24	0	PPM	25	25	0
Weather	Clear Cool	Clear Cool		Weather	Clear / Cool	Clear / Cool	
Instrument @	401						
Height of Instrument	5.23			Observer:	Erickson		
Height of Back Sight	0			Crew:	Mello		
Ref @ 401 H.I. =	Ht	HD		Notes			
Ref 401A	4.000	5.000			Warm Cloudy		
Ref 401B	5.000	10.000			Road Construction along Argonaut Road		
Ref @ 402 H.I. =	5.420						
Ref 402A	4.000	5.000					
Ref 402B	5.000	10.000					

Hor Dist 401-402	
Orig	543.025
Int@ 401	543.025
Int@ 402	543.023
401->402	0.000
402->401	-0.002

Calibration Instrument Model: Leica 1201+ Instrument SN: 261525

Last Clean and Adjust (Factory) : 1/9/2014

Component	Previous Value (")	Date	Current Value (")	Date	Accuracy in Sec (")	Int T [°C]
I Comp	0	8.1.14	0	9.1.14	X	26
t Comp	0	8.1.14	0	9.1.14	X	26
i V-index	0	8.1.14	0	9.1.14	X	26
c Hz-Col	3	8.1.14	2	9.1.14	X	26
a T-axis	2	8.1.14	1	9.1.14	X	26
ATR Hz	0	8.1.14	0	9.1.14	2	26
ATR V	0	8.1.14	0	9.1.14	1	26

Argonaut Dam Structural Monitoring — USACE Survey Section (SPK)

Event	Starting Time	Ending Time	Duration		Starting Time	Ending Time	Duration
Session 1.			0:00	**Session 2.**			0:00
Temp (F)			0	**Temp**			0
Pressure			0	**Pressure**			0
PPM			0	**PPM**			0
Weather				**Weather**			
Instrument @							
Height of Instrument				**Observer:**			
Height of Back Sight				**Crew:**			
Ref @ 401 H.I. =	**Ht**	**HD**		**Notes**			
Ref 401A							
Ref 401B							
Ref @ 402 H.I. =							
Ref 402A							
Ref 402B							

Hor Dist 401-402	
Orig	**543.025**
Int@ 401	
Int@ 402	
401->402	543.025
402->401	-543.025

Calibration Instrument Model: **Leica 1201+** Instrument SN: **261525**

Last Clean and Adjust (Factory) : **1/9/2014**

Component	Previous Value (")	Date	Current Value (")	Date	Accuracy in Sec (")	Int T [°C]
l Comp						
t Comp						
i V-index						
c Hz-Col						
a T-axis						
ATR Hz						
ATR V						

Argonaut Dam Structural Monitoring — USACE Surveying Section (SPK)

Event Baseline	Starting Time	Ending Time	Duration		Starting Time	Ending Time	Duration
Session 1.	10/19/15 10:00 AM	10/19/15 10:30 AM	0:30	Session 2.	10/19/15 10:45 AM	10/19/15 11:14 AM	0:29
Temp (F)	60	66	6	Temp	66	66	0
Pressure	29.87	29.87	0	Pressure	29.87	29.87	0
PPM	4	4	0	PPM	7	7	0
Weather	Clear, Cool, Windy	Clear Cool		Weather	Clear / Cool	Clear / Cool	
Instrument @	401						
Height of Instrument	5.12			Observer:	Erickson		
Height of Back Sight	4.87			Crew:	Mello		
Ref @ 401 H.I. =	Ht	HD		Notes			
Ref 401A	4.000	5.000			Clear, Cool, Windy		
Ref 401B	5.000	10.000			Recent Rains last 7 Days		
Ref @ 402 H.I. =	5.420				Site Conditions, Damp, Wet		
Ref 402A	4.000	5.000					
Ref 402B	5.000	10.000					

Hor Dist 401-402	
Orig	461.312
Int@ 401	461.312
Int@ 402	461.314
401->402	0.000
402->401	0.002

Calibration Instrument Model: Leica 1201 Instrument SN: 216504

Last Clean and Adjust (Factory) : 1/9/2014

Component	Previous Value (")	Date	Current Value (")	Date	Accuracy in Sec (")	Int T [°C]
I Comp	0	8.1.14	0	9.1.14	X	26
t Comp	0	8.1.14	0	9.1.14	X	26
i V-index	0	8.1.14	0	9.1.14	X	26
c Hz-Col	3	8.1.14	2	9.1.14	X	26
a T-axis	2	8.1.14	1	9.1.14	X	26
ATR Hz	0	8.1.14	0	9.1.14	2	26
ATR V	0	8.1.14	0	9.1.14	1	26

Prism Placement
Argonaut Dam

Location	Type	Prism	Tribrak
BS 402	GRP121	8802064	5693
401A	GRP121	5701292	5195
401B	GRP121	5701657	5494
401C	GRP121	8802071	5672
402A	GRP121	5701292	5672
402B	GRP121	5701657	
402C	GRP121	5701590	
402D	GRP121	5701657	5494
Dam			
1	GRP111	8713671	
2	GRP111	8713593	
3	GRP111	8713607	
4	GRP121	5701657	
5	GRP121	8802071	
6	GRP121	5701292	
7	GRP121	5701134	
8	GRP121	5701590	
9	GRP111	8713679	
10	GRP111	8713589	
11	GRP111	8713588	

Alignment: Argo 1		Baseline 10-19-2015					Alignment: argo test 2			Survey 10-20-2015								
Point ID	Station	Offset	Elevation	Z Change	Northing	Easting	Point ID	Station	Offset	Elevation	Z Change	Northing	Easting	Tangental	Deflection	Pos North	Pos East	Pos Z
		0.000			4842.466	9946.243		4.998	0.000			4838.144	9943.733	(+) = Rt	(+) = U/S	d N	d E	
1	5.000	0.000	989.209	0.000	4838.142	9943.732	1	4.998	0.003	989.207		4838.146	9943.731	-0.002	0.003	0.004	-0.001	-0.002
	37.068	0.000			4810.409	9927.631		37.066	0.000			4810.411	9927.632					
2	37.068	-0.187	989.385		4810.316	9927.792	2	37.066	-0.184	989.382		4810.319	9927.791	-0.002	0.002	0.003	-0.001	-0.003
	68.821	0.000			4782.949	9911.687		68.818	0.000			4782.951	9911.689					
3	68.821	0.057	989.284		4782.977	9911.638	3	68.818	0.060	989.280		4782.981	9911.637	-0.003	0.003	0.004	-0.001	-0.004
	101.008	0.000			4755.113	9895.526		101.006	0.000			4755.115	9895.527					
4	101.008	0.011	989.385		4755.119	9895.517	4	101.006	0.010	989.381		4755.120	9895.519	-0.002	-0.001	0.001	0.002	-0.004
	132.824	0.000			4727.599	9879.552		132.822	0.000			4727.601	9879.553					
5	132.824	0.154	989.332		4727.676	9879.418	5	132.822	0.155	989.332		4727.678	9879.419	-0.002	0.000	0.002	0.001	0.000
	164.660	0.000			4700.067	9863.567		164.657	0.000			4700.069	9863.568					
6	164.660	0.296	989.404		4700.215	9863.311	6	164.657	0.298	989.402		4700.218	9863.311	-0.003	0.002	0.003	0.000	-0.002
	196.913	0.000			4672.174	9847.373		196.91	0.000			4672.176	9847.374					
7	196.913	0.188	989.350		4672.268	9847.210	7	196.91	0.192	989.344		4672.273	9847.208	-0.003	0.004	0.005	-0.002	-0.006
	228.797	0.000			4644.600	9831.364		228.796	0.000			4644.601	9831.364					
8	228.797	-0.002	989.435		4644.599	9831.366	8	228.796	0.001	989.431		4644.602	9831.363	-0.001	0.004	0.003	-0.003	-0.004
	260.840	0.000			4616.889	9815.275		260.838	0.000			4616.891	9815.276					
9	260.840	-0.148	989.523		4616.815	9815.404	9	260.838	-0.147	989.518		4616.817	9815.403	-0.002	0.001	0.002	-0.001	-0.005
	292.513	0.000			4589.497	9799.372		292.511	0.000			4589.500	9799.373					
10	292.513	0.120	989.373		4589.558	9799.268	10	292.511	0.1272	989.372		4589.563	9799.263	-0.002	0.007	0.005	-0.005	-0.001
	324.403	0.000			4561.919	9783.360		324.401	0			4561.921	9783.361					
11	324.403	0.000	989.261		4561.919	9783.360	11	324.401	0.0047	989.268		4561.923	9783.357	-0.002	0.005	0.004	-0.003	0.007
Argo Alignmei	329.403	0.000			4557.595	9780.850		329.403	0			4557.595	9780.85					

Argonaut Levels
10/20/2015
Structural Monitoring

		Alignment: argo test 2		
		Point ID	**Elevation (ft)**	
Argo 1	10/19/2015	**argo test 2**	10/20/2015	
BM-L	988.835		988.837	
1	988.996		988.997	0.001
2	989.176		989.173	-0.003
3	989.072		989.072	0.000
4	989.172		989.174	0.002
5	989.122		989.125	0.003
6	989.192		989.193	0.001
7	989.133		989.137	0.004
8	989.217		989.222	0.005
9	989.308		989.314	0.006
10	989.158		989.163	0.005
11	989.046		989.051	0.005
BM-R	988.747		988.752	0.005

ARGONAUT DAM -- EXTERNAL MOVEMENT DATA

DEFLECTION -- TANGENTIAL -- VERTICAL

Baseline Survey 10-19-2015 OBSERVER(S) : Erickson DATE : 10/19/2015
vs.
Field Survey 10-20-2015 RODMAN : Mello AIR TEMP. : 60 °F
PRESURE: 29.87

	DEFLECTION			TANGENTIAL			VERTICAL		
PIER NO.	Offset Baseline	Offset Present	**"-" = D/S USFT**	Station Baseline	Station Present	**"+" = RT. USFT**	Baseline	Present	**"+" = Up USFT**
1	0.000	0.003	**0.0031**	5.000	4.998	**-0.0020**	988.996	988.997	**0.001**
2	-0.187	-0.184	**0.0023**	37.068	37.066	**-0.0020**	989.176	989.173	**-0.003**
3	0.057	0.060	**0.0029**	68.821	68.818	**-0.0030**	989.072	989.072	**0.000**
4	0.011	0.010	**-0.0007**	101.008	101.006	**-0.0020**	989.172	989.174	**0.002**
5	0.154	0.155	**0.0004**	132.824	132.822	**-0.0020**	989.122	989.125	**0.003**
6	0.296	0.298	**0.0019**	164.660	164.657	**-0.0030**	989.192	989.193	**0.001**
7	0.188	0.192	**0.0044**	196.913	196.910	**-0.0030**	989.133	989.137	**0.004**
8	-0.002	0.001	**0.0037**	228.797	228.796	**-0.0010**	989.217	989.222	**0.005**
9	-0.148	-0.147	**0.0012**	260.840	260.838	**-0.0020**	989.308	989.314	**0.006**
10	0.120	0.127	**0.0072**	292.513	292.511	**-0.0020**	989.158	989.163	**0.005**
11	0.000	0.005	**0.0052**	324.403	324.401	**-0.0020**	989.046	989.051	**0.005**

	POSITIONAL						Reference Points		
	Baseline Northing	Baseline Easting	Present Northing	Present Easting	**Δ N USFT**	**Δ E USFT**	Orginal Ref Dist	Current Ref Dist	Diff
1	4838.142	9943.732	4838.146	9943.731	**0.004**	**-0.001**	**401-402** 461.324		
2	4810.316	9927.792	4810.319	9927.791	**0.003**	**-0.001**			
3	4782.977	9911.638	4782.981	9911.637	**0.004**	**-0.001**	**401-401A** 40.895		
4	4755.119	9895.517	4755.120	9895.519	**0.001**	**0.002**			
5	4727.676	9879.418	4727.678	9879.419	**0.002**	**0.001**	**401-401B** 58.744		
6	4700.215	9863.311	4700.218	9863.311	**0.003**	**0.000**			
7	4672.268	9847.210	4672.273	9847.208	**0.005**	**-0.002**	**401-401C** 64.370		
8	4644.599	9831.366	4644.602	9831.363	**0.003**	**-0.003**			
9	4616.815	9815.404	4616.817	9815.403	**0.002**	**-0.001**	**402-402A** 263.365		
10	4589.558	9799.268	4589.563	9799.263	**0.005**	**-0.005**			
11	4561.919	9783.360	4561.923	9783.357	**0.004**	**-0.003**	**402-402B** 67.822		
							402-402C 72.006		
							402-402B 61.380		

COMMENTS: Example
1. 10-19-2015 Clear Windy
2. Heavy Rains Previous 7 Days
3. Pressure measured from Sherpa Instrument

Weather: 10-19-2015 Clear, Warm, Windy
10-20-2015 Clear, Warm, Calm
Event: Baseline Survey and Survey No.1

ARGONAUT DAM -- EXTERNAL MOVEMENT DATA

DEFLECTION -- TANGENTIAL -- VERTICAL

OBSERVER(S) : DATE :

RODMAN : AIR TEMP. :
PRESURE:

	DEFLECTION			**TANGENTIAL**			**VERTICAL**		
PIER NO.	Offset Baseline	Offset Present	**"-" = D/S USFT**	Station Baseline	Station Present	**"+" = RT. USFT**	Baseline	Present	**"+" = Up USFT**
1	0.000			5.000			988.996		
2	-0.187			37.068			989.176		
3	0.057			68.821			989.072		
4	0.011			101.008			989.172		
5	0.154			132.824			989.122		
6	0.296			164.660			989.192		
7	0.188			196.913			989.133		
8	-0.002			228.797			989.217		
9	-0.148			260.840			989.308		
10	0.120			292.513			989.158		
11	0.000			324.403			989.046		

	POSITIONAL						**Reference Points**		
	Baseline Northing	Baseline Easting	Present Northing	Present Easting	**Δ N USFT**	**Δ E USFT**	Orginal Ref Dist	Current Ref Dist	Diff
1	4838.142	9943.732					**401-402** 461.324		
2	4810.316	9927.792							
3	4782.977	9911.638					**401-401A** 40.895		
4	4755.119	9895.517							
5	4727.676	9879.418					**401-401B** 58.744		
6	4700.215	9863.311							
7	4672.268	9847.210					**401-401C** 64.370		
8	4644.599	9831.366							
9	4616.815	9815.404					**402-402A** 263.365		
10	4589.558	9799.268							
11	4561.919	9783.360					**402-402B** 67.822		
							402-402C 72.006		
							402-402B 61.380		

COMMENTS:

Weather: 10-19-2015 Clear, Warm, Windy

Event: Baseline Survey and Survey No.

Appendices b. Starnet Least Square Adjustment Report

Baseline Survey 10-19-2015
Secondary Survey 10-20-2015

STAR*NET-PRO Version 6.00

Run Date: 10-21-2015

Summary of Files Used and Option Settings

Project Folder and Data Files

Project Name	ARGO
Data File List	19.dat

Project Option Settings

STAR*NET Run Mode	: Adjust with Error Propagation
Type of Adjustment	: 3D
Project Units	: FeetUS
Coordinate System	: LOCAL
Apply Average Scale Factor	: 1.0000000000
Input/Output Coordinate Order	: North-East
Angle Data Station Order	: At-From-To
Distance/Vertical Data Type	: Slope/Zenith
Convergence Limit; Max Iterations	: 0.0010; 10
Default Coefficient of Refraction	: 0.0700
Earth Radius	: 6372000.00 Meters
Create Coordinate File	: Yes
Create Ground Scale Coordinate File	: No
Create Dump File	: No

Instrument Standard Error Settings

Project Default Instrument		
Distances (Constant)	:	0.00300 FeetUS
Distances (PPM)	:	1.00000
Angles	:	1.40000 Seconds
Directions	:	1.00000 Seconds
Azimuths & Bearings	:	1.40000 Seconds
Zeniths	:	5.00000 Seconds
Elevation Differences (Constant)	:	0.01000 FeetUS
Elevation Differences (PPM)	:	0.00000
Centering Error Instrument	:	0.00200 FeetUS
Centering Error Target	:	0.00150 FeetUS
Centering Error Vertical	:	0.00150 FeetUS

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Listing of Input Data

```
#Job File:         20151019
## Created:          2015-10-19

C   401           5000.000    10000.000 1000.000 ! ! !
C   402           4538.677    10000.000  958.273 ! ! !
#C   401A          5010.086     9960.368 1000.729 * * *
#C   401B          5049.064     9967.695 1005.216 * * *
#C   401C          5062.773    10014.248 1008.657 * * *
#C   1             4838.142     9943.733  989.209 * * *
#C   2             4810.315     9927.793  989.385 * * *
#C   3             4782.977     9911.639  989.284 * * *
#C   4             4755.118     9895.517  989.385 * * *
#C   5             4727.676     9879.419  989.332 * * *
```

```
#C   6            4700.215     9863.312  989.404 * * *
#C   7            4672.268     9847.211  989.350 * * *
#C   8            4644.598     9831.366  989.435 * * *
#C   9            4616.814     9815.405  989.523 * * *
#C   10           4589.557     9799.269  989.373 * * *
#C   11           4561.918     9783.362  989.261 * * *
#C   402B         4475.231     9976.032  957.869 * * *
#C   402C         4497.388     9941.007  961.917 * * *
#C   402D         4595.816     9977.583  958.771 * * *
#C   402A         4384.201    10213.304  931.224 * * *

##
#.DELTA OFF
A       401-402-401A      104-16-42.28012
A       401-402-401B      146-38-15.06682
A       401-402-401C      192-47-17.81954
DV      401-402                    463.245 95-13-14.43839 5.050/4.630
DV      401-401A                    40.897 89-30-38.89974 5.050/4.670
DV      401-401B                    58.946 85-15-17.31440 5.050/4.710
DV      401-401C                    64.858 82-58-14.21225 5.050/4.330
##


##
#.DELTA OFF
A       401-402-1         19-10-09.14227
A       401-402-2         20-50-25.27098
A       401-402-3         22-09-13.44845
A       401-402-4         23-06-22.60394
A       401-402-5         23-52-59.02713
A       401-402-6         24-30-38.69455
A       401-402-7         24-59-41.80204
A       401-402-8         25-23-01.41545
A       401-402-9         25-43-18.89804
A       401-402-10        26-03-40.98560
A       401-402-11        26-18-47.24509
DV      401-402                    463.246 95-13-19.72963 5.050/4.630
DV      401-1                      172.090 95-16-53.85883 5.050/0.000
DV      401-2                      203.567 94-24-49.64082 5.050/0.000
DV      401-3                      234.852 93-50-58.20763 5.050/0.000
DV      401-4                      266.700 93-22-03.33060 5.050/0.000
DV      401-5                      298.240 93-01-16.83979 5.050/0.000
DV      401-6                      329.848 92-43-08.83395 5.050/0.000
DV      401-7                      361.938 92-29-11.87558 5.050/0.000
DV      401-8                      393.690 92-16-24.74047 5.050/0.000
DV      401-9                      425.615 92-05-28.27979 5.050/0.000
DV      401-10                     457.167 91-57-56.66692 5.050/0.000
DV      401-11                     488.976 91-51-03.44117 5.050/0.000
##


##
#.DELTA OFF
A       402-401-402B      200-41-42.77240
A       402-401-402C      235-00-42.62913
A       402-401-402D      338-34-44.95986
A       402-401-402A      125-54-43.74053
DV      402-401                    463.236 84-46-44.93935 4.640/5.070
DV      402-402B                    67.822 89-52-06.57536 4.640/5.200
DV      402-402C                    72.104 87-01-25.99600 4.640/4.740
DV      402-402D                    61.387 89-07-26.37592 4.640/5.080
DV      402-401                    463.236 84-46-44.39345 4.640/5.070
DV      402-402A                   264.746 95-51-12.75768 4.640/4.690
```

##
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Summary of Unadjusted Input Observations

Number of Entered Stations (FeetUS) = 2

Fixed Stations	N	E	Elev	Description
401	5000.0000	10000.0000	1000.0000	
402	4538.6770	10000.0000	958.2730	

Number of Angle Observations (DMS) = 18

At	From	To	Angle	StdErr
401	402	401A	104-16-42.28	12.91
401	402	401B	146-38-15.07	9.53
401	402	401C	192-47-17.82	8.86
401	402	1	19-10-09.14	2.86
401	402	2	20-50-25.27	2.50
401	402	3	22-09-13.45	2.27
401	402	4	23-06-22.60	2.10
401	402	5	23-52-59.03	1.99
401	402	6	24-30-38.69	1.90
401	402	7	24-59-41.80	1.84
401	402	8	25-23-01.42	1.80
401	402	9	25-43-18.90	1.77
401	402	10	26-03-40.99	1.74
401	402	11	26-18-47.25	1.72
402	401	402B	200-41-42.77	8.44
402	401	402C	235-00-42.63	7.77
402	401	402D	338-34-44.96	7.91
402	401	402A	125-54-43.74	2.95

Number of Distance Observations (FeetUS) = 22

From	To	Distance	StdErr	HI	HT	Type
401	402	463.2450	0.0043	5.050	4.630	S
401	401A	40.8970	0.0039	5.050	4.670	S
401	401B	58.9460	0.0039	5.050	4.710	S
401	401C	64.8580	0.0040	5.050	4.330	S
401	402	463.2460	0.0043	5.050	4.630	S
401	1	172.0900	0.0040	5.050	0.000	S
401	2	203.5670	0.0041	5.050	0.000	S
401	3	234.8520	0.0041	5.050	0.000	S
401	4	266.7000	0.0041	5.050	0.000	S
401	5	298.2400	0.0041	5.050	0.000	S
401	6	329.8480	0.0042	5.050	0.000	S
401	7	361.9380	0.0042	5.050	0.000	S
401	8	393.6900	0.0042	5.050	0.000	S
401	9	425.6150	0.0042	5.050	0.000	S
401	10	457.1670	0.0043	5.050	0.000	S
401	11	488.9760	0.0043	5.050	0.000	S
402	401	463.2360	0.0043	4.640	5.070	S
402	402B	67.8220	0.0040	4.640	5.200	S
402	402C	72.1040	0.0040	4.640	4.740	S
402	402D	61.3870	0.0040	4.640	5.080	S
402	401	463.2360	0.0043	4.640	5.070	S
402	402A	264.7460	0.0041	4.640	4.690	S

Number of Zenith Observations (DMS) = 22

From	To	Zenith	StdErr	HI	HT
401	402	95-13-14.44	5.09	5.050	4.630

401	401A	89-30-38.90	11.81	5.050	4.670
401	401B	85-15-17.31	8.96	5.050	4.710
401	401C	82-58-14.21	8.41	5.050	4.330
401	402	95-13-19.73	5.09	5.050	4.630
401	1	95-16-53.86	5.61	5.050	0.000
401	2	94-24-49.64	5.44	5.050	0.000
401	3	93-50-58.21	5.34	5.050	0.000
401	4	93-22-03.33	5.26	5.050	0.000
401	5	93-01-16.84	5.21	5.050	0.000
401	6	92-43-08.83	5.17	5.050	0.000
401	7	92-29-11.88	5.14	5.050	0.000
401	8	92-16-24.74	5.12	5.050	0.000
401	9	92-05-28.28	5.10	5.050	0.000
401	10	91-57-56.67	5.09	5.050	0.000
401	11	91-51-03.44	5.08	5.050	0.000
402	401	84-46-44.94	5.09	4.640	5.070
402	402B	89-52-06.58	8.16	4.640	5.200
402	402C	87-01-26.00	7.87	4.640	4.740
402	402D	89-07-26.38	8.71	4.640	5.080
402	401	84-46-44.39	5.09	4.640	5.070
402	402A	95-51-12.76	5.27	4.640	4.690

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Adjustment Statistical Summary

Convergence Iterations = 3

Number of Stations = 20

Number of Observations = 62
Number of Unknowns = 54
Number of Redundant Obs = 8

Observation	Count	Sum Squares of StdRes	Error Factor
Angles	18	0.00	0.00
Distances	22	9.68	1.85
Zeniths	22	1.13	0.63
Total	62	10.81	1.16

Adjustment Passed the Chi Square Test at 5% Level

Adjusted Coordinates (FeetUS)

Station	N	E	Elev	Description
401	5000.0000	10000.0000	1000.0000	
402	4538.6770	10000.0000	958.2730	
401A	5010.0862	9960.3678	1000.7292	
401B	5049.0634	9967.6947	1005.2164	
401C	5062.7737	10014.2483	1008.6573	
1	4838.1420	9943.7326	989.2095	
2	4810.3155	9927.7927	989.3845	
3	4782.9766	9911.6387	989.2841	
4	4755.1186	9895.5175	989.3850	
5	4727.6762	9879.4190	989.3322	
6	4700.2146	9863.3120	989.4043	
7	4672.2681	9847.2113	989.3495	
8	4644.5979	9831.3664	989.4354	
9	4616.8140	9815.4045	989.5230	
10	4589.5576	9799.2692	989.3726	
11	4561.9179	9783.3615	989.2612	

402B	4475.2315	9976.0320	957.8688
402C	4497.3878	9941.0070	961.9167
402D	4595.8169	9977.5831	958.7716
402A	4384.2014	10213.3044	931.2240

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Adjusted Observations and Residuals

Adjusted Angle Observations (DMS)

At	From	To	Angle	Residual	StdErr	StdRes
401	402	401A	104-16-42.28	0-00-00.00	12.91	0.0
401	402	401B	146-38-15.07	0-00-00.00	9.53	0.0
401	402	401C	192-47-17.82	0-00-00.00	8.86	0.0
401	402	1	19-10-09.14	-0-00-00.00	2.86	0.0
401	402	2	20-50-25.27	-0-00-00.00	2.50	0.0
401	402	3	22-09-13.45	-0-00-00.00	2.27	0.0
401	402	4	23-06-22.60	0-00-00.00	2.10	0.0
401	402	5	23-52-59.03	0-00-00.00	1.99	0.0
401	402	6	24-30-38.69	-0-00-00.00	1.90	0.0
401	402	7	24-59-41.80	0-00-00.00	1.84	0.0
401	402	8	25-23-01.42	-0-00-00.00	1.80	0.0
401	402	9	25-43-18.90	0-00-00.00	1.77	0.0
401	402	10	26-03-40.99	-0-00-00.00	1.74	0.0
401	402	11	26-18-47.25	0-00-00.00	1.72	0.0
402	401	402B	200-41-42.77	0-00-00.00	8.44	0.0
402	401	402C	235-00-42.63	-0-00-00.00	7.77	0.0
402	401	402D	338-34-44.96	0-00-00.00	7.91	0.0
402	401	402A	125-54-43.74	-0-00-00.00	2.95	0.0

Adjusted Distance Observations (FeetUS)

From	To	Distance	Residual	StdErr	StdRes
401	402	463.2444	-0.0006	0.0043	0.1
401	401A	40.8970	0.0000	0.0039	0.0
401	401B	58.9460	0.0000	0.0039	0.0
401	401C	64.8580	0.0000	0.0040	0.0
401	402	463.2444	-0.0016	0.0043	0.4
401	1	172.0900	0.0000	0.0040	0.0
401	2	203.5670	0.0000	0.0041	0.0
401	3	234.8520	-0.0000	0.0041	0.0
401	4	266.7000	0.0000	0.0041	0.0
401	5	298.2400	-0.0000	0.0041	0.0
401	6	329.8480	-0.0000	0.0042	0.0
401	7	361.9380	0.0000	0.0042	0.0
401	8	393.6900	0.0000	0.0042	0.0
401	9	425.6150	0.0000	0.0042	0.0
401	10	457.1670	-0.0000	0.0043	0.0
401	11	488.9760	-0.0000	0.0043	0.0
402	401	463.2453	0.0093	0.0043	2.2
402	402B	67.8220	0.0000	0.0040	0.0
402	402C	72.1040	0.0000	0.0040	0.0
402	402D	61.3870	0.0000	0.0040	0.0
402	401	463.2453	0.0093	0.0043	2.2
402	402A	264.7460	-0.0000	0.0041	0.0

Adjusted Zenith Observations (DMS)

From	To	Zenith	Residual	StdErr	StdRes
401	402	95-13-14.37	-0-00-00.07	5.09	0.0
401	401A	89-30-38.90	-0-00-00.00	11.81	0.0
401	401B	85-15-17.31	-0-00-00.00	8.96	0.0
401	401C	82-58-14.21	-0-00-00.00	8.41	0.0

401	402	95-13-14.37	-0-00-05.36	5.09	1.1
401	1	95-16-53.86	0-00-00.00	5.61	0.0
401	2	94-24-49.64	0-00-00.00	5.44	0.0
401	3	93-50-58.21	-0-00-00.00	5.34	0.0
401	4	93-22-03.33	0-00-00.00	5.26	0.0
401	5	93-01-16.84	-0-00-00.00	5.21	0.0
401	6	92-43-08.83	-0-00-00.00	5.17	0.0
401	7	92-29-11.88	0-00-00.00	5.14	0.0
401	8	92-16-24.74	0-00-00.00	5.12	0.0
401	9	92-05-28.28	0-00-00.00	5.10	0.0
401	10	91-57-56.67	-0-00-00.00	5.09	0.0
401	11	91-51-03.44	-0-00-00.00	5.08	0.0
402	401	84-46-45.11	0-00-00.17	5.09	0.0
402	402B	89-52-06.58	-0-00-00.00	8.16	0.0
402	402C	87-01-26.00	-0-00-00.00	7.87	0.0
402	402D	89-07-26.38	-0-00-00.00	8.71	0.0
402	401	84-46-45.11	0-00-00.71	5.09	0.1
402	402A	95-51-12.76	-0-00-00.00	5.27	0.0

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Adjusted Bearings (DMS) and Horizontal Distances (FeetUS)

(Relative Confidence of Bearing is in Seconds)

From	To	Bearing	Distance	95% RelConfidence Brg	Dist	PPM
401	1	S19-10-09.14W	171.3594	7.01	0.0099	57.7498
401	2	S20-50-25.27W	202.9633	6.13	0.0100	49.1003
401	3	S22-09-13.45W	234.3222	5.55	0.0100	42.8129
401	4	S23-06-22.60W	266.2395	5.14	0.0101	37.9255
401	5	S23-52-59.03W	297.8255	4.86	0.0102	34.1188
401	6	S24-30-38.69W	329.4767	4.66	0.0102	31.0332
401	7	S24-59-41.80W	361.5973	4.51	0.0103	28.4548
401	8	S25-23-01.42W	393.3802	4.40	0.0104	26.3160
401	9	S25-43-18.90W	425.3316	4.32	0.0104	24.4880
401	10	S26-03-40.99W	456.8981	4.26	0.0105	22.9355
401	11	S26-18-47.25W	488.7210	4.22	0.0105	21.5732
401	402	S00-00-00.00E	461.3230	0.00	0.0000	0.0008
401	401A	N75-43-17.72W	40.8955	31.60	0.0096	235.6154
401	401B	N33-21-44.93W	58.7439	23.32	0.0096	164.2235
401	401C	N12-47-17.82E	64.3705	21.70	0.0096	149.6506
402	402A	S54-05-16.26E	263.3657	7.21	0.0101	38.5341
402	402B	S20-41-42.77W	67.8218	20.65	0.0097	142.8281
402	402C	S55-00-42.63W	72.0067	19.02	0.0097	134.5260
402	402D	N21-25-15.04W	61.3798	19.37	0.0097	157.6072

♀

Error Propagation

Station Coordinate Standard Deviations (FeetUS)

Station	N	E	Elev
401	0.00000	0.00000	0.00000
402	0.00000	0.00000	0.00000
401A	0.00266	0.00387	0.00234
401B	0.00361	0.00314	0.00257
401C	0.00389	0.00283	0.00267
1	0.00390	0.00261	0.00468
2	0.00390	0.00272	0.00537
3	0.00392	0.00284	0.00607
4	0.00394	0.00297	0.00680
5	0.00397	0.00311	0.00753
6	0.00400	0.00326	0.00827
7	0.00405	0.00342	0.00902

8	0.00409	0.00359	0.00977
9	0.00415	0.00376	0.01053
10	0.00420	0.00394	0.01128
11	0.00426	0.00413	0.01204
402B	0.00383	0.00295	0.00268
402C	0.00318	0.00360	0.00275
402D	0.00378	0.00262	0.00259
402A	0.00390	0.00402	0.00674

Station Coordinate Error Ellipses (FeetUS)
Confidence Region = 95%

Station	Semi-Major Axis	Semi-Minor Axis	Azimuth of Major Axis	Elev
401	0.00000	0.00000	0-00	0.00000
402	0.00000	0.00000	0-00	0.00000
401A	0.00964	0.00627	104-17	0.00459
401B	0.00965	0.00664	146-38	0.00504
401C	0.00963	0.00677	12-47	0.00523
1	0.00990	0.00582	19-10	0.00917
2	0.00997	0.00603	20-50	0.01052
3	0.01003	0.00630	22-09	0.01189
4	0.01010	0.00664	23-06	0.01332
5	0.01016	0.00702	23-53	0.01475
6	0.01022	0.00744	24-31	0.01620
7	0.01029	0.00791	25-00	0.01768
8	0.01035	0.00839	25-23	0.01915
9	0.01042	0.00891	25-43	0.02063
10	0.01048	0.00944	26-04	0.02210
11	0.01054	0.00999	26-19	0.02359
402B	0.00969	0.00679	20-42	0.00526
402C	0.00969	0.00664	55-01	0.00540
402D	0.00967	0.00576	158-35	0.00508
402A	0.01015	0.00921	125-55	0.01321

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Relative Error Ellipses (FeetUS)
Confidence Region = 95%

Stations From	To	Semi-Major Axis	Semi-Minor Axis	Azimuth of Major Axis	Vertical
401	1	0.00990	0.00582	19-10	0.00917
401	2	0.00997	0.00603	20-50	0.01052
401	3	0.01003	0.00630	22-09	0.01189
401	4	0.01010	0.00664	23-06	0.01332
401	5	0.01016	0.00702	23-53	0.01475
401	6	0.01022	0.00744	24-31	0.01620
401	7	0.01029	0.00791	25-00	0.01768
401	8	0.01035	0.00839	25-23	0.01915
401	9	0.01042	0.00891	25-43	0.02063
401	10	0.01048	0.00944	26-04	0.02210
401	11	0.01054	0.00999	26-19	0.02359
401	402	0.00000	0.00000	0-00	0.00000
401	401A	0.00964	0.00627	104-17	0.00459
401	401B	0.00965	0.00664	146-38	0.00504
401	401C	0.00963	0.00677	12-47	0.00523
402	402A	0.01015	0.00921	125-55	0.01321
402	402B	0.00969	0.00679	20-42	0.00526
402	402C	0.00969	0.00664	55-01	0.00540
402	402D	0.00967	0.00576	158-35	0.00508

Elapsed Time = 00:00:00

→25

```
42
01 00000000 Top of File
01 00000006 Summary of Files Used and Option Settings
02 00000009 Project Folder and Data Files
02 00000015 Project Option Settings
02 00000032 Instrument Standard Error Settings
03 00000034 Project Default Instrument
01 00000047 Listing of Input Data
01 00000133 Summary of Unadjusted Input Observations
02 00000136 Entered Stations
03 00000138 Fixed Coordinates
02 00000142 Angle Observations
02 00000164 Distance Observations
02 00000190 Zenith Observations
01 00000216 Adjustment Statistical Summary
01 00000237 Adjusted Coordinates
01 00000262 Adjusted Observations and Residuals
02 00000265 Adjusted Angle Observations
02 00000287 Adjusted Distance Observations
02 00000313 Adjusted Zenith Observations
01 00000339 Adjusted Bearings and Horizontal Distances
01 00000365 Error Propagation
02 00000368 Station Coordinate Standard Deviations
02 00000392 Station Coordinate Error Ellipses
02 00000418 Relative Error Ellipses
01 00000442 End of File
0000618C
STARPLUS
00016D44
```

STAR*NET-PRO Version 6.00

Run Date: 10-21-2015

Summary of Files Used and Option Settings

Project Folder and Data Files

```
Project Name    ARGO
Data File List  20.dat
```

Project Option Settings

```
STAR*NET Run Mode                      : Adjust with Error Propagation
Type of Adjustment                     : 3D
Project Units                          : FeetUS
Coordinate System                      : LOCAL
Apply Average Scale Factor             : 1.0000000000
Input/Output Coordinate Order          : North-East
Angle Data Station Order               : At-From-To
Distance/Vertical Data Type            : Slope/Zenith
Convergence Limit; Max Iterations      : 0.0010; 10
Default Coefficient of Refraction      : 0.0700
Earth Radius                           : 6372000.00 Meters
Create Coordinate File                 : Yes
Create Ground Scale Coordinate File    : No
Create Dump File                       : No
```

Instrument Standard Error Settings

```
Project Default Instrument
  Distances (Constant)                 :     0.00300 FeetUS
  Distances (PPM)                      :     1.00000
  Angles                               :     1.40000 Seconds
  Directions                           :     1.00000 Seconds
  Azimuths & Bearings                  :     1.40000 Seconds
  Zeniths                              :     5.00000 Seconds
  Elevation Differences (Constant)     :     0.01000 FeetUS
  Elevation Differences (PPM)          :     0.00000
  Centering Error Instrument           :     0.00200 FeetUS
  Centering Error Target               :     0.00150 FeetUS
  Centering Error Vertical             :     0.00150 FeetUS
```

♀

Listing of Input Data

```
## Job File:        20151020
## Created:        2015-10-19

C   401          5000.000    10000.000 1000.000 ! ! !
C   402          4538.683    10000.000  958.273 ! ! !
#C   1            4838.146     9943.731  989.207 * * *
#C   2            4810.319     9927.791  989.382 * * *
#C   3            4782.981     9911.637  989.280 * * *
#C   4            4755.120     9895.519  989.381 * * *
#C   5            4727.678     9879.419  989.332 * * *
#C   6            4700.218     9863.311  989.402 * * *
```

```
#C   7             4672.273     9847.208  989.344 * * *
#C   8             4644.602     9831.363  989.431 * * *
#C   9             4616.817     9815.403  989.518 * * *
#C   10            4589.563     9799.263  989.372 * * *
#C   11            4561.923     9783.357  989.268 * * *

##
#.DELTA OFF
A       401-402-1         19-10-12.87524
A       401-402-2         20-50-27.78482
A       401-402-3         22-09-16.08036
A       401-402-4         23-06-22.34196
A       401-402-5         23-52-59.66179
A       401-402-6         24-30-40.29674
A       401-402-7         24-59-44.71857
A       401-402-8         25-23-03.81208
A       401-402-9         25-43-19.97651
A       401-402-10        26-03-44.69850
A       401-402-11        26-18-49.94236
DV      401-402                    463.224 95-12-03.39354 5.12/4.870
DV      401-1                      172.094 95-18-20.50306 5.12/0.000
DV      401-2                      203.570 94-26-03.23113 5.12/0.000
DV      401-3                      234.853 93-52-03.25165 5.12/0.000
DV      401-4                      266.702 93-23-00.32744 5.12/0.000
DV      401-5                      298.242 93-02-05.58205 5.12/0.000
DV      401-6                      329.849 92-43-54.27820 5.12/0.000
DV      401-7                      361.939 92-29-54.71662 5.12/0.000
DV      401-8                      393.691 92-17-03.93990 5.12/0.000
DV      401-9                      425.616 92-06-04.51616 5.12/0.000
DV      401-10                     457.167 91-58-28.37411 5.12/0.000
DV      401-11                     488.975 91-51-29.99627 5.12/0.000
##
♀
```

Summary of Unadjusted Input Observations
==

Number of Entered Stations (FeetUS) = 2

Fixed Stations	N	E	Elev	Description
401	5000.0000	10000.0000	1000.0000	
402	4538.6830	10000.0000	958.2730	

Number of Angle Observations (DMS) = 11

At	From	To	Angle	StdErr
401	402	1	19-10-12.88	2.86
401	402	2	20-50-27.78	2.50
401	402	3	22-09-16.08	2.27
401	402	4	23-06-22.34	2.10
401	402	5	23-52-59.66	1.99
401	402	6	24-30-40.30	1.90
401	402	7	24-59-44.72	1.84
401	402	8	25-23-03.81	1.80
401	402	9	25-43-19.98	1.77
401	402	10	26-03-44.70	1.74
401	402	11	26-18-49.94	1.72

Number of Distance Observations (FeetUS) = 12

From	To	Distance	StdErr	HI	HT	Type
401	402	463.2240	0.0043	5.120	4.870	S
401	1	172.0940	0.0040	5.120	0.000	S
401	2	203.5700	0.0041	5.120	0.000	S

401	3	234.8530	0.0041	5.120	0.000	S
401	4	266.7020	0.0041	5.120	0.000	S
401	5	298.2420	0.0041	5.120	0.000	S
401	6	329.8490	0.0042	5.120	0.000	S
401	7	361.9390	0.0042	5.120	0.000	S
401	8	393.6910	0.0042	5.120	0.000	S
401	9	425.6160	0.0042	5.120	0.000	S
401	10	457.1670	0.0043	5.120	0.000	S
401	11	488.9750	0.0043	5.120	0.000	S

Number of Zenith Observations (DMS) = 12

From	To	Zenith	StdErr	HI	HT
401	402	95-12-03.39	5.09	5.120	4.870
401	1	95-18-20.50	5.61	5.120	0.000
401	2	94-26-03.23	5.44	5.120	0.000
401	3	93-52-03.25	5.34	5.120	0.000
401	4	93-23-00.33	5.26	5.120	0.000
401	5	93-02-05.58	5.21	5.120	0.000
401	6	92-43-54.28	5.17	5.120	0.000
401	7	92-29-54.72	5.14	5.120	0.000
401	8	92-17-03.94	5.12	5.120	0.000
401	9	92-06-04.52	5.10	5.120	0.000
401	10	91-58-28.37	5.09	5.120	0.000
401	11	91-51-30.00	5.08	5.120	0.000

♀

Adjustment Statistical Summary

Convergence Iterations = 3

Number of Stations = 13

Number of Observations = 35
Number of Unknowns = 33
Number of Redundant Obs = 2

Observation	Count	Sum Squares of StdRes	Error Factor
Angles	11	0.00	0.00
Distances	12	0.06	0.28
Zeniths	12	0.67	0.99
Total	35	0.72	0.60

Adjustment Passed the Chi Square Test at 5% Level

Adjusted Coordinates (FeetUS)

Station	N	E	Elev	Description
401	5000.0000	10000.0000	1000.0000	
402	4538.6830	10000.0000	958.2730	
1	4838.1455	9943.7305	989.2071	
2	4810.3188	9927.7913	989.3819	
3	4782.9814	9911.6375	989.2802	
4	4755.1206	9895.5187	989.3814	
5	4727.6782	9879.4189	989.3317	
6	4700.2179	9863.3107	989.4017	
7	4672.2723	9847.2076	989.3444	
8	4644.6016	9831.3631	989.4306	
9	4616.8165	9815.4032	989.5183	
10	4589.5634	9799.2629	989.3724	

11	4561.9235	9783.3571	989.2683

♀

Adjusted Observations and Residuals

Adjusted Angle Observations (DMS)

At	From	To	Angle	Residual	StdErr	StdRes
401	402	1	19-10-12.88	0-00-00.00	2.86	0.0
401	402	2	20-50-27.78	0-00-00.00	2.50	0.0
401	402	3	22-09-16.08	-0-00-00.00	2.27	0.0
401	402	4	23-06-22.34	-0-00-00.00	2.10	0.0
401	402	5	23-52-59.66	0-00-00.00	1.99	0.0
401	402	6	24-30-40.30	0-00-00.00	1.90	0.0
401	402	7	24-59-44.72	-0-00-00.00	1.84	0.0
401	402	8	25-23-03.81	0-00-00.00	1.80	0.0
401	402	9	25-43-19.98	-0-00-00.00	1.77	0.0
401	402	10	26-03-44.70	0-00-00.00	1.74	0.0
401	402	11	26-18-49.94	0-00-00.00	1.72	0.0

Adjusted Distance Observations (FeetUS)

From	To	Distance	Residual	StdErr	StdRes
401	402	463.2230	-0.0010	0.0043	0.2
401	1	172.0940	0.0000	0.0040	0.0
401	2	203.5700	-0.0000	0.0041	0.0
401	3	234.8530	0.0000	0.0041	0.0
401	4	266.7020	-0.0000	0.0041	0.0
401	5	298.2420	0.0000	0.0041	0.0
401	6	329.8490	-0.0000	0.0042	0.0
401	7	361.9390	0.0000	0.0042	0.0
401	8	393.6910	-0.0000	0.0042	0.0
401	9	425.6160	-0.0000	0.0042	0.0
401	10	457.1670	-0.0000	0.0043	0.0
401	11	488.9750	0.0000	0.0043	0.0

Adjusted Zenith Observations (DMS)

From	To	Zenith	Residual	StdErr	StdRes
401	402	95-11-59.23	-0-00-04.16	5.09	0.8
401	1	95-18-20.50	0-00-00.00	5.61	0.0
401	2	94-26-03.23	-0-00-00.00	5.44	0.0
401	3	93-52-03.25	0-00-00.00	5.34	0.0
401	4	93-23-00.33	-0-00-00.00	5.26	0.0
401	5	93-02-05.58	0-00-00.00	5.21	0.0
401	6	92-43-54.28	-0-00-00.00	5.17	0.0
401	7	92-29-54.72	0-00-00.00	5.14	0.0
401	8	92-17-03.94	-0-00-00.00	5.12	0.0
401	9	92-06-04.52	-0-00-00.00	5.10	0.0
401	10	91-58-28.37	-0-00-00.00	5.09	0.0
401	11	91-51-30.00	0-00-00.00	5.08	0.0

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Adjusted Bearings (DMS) and Horizontal Distances (FeetUS)

(Relative Confidence of Bearing is in Seconds)

From	To	Bearing	Distance	95% RelConfidence Brg	Dist	PPM
401	1	S19-10-12.88W	171.3567	7.01	0.0099	57.7513
401	2	S20-50-27.78W	202.9607	6.13	0.0100	49.1019
401	3	S22-09-16.08W	234.3182	5.55	0.0100	42.8147
401	4	S23-06-22.34W	266.2372	5.14	0.0101	37.9269
401	5	S23-52-59.66W	297.8238	4.86	0.0102	34.1199

401	6	S24-30-40.30W	329.4742	4.66	0.0102	31.0343
401	7	S24-59-44.72W	361.5950	4.51	0.0103	28.4559
401	8	S25-23-03.81W	393.3782	4.40	0.0104	26.3170
401	9	S25-43-19.98W	425.3299	4.32	0.0104	24.4889
401	10	S26-03-44.70W	456.8956	4.26	0.0105	22.9363
401	11	S26-18-49.94W	488.7179	4.22	0.0105	21.5739
401	402	S00-00-00.00E	461.3170	0.00	0.0000	0.0008

♀

Error Propagation

Station Coordinate Standard Deviations (FeetUS)

Station	N	E	Elev
401	0.00000	0.00000	0.00000
402	0.00000	0.00000	0.00000
1	0.00390	0.00261	0.00468
2	0.00390	0.00272	0.00537
3	0.00392	0.00284	0.00607
4	0.00394	0.00297	0.00680
5	0.00397	0.00311	0.00753
6	0.00400	0.00326	0.00827
7	0.00405	0.00342	0.00902
8	0.00409	0.00359	0.00977
9	0.00415	0.00376	0.01053
10	0.00420	0.00394	0.01128
11	0.00426	0.00413	0.01204

Station Coordinate Error Ellipses (FeetUS)
Confidence Region = 95%

Station	Semi-Major Axis	Semi-Minor Axis	Azimuth of Major Axis	Elev
401	0.00000	0.00000	0-00	0.00000
402	0.00000	0.00000	0-00	0.00000
1	0.00990	0.00582	19-10	0.00917
2	0.00997	0.00603	20-50	0.01052
3	0.01003	0.00630	22-09	0.01189
4	0.01010	0.00664	23-06	0.01332
5	0.01016	0.00702	23-53	0.01475
6	0.01023	0.00744	24-31	0.01620
7	0.01029	0.00791	25-00	0.01768
8	0.01035	0.00839	25-23	0.01915
9	0.01042	0.00891	25-43	0.02063
10	0.01048	0.00944	26-04	0.02210
11	0.01054	0.00999	26-19	0.02359

♀

Relative Error Ellipses (FeetUS)
Confidence Region = 95%

Stations From	To	Semi-Major Axis	Semi-Minor Axis	Azimuth of Major Axis	Vertical
401	1	0.00990	0.00582	19-10	0.00917
401	2	0.00997	0.00603	20-50	0.01052
401	3	0.01003	0.00630	22-09	0.01189
401	4	0.01010	0.00664	23-06	0.01332
401	5	0.01016	0.00702	23-53	0.01475
401	6	0.01023	0.00744	24-31	0.01620
401	7	0.01029	0.00791	25-00	0.01768
401	8	0.01035	0.00839	25-23	0.01915
401	9	0.01042	0.00891	25-43	0.02063
401	10	0.01048	0.00944	26-04	0.02210
401	11	0.01054	0.00999	26-19	0.02359

401	402	0.00000	0.00000	0-00	0.00000

Elapsed Time = 00:00:00

→25
42
01 00000000 Top of File
01 00000006 Summary of Files Used and Option Settings
02 00000009 Project Folder and Data Files
02 00000015 Project Option Settings
02 00000032 Instrument Standard Error Settings
03 00000034 Project Default Instrument
01 00000047 Listing of Input Data
01 00000102 Summary of Unadjusted Input Observations
02 00000105 Entered Stations
03 00000107 Fixed Coordinates
02 00000111 Angle Observations
02 00000126 Distance Observations
02 00000142 Zenith Observations
01 00000158 Adjustment Statistical Summary
01 00000179 Adjusted Coordinates
01 00000197 Adjusted Observations and Residuals
02 00000200 Adjusted Angle Observations
02 00000215 Adjusted Distance Observations
02 00000231 Adjusted Zenith Observations
01 00000247 Adjusted Bearings and Horizontal Distances
01 00000266 Error Propagation
02 00000269 Station Coordinate Standard Deviations
02 00000286 Station Coordinate Error Ellipses
02 00000305 Relative Error Ellipses
01 00000322 End of File
000043F4
STARPLUS
00014AD5

Appendices c. Horizontal MTA Reports (Mean Turned Angle)

Field Monitoring Report MTA / Baseline Survey 10-19-2015
Field Monitoring Report MTA / Baseline Survey 10-20-2015

Monitoring Report

Job Name	15ARGO-20151019
Version	2.01
Distance units	USSurveyFeet
Angle units	DMSDegrees
Pressure units	InchHg
Temperature units	Fahrenheit

Station Setup

Point Name	401	**Point Code**	CP	**Inst ht**	5.050
North	5000.000	**East**	10000.000	**Elevation**	1000.000

Point Name	1	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4838.142	**East**	9943.733	**Elevation**	989.209
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	199°10'11"	95°16'54"	172.087	-0°00'01"	0°00'00"	-0.002	0.001	0.000	12:55:30
F2	199°10'18"	95°17'08"	172.089	0°00'06"	0°00'15"	-0.002	0.002	0.012	13:03:13
F1	199°10'11"	95°16'44"	172.088	-0°00'08"	-0°00'10"	0.000	0.002	-0.009	13:03:48
F2	199°10'18"	95°17'03"	172.089	-0°00'01"	0°00'09"	0.003	-0.009	0.007	13:06:57
F1	199°10'12"	95°16'48"	172.089	0°00'00"	-0°00'06"	-0.001	0.003	-0.005	13:07:38
F2	199°10'18"	95°16'59"	172.090	0°00'05"	0°00'05"	0.000	0.002	0.004	13:10:42
F1	199°10'10"	95°16'46"	172.090	-0°00'03"	-0°00'08"	0.002	0.001	-0.007	13:11:17
F2	199°10'17"	95°16'57"	172.090	0°00'05"	0°00'03"	0.000	0.002	0.002	13:14:19
F1	199°10'13"	95°16'44"	172.090	-0°00'05"	-0°00'10"	0.001	0.004	-0.008	13:15:06
F2	199°10'20"	95°16'56"	172.089	0°00'02"	0°00'02"	0.001	-0.005	0.001	13:18:04
MTA	199°10'18"	95°16'54"	172.089	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	10	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4589.557	**East**	9799.269	**Elevation**	989.373
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	206°03'42"	91°57'57"	457.164	-0°00'02"	-0°00'00"	-0.001	0.001	0.000	13:00:55
F2	206°03'52"	91°58'06"	457.166	0°00'08"	0°00'09"	-0.005	0.010	0.020	13:01:59

F1	206°03'41"	91°57'49"	457.165	-0°00'10"	-0°00'08"	0.000	0.000	-0.017	13:05:09
F2	206°03'48"	91°58'01"	457.166	-0°00'03"	0°00'04"	0.013	-0.025	0.009	13:05:40
F1	206°03'53"	91°57'49"	457.165	0°00'09"	-0°00'07"	-0.011	0.025	-0.015	13:08:55
F2	206°03'48"	91°57'59"	457.163	0°00'04"	0°00'02"	-0.002	0.000	0.005	13:09:27
F1	206°03'42"	91°57'49"	457.164	-0°00'02"	-0°00'08"	-0.001	0.002	-0.016	13:12:35
F2	206°03'47"	91°57'59"	457.164	0°00'03"	0°00'03"	-0.001	0.000	0.006	13:13:04
F1	206°03'41"	91°58'00"	457.164	-0°00'08"	0°00'03"	-0.001	0.001	0.007	13:16:21
F2	206°03'51"	91°57'59"	457.164	0°00'01"	0°00'02"	0.006	-0.015	0.005	13:16:49
MTA	206°03'49"	91°57'57"	457.165	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	11	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4561.918	**East**	9783.362	**Elevation**	989.261
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	206°18'48"	91°50'59"	488.973	-0°00'02"	-0°00'04"	-0.001	0.003	-0.010	13:01:26
F2	206°18'55"	91°51'03"	488.973	0°00'05"	-0°00'01"	-0.003	0.006	-0.002	13:01:50
F1	206°18'49"	91°51'06"	488.973	-0°00'08"	0°00'02"	-0.002	0.004	0.006	13:05:18
F2	206°18'55"	91°51'04"	488.972	-0°00'02"	0°00'01"	0.013	-0.027	0.001	13:05:32
F1	206°18'48"	91°51'05"	488.974	-0°00'02"	0°00'02"	-0.001	0.003	0.004	13:09:05
F2	206°19'03"	91°51'04"	488.973	0°00'13"	0°00'01"	-0.010	0.022	0.002	13:09:19
F1	206°18'50"	91°51'04"	488.973	-0°00'01"	0°00'00"	-0.002	0.005	0.000	13:12:44
F2	206°18'52"	91°51'02"	488.971	0°00'02"	-0°00'02"	0.000	-0.003	-0.004	13:12:56
F1	206°18'51"	91°51'05"	488.971	-0°00'05"	0°00'01"	-0.005	0.007	0.002	13:16:29
F2	206°18'56"	91°51'03"	488.973	0°00'00"	-0°00'00"	0.009	-0.017	-0.001	13:16:41
MTA	206°18'56"	91°51'03"	488.973	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	2	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4810.315	**East**	9927.793	**Elevation**	989.385
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	200°50'27"	94°24'48"	203.566	-0°00'01"	-0°00'02"	0.000	0.002	-0.001	12:56:22
F2	200°50'29"	94°25'06"	203.565	0°00'01"	0°00'16"	-0.002	-0.002	0.016	13:03:03
F1	200°50'28"	94°24'40"	203.565	-0°00'07"	-0°00'10"	-0.002	0.003	-0.009	13:03:55
F2	200°50'33"	94°24'55"	203.565	-0°00'02"	0°00'05"	0.003	-0.011	0.005	13:06:45
F1	200°50'26"	94°24'39"	203.566	-0°00'02"	-0°00'11"	0.000	0.002	-0.010	13:07:46
F2	200°50'43"	94°25'02"	203.568	0°00'15"	0°00'13"	-0.004	0.011	0.013	13:10:32

F1	200°50'28"	94°24'40"	203.568	-0°00'00"	-0°00'09"	0.001	0.004	-0.009	13:11:26
F2	200°50'31"	94°24'55"	203.566	0°00'03"	0°00'05"	0.000	0.000	0.005	13:14:12
F1	200°50'28"	94°24'39"	203.566	-0°00'06"	-0°00'10"	-0.001	0.003	-0.010	13:15:13
F2	200°50'33"	94°24'52"	203.565	-0°00'01"	0°00'03"	0.002	-0.009	0.003	13:17:56
MTA	200°50'34"	94°24'50"	203.566	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	3	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4782.977	**East**	9911.639	**Elevation**	989.284
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	202°09'16"	93°50'59"	234.851	0°00'00"	0°00'01"	0.000	0.004	0.001	12:56:55
F2	202°09'10"	93°51'02"	234.851	-0°00'06"	0°00'04"	0.005	-0.009	0.005	13:02:54
F1	202°09'18"	93°50'50"	234.851	-0°00'05"	-0°00'08"	-0.001	0.006	-0.009	13:04:04
F2	202°09'23"	93°51'02"	234.849	-0°00'00"	0°00'03"	0.003	-0.011	0.004	13:06:36
F1	202°09'17"	93°50'53"	234.850	0°00'00"	-0°00'05"	-0.001	0.003	-0.006	13:07:54
F2	202°09'21"	93°51'02"	234.851	0°00'04"	0°00'04"	0.000	0.002	0.004	13:10:24
F1	202°09'18"	93°50'51"	234.851	0°00'01"	-0°00'08"	-0.001	0.005	-0.009	13:11:34
F2	202°09'22"	93°51'08"	234.849	0°00'05"	0°00'10"	-0.003	0.001	0.011	13:14:03
F1	202°09'19"	93°50'52"	234.851	-0°00'03"	-0°00'07"	-0.001	0.006	-0.008	13:15:22
F2	202°09'26"	93°51'03"	234.849	0°00'04"	0°00'05"	0.001	-0.005	0.005	13:17:47
MTA	202°09'22"	93°50'58"	234.850	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	4	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4755.118	**East**	9895.517	**Elevation**	989.385
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	203°06'25"	93°21'58"	266.700	-0°00'01"	-0°00'05"	0.000	0.003	-0.006	12:57:36
F2	203°06'30"	93°22'15"	266.699	0°00'05"	0°00'12"	-0.002	0.002	0.015	13:02:46
F1	203°06'26"	93°22'00"	266.697	-0°00'07"	-0°00'03"	-0.003	0.003	-0.004	13:04:14
F2	203°06'31"	93°22'16"	266.699	-0°00'02"	0°00'12"	0.005	-0.015	0.016	13:06:28
F1	203°06'26"	93°21'51"	266.700	0°00'00"	-0°00'13"	0.000	0.004	-0.016	13:08:04
F2	203°06'29"	93°22'03"	266.699	0°00'04"	0°00'00"	0.000	0.000	0.000	13:10:15
F1	203°06'28"	93°21'52"	266.698	0°00'02"	-0°00'12"	-0.002	0.006	-0.015	13:11:43
F2	203°06'29"	93°22'14"	266.699	0°00'04"	0°00'10"	-0.001	0.000	0.013	13:13:54
F1	203°06'26"	93°21'52"	266.699	-0°00'05"	-0°00'12"	-0.001	0.004	-0.015	13:15:30
F2	203°06'31"	93°22'13"	266.698	0°00'00"	0°00'10"	0.002	-0.011	0.013	13:17:39

MTA	203°06'31"	93°22'03"	266.699	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Station Setup

Point Name	401	**Point Code**	CP	**Inst ht**	5.050
North	5000.000	**East**	10000.000	**Elevation**	1000.000

Point Name	402	**Point Code**	CP	**Class**	Mean turned angle (MTA)
North	4538.677	**East**	10000.000	**Elevation**	958.273
Nbr of Obs	1				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	180°00'00"	95°13'11"	463.243			0.002	0.000	-0.007	12:46:17

Station Setup

Point Name	401	**Point Code**	CP	**Inst ht**	5.050
North	5000.000	**East**	10000.000	**Elevation**	1000.000

Point Name	402	**Point Code**	CP	**Class**	Mean turned angle (MTA)
North	4538.677	**East**	10000.000	**Elevation**	958.273
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	180°00'00"	95°13'18"	463.243	-0°00'03"	-0°00'02"	0.001	0.000	0.007	12:53:23
F2	180°00'06"	95°13'21"	463.243	0°00'03"	0°00'02"	0.000	0.000	0.016	13:03:21
F1	180°00'00"	95°13'11"	463.244	-0°00'10"	-0°00'09"	0.003	0.000	-0.007	13:03:39
F2	180°00'20"	95°13'31"	463.243	0°00'10"	0°00'12"	-0.001	0.000	0.038	13:07:06
F1	180°00'00"	95°13'12"	463.243	-0°00'03"	-0°00'08"	0.002	0.000	-0.006	13:07:27
F2	180°00'06"	95°13'31"	463.241	0°00'03"	0°00'11"	-0.004	0.000	0.037	13:10:50
F1	180°00'00"	95°13'12"	463.244	-0°00'03"	-0°00'08"	0.003	0.000	-0.005	13:11:08
F2	180°00'06"	95°13'23"	463.243	0°00'03"	0°00'03"	0.000	0.000	0.020	13:14:27
F1	180°00'00"	95°13'12"	463.243	-0°00'08"	-0°00'08"	0.002	0.000	-0.005	13:14:55
F2	180°00'17"	95°13'26"	463.243	0°00'08"	0°00'06"	-0.001	0.000	0.026	13:18:15
MTA	180°00'08"	95°13'20"	463.243	0°00'00"	0°00'00"	0.001	0.000	0.012	13:21:27

Point Name	5	**Point Code**	PIER	**Class**	Mean turned angle (MTA)

North	4727.676	East	9879.419	Elevation	989.332
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	203°53'02"	93°01'10"	298.239	0°00'00"	-0°00'06"	-0.001	0.005	-0.009	12:58:27
F2	203°53'02"	93°01'26"	298.239	-0°00'00"	0°00'09"	0.001	-0.004	0.012	13:02:37
F1	203°53'05"	93°01'11"	298.239	-0°00'04"	-0°00'06"	-0.003	0.008	-0.009	13:04:22
F2	203°53'07"	93°01'26"	298.238	-0°00'03"	0°00'09"	0.006	-0.017	0.012	13:06:19
F1	203°53'03"	93°01'17"	298.240	0°00'01"	-0°00'00"	-0.001	0.005	0.000	13:08:13
F2	203°53'06"	93°01'25"	298.238	0°00'04"	0°00'08"	-0.001	0.001	0.011	13:10:06
F1	203°53'03"	93°01'03"	298.239	0°00'01"	-0°00'14"	-0.001	0.006	-0.020	13:11:52
F2	203°53'06"	93°01'24"	298.237	0°00'03"	0°00'07"	-0.002	0.000	0.010	13:13:45
F1	203°53'04"	93°01'14"	298.240	-0°00'03"	-0°00'03"	-0.002	0.008	-0.005	13:15:39
F2	203°53'09"	93°01'14"	298.239	0°00'01"	-0°00'03"	0.005	-0.009	-0.004	13:17:31
MTA	203°53'07"	93°01'17"	298.239	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	6	Point Code	PIER	Class	Mean turned angle (MTA)
North	4700.215	East	9863.312	Elevation	989.404
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	204°30'43"	92°43'04"	329.846	0°00'01"	-0°00'05"	-0.002	0.006	-0.008	12:58:59
F2	204°30'45"	92°43'20"	329.846	0°00'03"	0°00'11"	0.000	0.000	0.017	13:02:30
F1	204°30'44"	92°43'09"	329.846	-0°00'05"	0°00'01"	-0.004	0.008	0.001	13:04:31
F2	204°30'40"	92°43'18"	329.846	-0°00'09"	0°00'09"	0.013	-0.028	0.014	13:06:12
F1	204°30'42"	92°43'08"	329.846	0°00'01"	-0°00'01"	-0.002	0.006	-0.002	13:08:22
F2	204°30'47"	92°43'18"	329.846	0°00'06"	0°00'09"	-0.002	0.004	0.014	13:09:58
F1	204°30'44"	92°42'57"	329.846	0°00'02"	-0°00'11"	-0.002	0.008	-0.019	13:12:00
F2	204°30'46"	92°43'05"	329.844	0°00'04"	-0°00'04"	-0.001	0.001	-0.006	13:13:37
F1	204°30'43"	92°43'00"	329.845	-0°00'04"	-0°00'09"	-0.002	0.006	-0.015	13:15:47
F2	204°30'48"	92°43'09"	329.846	0°00'01"	0°00'01"	0.006	-0.011	0.001	13:17:22
MTA	204°30'47"	92°43'09"	329.846	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	7	Point Code	PIER	Class	Mean turned angle (MTA)
North	4672.268	East	9847.211	Elevation	989.350
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time

F1	204°59'42"	92°29'09"	361.936	-0°00'02"	-0°00'03"	0.000	0.001	-0.005	12:59:28
F2	204°59'49"	92°29'16"	361.936	0°00'05"	0°00'04"	-0.002	0.003	0.008	13:02:23
F1	204°59'50"	92°29'05"	361.936	-0°00'02"	-0°00'07"	-0.006	0.013	-0.012	13:04:39
F2	204°59'46"	92°29'12"	361.936	-0°00'05"	0°00'00"	0.012	-0.025	0.001	13:06:04
F1	204°59'44"	92°29'13"	361.937	-0°00'01"	0°00'02"	-0.001	0.004	0.003	13:08:30
F2	204°59'50"	92°29'21"	361.935	0°00'05"	0°00'09"	-0.003	0.002	0.016	13:09:50
F1	204°59'46"	92°29'06"	361.937	0°00'01"	-0°00'06"	-0.002	0.007	-0.011	13:12:08
F2	204°59'48"	92°29'24"	361.937	0°00'03"	0°00'12"	0.000	0.000	0.021	13:13:29
F1	204°59'46"	92°29'01"	361.936	-0°00'04"	-0°00'10"	-0.002	0.007	-0.018	13:15:56
F2	204°59'50"	92°29'13"	361.935	-0°00'00"	0°00'01"	0.006	-0.015	0.002	13:17:13
MTA	204°59'50"	92°29'12"	361.936	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	8	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4644.598	**East**	9831.366	**Elevation**	989.435
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	205°23'03"	92°16'21"	393.689	-0°00'02"	-0°00'03"	0.000	0.003	-0.007	12:59:57
F2	205°23'07"	92°16'36"	393.688	0°00'03"	0°00'11"	-0.001	0.000	0.020	13:02:14
F1	205°23'05"	92°16'23"	393.687	-0°00'07"	-0°00'02"	-0.003	0.005	-0.005	13:04:47
F2	205°23'06"	92°16'26"	393.688	-0°00'05"	0°00'01"	0.012	-0.027	0.001	13:05:56
F1	205°23'03"	92°16'28"	393.688	-0°00'01"	0°00'03"	-0.002	0.003	0.005	13:08:38
F2	205°23'20"	92°16'36"	393.686	0°00'16"	0°00'11"	-0.013	0.021	0.021	13:09:42
F1	205°23'05"	92°16'15"	393.688	0°00'01"	-0°00'10"	-0.002	0.007	-0.020	13:12:17
F2	205°23'06"	92°16'24"	393.688	0°00'02"	-0°00'01"	0.002	-0.003	-0.001	13:13:21
F1	205°23'05"	92°16'15"	393.687	-0°00'05"	-0°00'10"	-0.003	0.005	-0.019	13:16:05
F2	205°23'09"	92°16'25"	393.687	-0°00'01"	-0°00'00"	0.007	-0.017	-0.001	13:17:05
MTA	205°23'10"	92°16'25"	393.687	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Point Name	9	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4616.814	**East**	9815.405	**Elevation**	989.523
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	205°43'16"	92°05'25"	425.612	-0°00'06"	-0°00'04"	0.002	-0.005	-0.007	13:00:30
F2	205°43'24"	92°05'29"	425.612	0°00'03"	0°00'01"	0.000	0.000	0.001	13:02:06
F1	205°43'24"	92°05'32"	425.612	-0°00'05"	0°00'03"	-0.005	0.010	0.007	13:04:59
F2	205°43'21"	92°05'34"	425.612	-0°00'08"	0°00'05"	0.015	-0.034	0.011	13:05:48

F1	205°43'32"	92°05'18"	425.614	0°00'10"	-0°00'10"	-0.009	0.025	-0.021	13:08:48
F2	205°43'34"	92°05'34"	425.612	0°00'12"	0°00'06"	-0.009	0.017	0.012	13:09:35
F1	205°43'16"	92°05'25"	425.612	-0°00'06"	-0°00'04"	0.003	-0.005	-0.007	13:12:26
F2	205°43'22"	92°05'28"	425.610	-0°00'00"	-0°00'00"	0.001	-0.007	0.000	13:13:12
F1	205°43'20"	92°05'31"	425.613	-0°00'07"	0°00'02"	-0.001	0.003	0.005	13:16:13
F2	205°43'35"	92°05'28"	425.612	0°00'08"	0°00'00"	0.000	0.000	0.000	13:16:57
MTA	205°43'27"	92°05'28"	425.612	0°00'00"	0°00'00"	0.000	0.000	0.000	13:21:27

Station Setup

Point Name	401	**Point Code**	CP	**Inst ht**	5.050
North	5000.000	**East**	10000.000	**Elevation**	1000.000

Point Name	401A	**Point Code**	CP/REF	**Class**	Mean turned angle (MTA)
North	5010.086	**East**	9960.368	**Elevation**	1000.729
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	284°16'35"	89°30'31"	40.898	-0°00'10"	-0°00'08"	0.001	0.001	-0.002	12:09:36
F2	284°16'54"	89°30'46"	40.897	0°00'09"	0°00'07"	-0.001	0.000	0.001	12:11:32
F1	284°16'36"	89°30'38"	40.898	-0°00'09"	-0°00'01"	0.001	0.001	0.000	12:12:10
F2	284°16'54"	89°30'44"	40.896	0°00'10"	0°00'05"	-0.001	-0.001	0.001	12:13:00
F1	284°16'38"	89°30'36"	40.897	-0°00'07"	-0°00'03"	0.001	0.000	-0.001	12:13:38
F2	284°16'42"	89°30'45"	40.898	-0°00'03"	0°00'06"	0.001	0.001	0.001	12:14:31
F1	284°16'50"	89°30'37"	40.897	0°00'04"	-0°00'02"	-0.002	0.000	-0.001	12:15:15
F2	284°16'53"	89°30'47"	40.896	0°00'08"	0°00'08"	-0.001	-0.001	0.001	12:16:13
F1	284°16'38"	89°30'33"	40.897	-0°00'07"	-0°00'06"	0.001	0.001	-0.001	12:16:54
F2	284°16'50"	89°30'33"	40.896	0°00'05"	-0°00'06"	0.000	-0.001	-0.001	12:17:53
MTA	284°16'45"	89°30'39"	40.897	0°00'00"	0°00'00"	0.000	0.000	0.000	12:19:14

Point Name	401B	**Point Code**	CP/REF	**Class**	Mean turned angle (MTA)
North	5049.064	**East**	9967.695	**Elevation**	1005.216
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	326°38'16"	85°15'08"	58.946	-0°00'02"	-0°00'09"	0.000	0.000	-0.003	12:10:24
F2	326°38'20"	85°15'24"	58.945	0°00'01"	0°00'06"	0.001	0.001	0.001	12:11:21

F1	326°38'17"	85°15'13"	58.949	0°00'00"	-0°00'04"	-0.002	0.002	-0.002	12:12:19
F2	326°38'22"	85°15'22"	58.945	0°00'05"	0°00'05"	0.001	-0.001	0.001	12:12:51
F1	326°38'16"	85°15'14"	58.946	-0°00'01"	-0°00'03"	0.000	0.000	-0.001	12:13:47
F2	326°38'21"	85°15'25"	58.945	0°00'04"	0°00'07"	0.001	0.000	0.002	12:14:21
F1	326°38'19"	85°15'15"	58.945	0°00'01"	-0°00'02"	0.000	-0.001	-0.001	12:15:26
F2	326°38'20"	85°15'24"	58.946	0°00'02"	0°00'06"	0.001	0.001	0.001	12:16:01
F1	326°38'05"	85°15'04"	58.946	-0°00'13"	-0°00'13"	0.002	0.003	-0.004	12:17:05
F2	326°38'21"	85°15'24"	58.945	0°00'04"	0°00'07"	0.000	0.000	0.002	12:17:43
MTA	326°38'18"	85°15'17"	58.946	0°00'00"	0°00'00"	0.000	0.000	0.000	12:19:14

Point Name	401C	**Point Code**	CP/REF	**Class**	Mean turned angle (MTA)
North	5062.773	**East**	10014.248	**Elevation**	1008.657
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	12°47'08"	82°58'02"	64.857	-0°00'13"	-0°00'12"	0.000	0.003	-0.004	12:10:56
F2	12°47'25"	82°58'26"	64.858	0°00'04"	0°00'11"	-0.002	-0.001	0.003	12:11:13
F1	12°47'12"	82°58'10"	64.856	-0°00'08"	-0°00'04"	0.000	0.002	-0.001	12:12:29
F2	12°47'25"	82°58'18"	64.858	0°00'05"	0°00'03"	-0.001	-0.001	0.001	12:12:42
F1	12°47'21"	82°58'07"	64.856	0°00'01"	-0°00'07"	0.001	-0.001	-0.002	12:13:56
F2	12°47'26"	82°58'28"	64.858	0°00'06"	0°00'14"	-0.002	-0.002	0.004	12:14:10
F1	12°47'14"	82°58'07"	64.858	-0°00'07"	-0°00'07"	-0.001	0.001	-0.003	12:15:36
F2	12°47'28"	82°58'21"	64.856	0°00'07"	0°00'06"	0.001	-0.001	0.002	12:15:51
F1	12°47'21"	82°58'06"	64.857	0°00'01"	-0°00'08"	0.000	-0.001	-0.003	12:17:15
F2	12°47'24"	82°58'18"	64.858	0°00'04"	0°00'04"	-0.001	-0.001	0.001	12:17:29
MTA	12°47'20"	82°58'14"	64.857	0°00'00"	0°00'00"	0.000	0.000	0.000	12:19:14

Point Name	402	**Point Code**	CP	**Class**	Mean turned angle (MTA)
North	4538.677	**East**	10000.000	**Elevation**	958.273
Nbr of Obs	13				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	180°00'00"	95°13'14"	463.243	-0°00'03"	-0°00'00"	0.001	0.000	-0.001	11:58:08
F2	180°00'07"	95°13'15"	463.242	0°00'03"	0°00'00"	0.000	0.000	0.001	12:03:53
F1	180°00'00"	95°13'09"	463.241	0°00'00"	-0°00'05"	0.000	0.000	-0.012	12:04:20
F1	180°00'00"	95°13'15"	463.243	-0°00'03"	0°00'01"	0.001	0.000	0.002	12:08:48
F2	180°00'06"	95°13'17"	463.242	0°00'03"	0°00'02"	0.000	0.000	0.006	12:11:43
F1	180°00'00"	95°13'11"	463.242	-0°00'02"	-0°00'04"	0.001	0.000	-0.009	12:11:59

F2	180°00'04"	95°13'16"	463.243	0°00'02"	0°00'02"	0.000	0.000	0.004	12:13:11
F1	180°00'00"	95°13'11"	463.243	-0°00'02"	-0°00'04"	0.002	0.000	-0.008	12:13:26
F2	180°00'04"	95°13'19"	463.242	0°00'02"	0°00'04"	0.000	0.000	0.010	12:14:44
F1	180°00'00"	95°13'12"	463.242	-0°00'03"	-0°00'02"	0.001	0.000	-0.005	12:15:02
F2	180°00'06"	95°13'17"	463.242	0°00'03"	0°00'03"	-0.001	0.000	0.006	12:16:25
F1	180°00'00"	95°13'09"	463.242	-0°00'03"	-0°00'05"	0.001	0.000	-0.012	12:16:41
F2	180°00'05"	95°13'18"	463.243	0°00'03"	0°00'03"	0.000	0.000	0.008	12:18:03
MTA	180°00'03"	95°13'14"	463.242	0°00'00"	0°00'00"	0.000	0.000	0.000	12:19:14

Station Setup

Point Name	401	**Point Code**	CP	**Inst ht**	5.040
North	5000.000	**East**	10000.000	**Elevation**	1000.000

Point Name	402	**Point Code**	CP	**Class**	Mean turned angle (MTA)
North	4538.677	**East**	10000.000	**Elevation**	958.273
Nbr of Obs	1				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	180°00'00"	95°13'15"	463.234			-0.007	0.000	0.012	13:29:35

Station Setup

Point Name	401	**Point Code**	CP	**Inst ht**	5.040
North	5000.000	**East**	10000.000	**Elevation**	1000.000

Point Name	402	**Point Code**	CP	**Class**	Mean turned angle (MTA)
North	4538.677	**East**	10000.000	**Elevation**	958.273
Nbr of Obs	1				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	180°00'00"	95°13'17"	463.239			-0.002	0.000	0.015	13:35:46

Station Setup

Point Name	402	**Point Code**	CP	**Inst ht**	4.640
North	4538.677	**East**	10000.000	**Elevation**	958.273

Point Name	401	Point Code	CP	Class	Entered coordinates (Control)
North	5000.000	East	10000.000	Elevation	1000.000
Nbr of Obs	20				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	0°00'00"	84°46'36"	463.231	-359°59'57"	-0°00'08"	0.012	0.000	-0.018	15:13:57
F2	359°59'55"	84°46'55"	463.232	-0°00'03"	0°00'10"	0.008	0.000	0.023	15:18:57
F1	0°00'00"	84°46'37"	463.231	-0°00'06"	-0°00'08"	0.012	0.000	-0.016	15:19:15
F2	0°00'11"	84°46'52"	463.231	0°00'06"	0°00'07"	0.009	0.000	0.017	15:20:51
F1	0°00'00"	84°46'37"	463.231	-0°00'04"	-0°00'08"	0.012	0.000	-0.018	15:21:08
F2	0°00'09"	84°46'52"	463.233	0°00'04"	0°00'07"	0.007	0.000	0.017	15:22:45
F1	0°00'00"	84°46'38"	463.232	-0°00'06"	-0°00'07"	0.011	0.000	-0.015	15:23:07
F2	0°00'12"	84°46'52"	463.232	0°00'06"	0°00'07"	0.008	0.000	0.015	15:24:52
F1	0°00'00"	84°46'40"	463.232	-0°00'06"	-0°00'05"	0.011	0.000	-0.011	15:25:10
F2	0°00'13"	84°46'50"	463.232	0°00'06"	0°00'05"	0.009	0.000	0.013	15:26:48
MTA	0°00'06"	84°46'45"	463.232	0°00'00"	0°00'00"	0.010	0.000	0.001	15:27:32
F1	0°00'00"	84°46'30"	463.231	-0°00'05"	-0°00'14"	0.014	0.000	-0.032	15:32:36
F2	0°00'11"	84°46'52"	463.231	0°00'05"	0°00'07"	0.009	0.000	0.016	15:34:10
F1	0°00'00"	84°46'39"	463.231	-0°00'06"	-0°00'06"	0.011	0.000	-0.013	15:34:30
F2	0°00'13"	84°46'53"	463.231	0°00'06"	0°00'08"	0.009	0.000	0.019	15:35:11
F1	0°00'00"	84°46'36"	463.231	-0°00'06"	-0°00'09"	0.013	0.000	-0.019	15:35:29
F2	0°00'12"	84°46'53"	463.231	0°00'06"	0°00'08"	0.009	0.000	0.018	15:36:14
F1	0°00'00"	84°46'39"	463.231	-0°00'06"	-0°00'06"	0.012	0.000	-0.013	15:36:33
F2	0°00'13"	84°46'52"	463.232	0°00'06"	0°00'07"	0.008	0.000	0.015	15:37:17
F1	0°00'00"	84°46'38"	463.232	-0°00'04"	-0°00'07"	0.011	0.000	-0.014	15:37:37
F2	0°00'08"	84°46'52"	463.233	0°00'04"	0°00'08"	0.007	0.000	0.017	15:38:20
MTA	0°00'04"	84°46'44"	463.232	0°00'00"	-0°00'01"	0.010	0.000	-0.001	15:38:56

Point Name	402A	Point Code	CP/REF	Class	Mean turned angle (MTA)
North	4384.201	East	10213.304	Elevation	931.224
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	125°54'44"	95°51'05"	264.744	-0°00'05"	-0°00'07"	0.000	-0.001	-0.009	15:33:31
F2	125°54'54"	95°51'19"	264.744	0°00'05"	0°00'06"	-0.001	0.000	0.008	15:33:55
F1	125°54'54"	95°51'07"	264.742	0°00'03"	-0°00'05"	0.009	0.008	-0.007	15:34:44
F2	125°54'54"	95°51'15"	264.745	0°00'04"	0°00'02"	-0.002	-0.003	0.003	15:34:59

F1	125°54'46"	95°51'06"	264.742	-0°00'04"	-0°00'07"	0.002	0.002	-0.009	15:35:44
F2	125°54'53"	95°51'19"	264.743	0°00'03"	0°00'06"	-0.004	-0.001	0.008	15:36:00
F1	125°54'45"	95°51'07"	264.744	-0°00'06"	-0°00'06"	0.002	-0.001	-0.008	15:36:47
F2	125°54'51"	95°51'21"	264.744	0°00'01"	0°00'08"	-0.006	-0.004	0.010	15:37:02
F1	125°54'43"	95°51'06"	264.743	-0°00'05"	-0°00'07"	-0.001	-0.001	-0.009	15:37:51
F2	125°54'52"	95°51'22"	264.744	0°00'04"	0°00'10"	-0.001	0.000	0.012	15:38:06
MTA	125°54'48"	95°51'13"	264.743	0°00'00"	0°00'00"	0.000	0.000	0.000	15:38:56

Point Name	402B	**Point Code**	CP/REF	**Class**	Mean turned angle (MTA)
North	4475.231	**East**	9976.032	**Elevation**	957.869
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	200°41'30"	89°51'58"	67.822	-0°00'10"	-0°00'08"	0.002	-0.004	-0.002	15:16:15
F2	200°41'38"	89°52'17"	67.822	-0°00'02"	0°00'10"	0.000	0.000	0.004	15:18:44
F1	200°41'49"	89°51'58"	67.821	0°00'01"	-0°00'09"	-0.001	0.002	-0.003	15:19:30
F2	200°41'52"	89°52'15"	67.821	0°00'04"	0°00'08"	0.000	-0.001	0.003	15:20:37
F1	200°41'45"	89°52'00"	67.822	-0°00'02"	-0°00'07"	0.000	0.001	-0.002	15:21:25
F2	200°41'51"	89°52'15"	67.821	0°00'04"	0°00'09"	0.000	0.000	0.003	15:22:31
F1	200°41'47"	89°51'58"	67.823	-0°00'01"	-0°00'08"	0.001	0.002	-0.002	15:23:25
F2	200°41'55"	89°52'14"	67.821	0°00'06"	0°00'07"	-0.001	0.000	0.003	15:24:38
F1	200°41'47"	89°51'58"	67.821	-0°00'02"	-0°00'08"	-0.001	0.001	-0.002	15:25:26
F2	200°41'53"	89°52'13"	67.821	0°00'04"	0°00'07"	0.000	-0.001	0.003	15:26:35
MTA	200°41'49"	89°52'07"	67.821	0°00'00"	0°00'00"	0.000	0.000	0.000	15:27:32

Point Name	402C	**Point Code**	CP/REF	**Class**	Mean turned angle (MTA)
North	4497.388	**East**	9941.007	**Elevation**	961.917
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	235°00'31"	87°01'18"	72.103	-0°00'09"	-0°00'08"	0.004	-0.002	-0.002	15:17:08
F2	235°00'35"	87°01'32"	72.104	-0°00'05"	0°00'06"	0.001	0.000	0.003	15:18:33
F1	235°00'48"	87°01'19"	72.103	-0°00'01"	-0°00'07"	-0.001	0.000	-0.002	15:19:42
F2	235°00'52"	87°01'34"	72.104	0°00'04"	0°00'08"	0.002	0.000	0.003	15:20:25
F1	235°00'45"	87°01'19"	72.102	-0°00'02"	-0°00'07"	-0.001	-0.001	-0.002	15:21:37
F2	235°00'49"	87°01'33"	72.104	0°00'02"	0°00'07"	0.001	0.000	0.003	15:22:19
F1	235°00'49"	87°01'19"	72.103	0°00'00"	-0°00'07"	-0.002	0.001	-0.002	15:23:38
F2	235°00'53"	87°01'33"	72.102	0°00'04"	0°00'07"	0.000	-0.001	0.003	15:24:21

F1	235°00'49"	87°01'21"	72.104	-0°00'00"	-0°00'05"	-0.001	0.001	-0.001	15:25:38
F2	235°00'55"	87°01'32"	72.103	0°00'06"	0°00'06"	0.001	0.000	0.003	15:26:22
MTA	235°00'49"	87°01'26"	72.103	0°00'00"	0°00'00"	0.000	0.000	0.000	15:27:32

Point Name	402D	**Point Code**	CP/REF	**Class**	Mean turned angle (MTA)
North	4595.816	**East**	9977.583	**Elevation**	958.771
Nbr of Obs	10				

Obs	**Hz Angle**	**Vt Angle**	**Sl Dist**	**Delta HA**	**Delta VA**	**Delta N**	**Delta E**	**Delta Z**	**Time**
F1	338°34'32"	89°07'19"	61.386	-0°00'10"	-0°00'08"	0.001	0.003	-0.003	15:17:59
F2	338°34'38"	89°07'32"	61.386	-0°00'04"	0°00'06"	0.000	0.000	0.001	15:18:19
F1	338°34'50"	89°07'21"	61.387	-0°00'01"	-0°00'05"	-0.001	-0.001	-0.002	15:19:57
F2	338°34'55"	89°07'34"	61.386	0°00'04"	0°00'08"	0.000	0.000	0.002	15:20:11
F1	338°34'48"	89°07'19"	61.386	-0°00'01"	-0°00'07"	0.000	-0.001	-0.003	15:21:50
F2	338°34'52"	89°07'33"	61.386	0°00'03"	0°00'06"	0.000	0.000	0.001	15:22:06
F1	338°34'51"	89°07'19"	61.387	0°00'00"	-0°00'08"	-0.001	-0.002	-0.003	15:23:52
F2	338°34'56"	89°07'34"	61.386	0°00'05"	0°00'08"	0.000	0.000	0.002	15:24:07
F1	338°34'51"	89°07'19"	61.387	-0°00'00"	-0°00'08"	-0.001	-0.002	-0.003	15:25:56
F2	338°34'56"	89°07'34"	61.387	0°00'05"	0°00'08"	-0.001	0.000	0.002	15:26:09
MTA	338°34'51"	89°07'26"	61.386	0°00'00"	0°00'00"	0.000	0.000	0.000	15:27:32

Monitoring Report

Job Name	16_1512_argo_1
Version	2.22
Distance units	USSurveyFeet
Angle units	DMSDegrees
Pressure units	InchHg
Temperature units	Fahrenheit

Station Setup

Point Name	401	**Point Code**	CP	**Inst ht**	5.120
North	5000.000	**East**	10000.000	**Elevation**	1000.000

Point Name	1	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4838.146	**East**	9943.731	**Elevation**	989.207
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	199°10'09"	95°18'16"	172.094	-0°00'03"	-0°00'05"	0.002	-0.002	-0.004	11:31:24
F2	199°10'10"	95°18'30"	172.093	-0°00'02"	0°00'09"	0.000	-0.001	0.008	11:36:31
F1	199°10'15"	95°18'10"	172.093	0°00'01"	-0°00'11"	0.000	0.003	-0.009	11:37:10
F2	199°10'16"	95°18'30"	172.093	0°00'01"	0°00'09"	-0.001	-0.001	0.007	11:40:47
F1	199°10'13"	95°18'13"	172.093	-0°00'03"	-0°00'08"	0.000	0.000	-0.007	11:41:25
F2	199°10'20"	95°18'31"	172.095	0°00'04"	0°00'11"	0.001	0.001	0.009	11:45:02
F1	199°10'18"	95°18'07"	172.093	0°00'03"	-0°00'14"	-0.001	0.004	-0.012	11:45:40
F2	199°10'19"	95°18'30"	172.093	0°00'04"	0°00'10"	-0.002	0.001	0.008	11:49:18
F1	199°10'13"	95°18'09"	172.094	-0°00'04"	-0°00'11"	0.002	0.001	-0.009	11:49:56
F2	199°10'18"	95°18'29"	172.093	0°00'01"	0°00'09"	0.001	-0.003	0.007	11:53:39
MTA	199°10'17"	95°18'21"	172.093	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	10	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4589.563	**East**	9799.263	**Elevation**	989.372
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	206°03'39"	91°58'17"	457.165	-0°00'05"	-0°00'11"	0.006	-0.010	-0.025	11:34:13
F2	206°03'46"	91°58'38"	457.165	0°00'02"	0°00'10"	-0.004	0.005	0.022	11:34:55

F1	206°03'42"	91°58'22"	457.164	-0°00'05"	-0°00'06"	0.002	-0.006	-0.014	11:38:42
F2	206°03'50"	91°58'36"	457.166	0°00'03"	0°00'08"	-0.002	0.002	0.017	11:39:16
F1	206°03'41"	91°58'23"	457.165	-0°00'07"	-0°00'05"	0.003	-0.007	-0.012	11:42:57
F2	206°03'50"	91°58'37"	457.165	0°00'02"	0°00'08"	0.000	-0.003	0.018	11:43:31
F1	206°03'43"	91°58'25"	457.164	-0°00'04"	-0°00'03"	0.001	-0.004	-0.007	11:47:10
F2	206°03'53"	91°58'34"	457.166	0°00'06"	0°00'05"	-0.004	0.009	0.011	11:47:44
F1	206°03'51"	91°58'25"	457.165	0°00'02"	-0°00'03"	-0.006	0.013	-0.007	11:51:29
F2	206°03'54"	91°58'26"	457.165	0°00'05"	-0°00'02"	-0.001	0.002	-0.006	11:52:07
MTA	206°03'49"	91°58'28"	457.165	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	11	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4561.923	**East**	9783.357	**Elevation**	989.268
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	206°18'45"	91°51'24"	488.974	-0°00'04"	-0°00'06"	0.006	-0.010	-0.015	11:34:26
F2	206°18'51"	91°51'39"	488.974	0°00'02"	0°00'09"	-0.004	0.006	0.022	11:34:43
F1	206°18'52"	91°51'24"	488.975	0°00'00"	-0°00'06"	-0.001	0.005	-0.014	11:38:52
F2	206°18'58"	91°51'31"	488.974	0°00'06"	0°00'01"	-0.004	0.009	0.003	11:39:06
F1	206°18'46"	91°51'27"	488.972	-0°00'07"	-0°00'03"	0.003	-0.009	-0.007	11:43:06
F2	206°18'53"	91°51'38"	488.973	-0°00'00"	0°00'08"	0.003	-0.008	0.019	11:43:21
F1	206°18'53"	91°51'31"	488.973	0°00'01"	0°00'01"	-0.003	0.006	0.002	11:47:20
F2	206°18'54"	91°51'33"	488.973	0°00'01"	0°00'03"	0.000	-0.002	0.007	11:47:34
F1	206°18'51"	91°51'24"	488.974	-0°00'03"	-0°00'06"	0.000	0.003	-0.015	11:51:40
F2	206°18'58"	91°51'28"	488.973	0°00'04"	-0°00'02"	0.000	0.001	-0.004	11:51:55
MTA	206°18'54"	91°51'30"	488.974	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	2	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4810.319	**East**	9927.791	**Elevation**	989.382
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	200°50'26"	94°25'56"	203.569	-0°00'01"	-0°00'08"	0.001	-0.002	-0.007	11:31:40
F2	200°50'29"	94°26'14"	203.570	0°00'02"	0°00'11"	-0.001	0.002	0.011	11:36:20
F1	200°50'29"	94°25'53"	203.568	-0°00'01"	-0°00'10"	0.000	0.001	-0.010	11:37:21
F2	200°50'32"	94°26'10"	203.571	0°00'02"	0°00'07"	0.001	0.000	0.007	11:40:37
F1	200°50'28"	94°25'54"	203.570	-0°00'03"	-0°00'09"	0.001	0.000	-0.009	11:41:34
F2	200°50'33"	94°26'14"	203.569	0°00'02"	0°00'10"	0.000	-0.002	0.010	11:44:52

F1	200°50'28"	94°25'53"	203.570	-0°00'02"	-0°00'11"	0.002	0.000	-0.010	11:45:49
F2	200°50'33"	94°26'16"	203.570	0°00'03"	0°00'13"	0.000	0.000	0.013	11:49:07
F1	200°50'29"	94°25'51"	203.569	-0°00'03"	-0°00'13"	0.001	0.001	-0.012	11:50:05
F2	200°50'33"	94°26'12"	203.568	0°00'01"	0°00'09"	-0.001	-0.004	0.009	11:53:28
MTA	200°50'32"	94°26'03"	203.570	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	3	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4782.981	**East**	9911.637	**Elevation**	989.280
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	202°09'14"	93°51'57"	234.851	-0°00'01"	-0°00'06"	0.000	-0.003	-0.008	11:32:26
F2	202°09'16"	93°52'15"	234.853	0°00'01"	0°00'12"	-0.001	0.001	0.013	11:36:09
F1	202°09'18"	93°51'53"	234.854	-0°00'01"	-0°00'10"	0.001	0.002	-0.012	11:37:31
F2	202°09'18"	93°52'11"	234.852	0°00'00"	0°00'08"	0.000	-0.002	0.009	11:40:28
F1	202°09'19"	93°51'54"	234.853	0°00'00"	-0°00'10"	0.000	0.004	-0.011	11:41:44
F2	202°09'24"	93°52'14"	234.851	0°00'05"	0°00'11"	-0.003	0.000	0.012	11:44:41
F1	202°09'19"	93°51'51"	234.853	0°00'01"	-0°00'13"	0.000	0.003	-0.014	11:46:00
F2	202°09'21"	93°52'15"	234.853	0°00'03"	0°00'12"	-0.001	0.000	0.013	11:48:57
F1	202°09'15"	93°51'52"	234.852	-0°00'05"	-0°00'12"	0.001	-0.001	-0.013	11:50:17
F2	202°09'18"	93°52'11"	234.851	-0°00'02"	0°00'08"	0.001	-0.008	0.009	11:53:18
MTA	202°09'20"	93°52'03"	234.852	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	4	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4755.120	**East**	9895.519	**Elevation**	989.381
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	203°06'18"	93°22'50"	266.701	-0°00'03"	-0°00'10"	0.002	-0.004	-0.013	11:32:41
F2	203°06'22"	93°23'11"	266.701	0°00'00"	0°00'10"	-0.002	0.001	0.013	11:35:59
F1	203°06'26"	93°22'49"	266.701	0°00'02"	-0°00'12"	-0.001	0.005	-0.015	11:37:40
F2	203°06'26"	93°23'09"	266.701	0°00'02"	0°00'08"	-0.001	0.000	0.010	11:40:18
F1	203°06'22"	93°22'50"	266.703	-0°00'04"	-0°00'10"	0.002	0.000	-0.014	11:41:55
F2	203°06'28"	93°23'13"	266.701	0°00'03"	0°00'12"	-0.001	0.000	0.016	11:44:30
F1	203°06'23"	93°22'56"	266.702	-0°00'02"	-0°00'04"	0.001	0.002	-0.006	11:46:09
F2	203°06'29"	93°23'12"	266.701	0°00'05"	0°00'12"	-0.003	0.003	0.014	11:48:42
F1	203°06'25"	93°22'49"	266.701	-0°00'02"	-0°00'11"	-0.001	0.003	-0.015	11:50:26
F2	203°06'26"	93°23'05"	266.701	-0°00'01"	0°00'05"	0.002	-0.006	0.006	11:53:08

MTA	203°06'27"	93°23'00"	266.701	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	402	**Point Code**	CP	**Class**	Mean turned angle (MTA)
North	4538.683	**East**	10000.000	**Elevation**	958.264
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	180°00'00"	95°11'57"	463.223	0°00'01"	-0°00'06"	0.003	0.000	-0.013	11:29:28
F2	179°59'59"	95°12'12"	463.222	-0°00'01"	0°00'09"	-0.002	0.000	0.020	11:36:40
F1	180°00'00"	95°11'51"	463.222	-0°00'02"	-0°00'12"	0.002	0.000	-0.027	11:36:58
F2	180°00'04"	95°12'16"	463.222	0°00'02"	0°00'12"	-0.003	0.000	0.028	11:40:57
F1	180°00'00"	95°11'51"	463.222	-0°00'03"	-0°00'12"	0.003	0.000	-0.027	11:41:14
F2	180°00'06"	95°12'18"	463.222	0°00'03"	0°00'14"	-0.002	0.000	0.032	11:45:12
F1	180°00'00"	95°11'50"	463.222	-0°00'02"	-0°00'13"	0.003	0.000	-0.029	11:45:29
F2	180°00'04"	95°12'14"	463.221	0°00'02"	0°00'11"	-0.003	0.000	0.024	11:49:27
F1	180°00'00"	95°11'51"	463.222	-0°00'04"	-0°00'12"	0.003	0.000	-0.028	11:49:45
F2	180°00'08"	95°12'14"	463.222	0°00'04"	0°00'10"	-0.002	0.000	0.023	11:53:49
MTA	180°00'04"	95°12'03"	463.222	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	5	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4727.678	**East**	9879.419	**Elevation**	989.332
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	203°52'54"	93°01'55"	298.242	-0°00'05"	-0°00'10"	0.005	-0.007	-0.014	11:32:58
F2	203°53'01"	93°02'14"	298.240	0°00'02"	0°00'08"	-0.003	0.003	0.012	11:35:48
F1	203°52'58"	93°01'58"	298.240	-0°00'04"	-0°00'08"	0.001	-0.002	-0.011	11:37:51
F2	203°53'04"	93°02'13"	298.240	0°00'02"	0°00'08"	-0.002	-0.001	0.011	11:40:08
F1	203°52'58"	93°01'56"	298.239	-0°00'05"	-0°00'09"	0.000	-0.002	-0.013	11:42:06
F2	203°53'07"	93°02'17"	298.242	0°00'04"	0°00'11"	-0.001	0.001	0.017	11:44:21
F1	203°53'06"	93°01'59"	298.242	0°00'04"	-0°00'07"	-0.003	0.009	-0.010	11:46:19
F2	203°53'04"	93°02'16"	298.242	0°00'03"	0°00'10"	0.000	0.001	0.015	11:48:34
F1	203°53'02"	93°01'54"	298.241	-0°00'02"	-0°00'12"	-0.001	0.004	-0.017	11:50:36
F2	203°53'05"	93°02'14"	298.240	0°00'01"	0°00'09"	0.001	-0.005	0.013	11:52:58
MTA	203°53'04"	93°02'06"	298.241	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	6	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4700.218	**East**	9863.311	**Elevation**	989.402

Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	204°30'35"	92°43'45"	329.847	-0°00'05"	-0°00'09"	0.004	-0.008	-0.014	11:33:11
F2	204°30'41"	92°44'05"	329.848	0°00'01"	0°00'10"	-0.002	0.003	0.017	11:35:38
F1	204°30'41"	92°43'41"	329.848	-0°00'01"	-0°00'14"	0.000	0.002	-0.022	11:38:00
F2	204°30'46"	92°44'03"	329.847	0°00'03"	0°00'08"	-0.002	0.002	0.014	11:39:58
F1	204°30'41"	92°43'45"	329.847	-0°00'03"	-0°00'09"	0.000	0.001	-0.014	11:42:17
F2	204°30'47"	92°44'05"	329.847	0°00'03"	0°00'10"	-0.001	0.000	0.017	11:44:12
F1	204°30'41"	92°43'48"	329.847	-0°00'02"	-0°00'06"	0.000	0.001	-0.010	11:46:30
F2	204°30'48"	92°44'01"	329.847	0°00'05"	0°00'07"	-0.003	0.005	0.011	11:48:23
F1	204°30'41"	92°43'45"	329.847	-0°00'04"	-0°00'09"	0.000	0.001	-0.014	11:50:47
F2	204°30'45"	92°44'05"	329.847	0°00'01"	0°00'11"	0.001	-0.005	0.018	11:52:48
MTA	204°30'44"	92°43'54"	329.847	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	7	Point Code	PIER	Class	Mean turned angle (MTA)
North	4672.273	East	9847.208	Elevation	989.344
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	204°59'37"	92°29'44"	361.938	-0°00'07"	-0°00'10"	0.007	-0.011	-0.019	11:33:26
F2	204°59'45"	92°30'06"	361.936	0°00'01"	0°00'11"	-0.003	0.002	0.019	11:35:27
F1	204°59'45"	92°29'44"	361.937	-0°00'02"	-0°00'11"	0.001	0.000	-0.020	11:38:11
F2	204°59'50"	92°30'00"	361.938	0°00'03"	0°00'06"	0.000	0.002	0.009	11:39:47
F1	204°59'46"	92°29'46"	361.936	-0°00'02"	-0°00'09"	-0.001	0.002	-0.016	11:42:26
F2	204°59'50"	92°30'03"	361.937	0°00'02"	0°00'08"	0.001	-0.002	0.013	11:44:02
F1	204°59'46"	92°29'50"	361.937	-0°00'01"	-0°00'05"	0.000	0.002	-0.009	11:46:40
F2	204°59'53"	92°30'03"	361.938	0°00'06"	0°00'08"	-0.002	0.006	0.014	11:48:13
F1	204°59'46"	92°29'47"	361.937	-0°00'03"	-0°00'08"	0.000	0.002	-0.014	11:50:58
F2	204°59'52"	92°30'05"	361.938	0°00'04"	0°00'11"	0.000	-0.001	0.018	11:52:38
MTA	204°59'49"	92°29'55"	361.937	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	8	Point Code	PIER	Class	Mean turned angle (MTA)
North	4644.602	East	9831.363	Elevation	989.431
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	205°23'01"	92°16'55"	393.690	-0°00'02"	-0°00'09"	0.003	-0.004	-0.017	11:33:41

F2	205°23'04"	92°17'14"	393.689	0°00'01"	0°00'10"	-0.002	0.002	0.019	11:35:17
F1	205°23'08"	92°16'54"	393.689	0°00'02"	-0°00'10"	-0.003	0.007	-0.019	11:38:23
F2	205°23'08"	92°17'13"	393.690	0°00'02"	0°00'09"	0.000	-0.001	0.018	11:39:36
F1	205°23'01"	92°16'57"	393.688	-0°00'06"	-0°00'07"	0.002	-0.005	-0.013	11:42:37
F2	205°23'08"	92°17'13"	393.690	0°00'01"	0°00'09"	0.003	-0.004	0.017	11:43:52
F1	205°23'09"	92°16'58"	393.690	0°00'03"	-0°00'06"	-0.003	0.009	-0.011	11:46:49
F2	205°23'10"	92°17'11"	393.690	0°00'04"	0°00'07"	-0.001	0.003	0.013	11:48:04
F1	205°23'07"	92°16'56"	393.690	-0°00'01"	-0°00'08"	-0.001	0.005	-0.014	11:51:09
F2	205°23'05"	92°17'10"	393.690	-0°00'03"	0°00'06"	0.006	-0.013	0.011	11:52:27
MTA	205°23'08"	92°17'04"	393.689	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Point Name	9	**Point Code**	PIER	**Class**	Mean turned angle (MTA)
North	4616.817	**East**	9815.403	**Elevation**	989.518
Nbr of Obs	10				

Obs	Hz Angle	Vt Angle	Sl Dist	Delta HA	Delta VA	Delta N	Delta E	Delta Z	Time
F1	205°43'15"	92°05'51"	425.614	-0°00'04"	-0°00'14"	0.005	-0.009	-0.028	11:33:59
F2	205°43'21"	92°06'12"	425.614	0°00'02"	0°00'08"	-0.003	0.003	0.016	11:35:05
F1	205°43'23"	92°05'53"	425.613	0°00'01"	-0°00'12"	-0.003	0.006	-0.024	11:38:33
F2	205°43'25"	92°06'16"	425.614	0°00'03"	0°00'11"	-0.001	0.001	0.023	11:39:26
F1	205°43'19"	92°05'53"	425.615	-0°00'04"	-0°00'12"	0.003	-0.001	-0.024	11:42:46
F2	205°43'23"	92°06'14"	425.614	0°00'00"	0°00'09"	0.002	-0.006	0.018	11:43:42
F1	205°43'22"	92°05'59"	425.614	-0°00'00"	-0°00'05"	-0.002	0.004	-0.011	11:46:59
F2	205°43'26"	92°06'17"	425.615	0°00'04"	0°00'12"	-0.001	0.003	0.025	11:47:54
F1	205°43'22"	92°05'57"	425.616	-0°00'02"	-0°00'07"	0.000	0.005	-0.015	11:51:19
F2	205°43'24"	92°06'14"	425.614	0°00'00"	0°00'09"	0.003	-0.008	0.018	11:52:17
MTA	205°43'24"	92°06'05"	425.614	0°00'00"	0°00'00"	0.000	0.000	0.000	11:54:32

Appendices d. Vertical Leveling Sheets

Field Notes Vertical Leveling / Baseline Survey 10-19-2015
Field Notes Vertical Leveling / Baseline Survey

Argonaut Dam Leveling
Date: 10-19-2015

	Point	+'	HI	-'	Rod	Elevations	Description
	401					1000.000	Brass Cap
		2.596	1002.596				
1				6.976		995.620	
		1.644	997.264				
2				8.386		988.878	
		4.893	993.771				
3	BM-L			4.936		988.835	BM-L
		3.301	992.136				
					3.140	988.996	Pier 1
					2.960	989.176	Pier 2
					3.064	989.072	Pier 3
					2.964	989.172	Pier 4
					3.014	989.122	Pier 5
					2.944	989.192	Pier 6
4	Pier 7			3.003		989.133	Pier 7
		2.681	991.814				
					2.597	989.217	Pier 8
					2.506	989.308	Pier 9
					2.656	989.158	Pier 10
					2.768	989.046	Pier 11
5	BM-R			3.067		988.747	BM-R
		2.879	991.626				
6				6.429		985.197	
		6.595	991.792				
7				2.959		988.833	
		4.728	993.561				
8				4.799		988.762	
		8.359	997.121				
9				1.510		995.611	
		7.005	1002.616				
10				2.618		999.998	Closing Elevation
						1000.000	Initinal Elevation
						-0.002	Misclosure
						0.000	

Argonaut Dam Leveling
Date: 10-20-2015

Point	+'	HI	-'	Rod	Elevations	Description
401					1000.000	Brass Cap
	3.546	1003.546				
			7.924		995.622	
	1.426	997.048				
			8.282		988.766	
	4.946	993.712				
BM-L			4.875		988.837	BM-L
	2.964	991.801				
				2.804	988.997	Pier 1
				2.628	989.173	Pier 2
				2.729	989.072	Pier 3
				2.627	989.174	Pier 4
				2.676	989.125	Pier 5
				2.608	989.193	Pier 6
				2.664	989.137	Pier 7
			6.623		985.178	TP
	6.529	991.707				
				2.485	989.222	Pier 8
				2.393	989.314	Pier 9
				2.544	989.163	Pier 10
				2.656	989.051	Pier 11
			2.955		988.752	BM-R
	2.887	991.639				
			6.461		985.178	
	6.705	991.883				
			3.047		988.836	
	4.753	993.589				
			4.687		988.902	
	8.196	997.098				
			1.447		995.651	
	7.662	1003.313				
			3.312		1000.001	Closing Elevation
					1000.000	Initial Elevation
					0.001	

Appendices e. Equipment Technical Data Sheet and Specifications

Seco Product 5-114-150 150mm Rebar - Installed Measurement Point
Leica Prism Specification
Leica Tribrach Specification
Leica Prism Offset Technical Data Sheet
Leica TSP1201+ Total Station Instrument Technical Data Sheet
Leica DNA10 Digital Level Technical Data Sheet

PRODUCT BULLETIN

FEATURES & BENEFITS

- Silver-coated prism canister
- 42 mm precision prism
- Holder is constructed of aluminum
- Prism can pivot vertically and rotate with the plug-in pin
- Measuring point is always at center
- Available with prism constant of -30 mm, -34 mm, and -35 mm

APPLICATIONS

- Mining, tunneling, monitoring and rail

www.surveying.com

 032113

High-Quality Precision Prism Assemblies for Long Term Monitoring

Precision Tilting Prism Assemblies

4 520 002

4 520 001

PART NO.	TILTING AXIS HEIGHT	TIP TYPE	WEIGHS
4 520 001	40 mm	10 mm Stud	0.44 lb (0.20 kg)
4 520 002	70 mm	Swiss-Style Quick-Release	0.66 lb (0.30 kg)

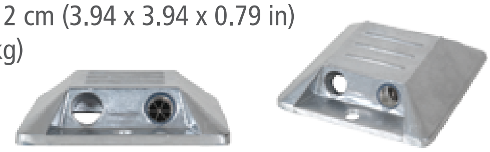
Contact your local SECO dealer today!

sēco PRODUCT BULLETIN

- Special prism for simple and robust assembly can be used in building inspections
- 25 mm prism diameter
- Weighs 0.22 lb (0.10 kg)

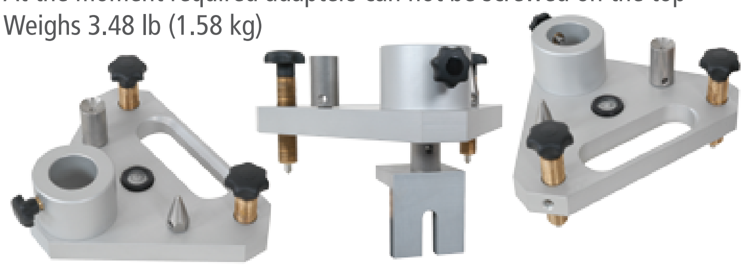
4 520 200 — 25 mm Prism for Building Monitoring

- Prisms with a 12.5 mm diameter in a wedge-shaped aluminum plate inserted as well as to the edge of the road marking
- Plate can be fixed with special adhesive on to the pavement
- Dimensions: 10 x 10 x 2 cm (3.94 x 3.94 x 0.79 in)
- Weighs 0.62 lb (0.28 kg)



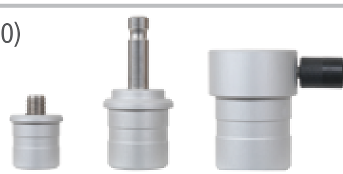
4 520 800 — For Building Monitoring for Mounting on a Street

- Optimal for fast and precise measurement of stopping points without a tripod and pole
- Designed to sit on different measurement points
- Three different adapters included: angle adapter for placing on chamfered edged walls, tip for measuring points with centering, depression adapter for curved measurement points without centering
- Prevents slipping from the point
- The base plate allows all three adapters to rotate freely and is leveled using a spirit level with two screws quickly and accurately
- At the moment required adapters can not be screwed on the top
- Weighs 3.48 lb (1.58 kg)



4 610 000 — 90 mm Height Bottom Plate

- Adapters for bottom plate (4 610 000) and other various prism systems



4 410 000 4 410 001 4 410 002

PART NO.	HEIGHT	TIP TYPE	WEIGHS
4 410 000	5 mm	5/8 x 11	0.26 lb (0.12 kg)
4 410 001	40 mm	Swiss-Style	0.31 lb (0.14 kg)
4 410 002	20 mm	10 mm Tip	0.31 lb (0.14 kg)

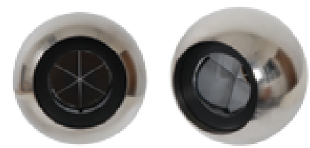
- Swiss-Style stud adapter with M8 threads
- For 100 mm wall distance
- Weighs 0.09 lb (0.04 kg)

5 113 100 — Swiss-Style Adapter with M8 Threads

- Precision mini prism holder constructed of aluminum
- 25 mm diameter prism
- Prism constant is -17 mm
- Tilting axis height 30 mm
- 10 mm stud type
- Weighs 0.22 lb (0.10 kg)

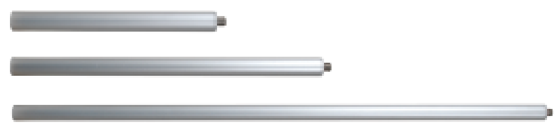
4 520 020 — Mini 25 mm Diameter Prism Tilting Holder

- Prism center is located in center of the ball
- 50 mm diameter
- 25 mm prism
- Weighs 0.75 lb (0.34 kg)



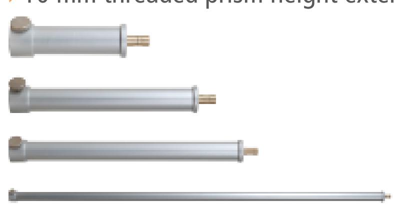
5 312 001 — 50 mm Diameter Prism Ball

- Inserted between the 5/8 x 11 thread prism pole and the prism to enlarge the height of the prism over the point
- Constructed of stainless steel
- 5/8 x 11 threaded prism height extensions



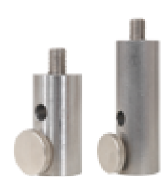
PART NO.	HEIGHT EXTENSION	THREAD TYPE	WEIGHS
4 520 120	30 cm (11.81 in)	5/8 x 11	0.57 lb (0.26 kg)
4 520 122	50 cm (19.68 in)	5/8 x 11	0.79 lb (0.36 kg)
4 520 121-5/8″	100 cm (39.37 in)	5/8 x 11	1.28 lb (0.58 kg)

- Inserted between the 10 mm stud prism pole and the prism to enlarge the height of the prism over the point
- Constructed of stainless steel
- 10 mm threaded prism height extension



PART NO.	HEIGHT EXTENSION	THREAD TYPE	WEIGHS
4 520 130	10 cm (3.94 in)	10 mm Stud	0.35 lb (0.16 kg)
4 520 131	20 cm (7.87 in)	10 mm Stud	0.40 lb (0.18 kg)
4 520 132	30 cm (11.81 in)	10 mm Stud	0.48 lb (0.22 kg)
4 520 133	100 cm (39.37 in)	10 mm Stud	1.06 lb (0.48 kg)

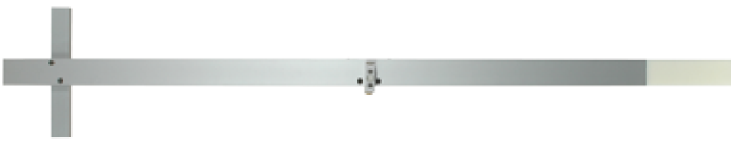
- Adapter is screwed into a M8 wall plug
- Use with 10 mm stud prism
- Wall distance depends on the prism used



PART NO.	LENGTH	WALL DISTANCE	ADAPTER	WEIGHS
5 111 040	40 mm	80 mm	10 mm to M8	0.18 lb (0.08 kg)
5 111 060	60 mm	100 mm	10 mm to M8	0.31 lb (0.14 kg)

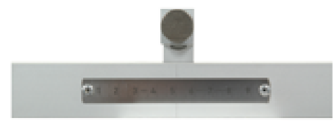
PRODUCT BULLETIN

- Track rod remeasures the track axis
- Can be accurately measured over the track center
- The holder for the prism mounted in the track axis and is rotatable
- When using the prism in the tilt holder of the measuring point is 100 mm perpendicular to the track axis
- Insulation prevents electrical shorting between the two rails
- The stop on the opposite end ensures a clean application to the rail inner edge
- The attack pushes exactly on the reference height of 14 mm below the top of rail to rail
- All track benchmarks are supplied as standard for a track gauge of 1435 mm



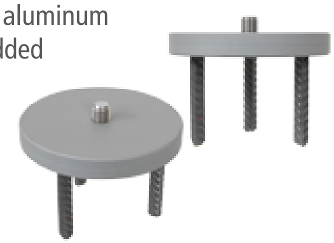
PART NO.	TIP TYPE	WEIGHS
5 230 000	5/8 x 11 Tip	6.26 lb (2.84 kg)
5 230 001	Wild-Style Tip	6.26 lb (2.84 kg)
5 230 002	10 mm Tip	6.17 lb (2.80 kg)

- The track has a bracket for tram or track shortened leg to allow the measurement in grooved rails
- With moving across the track axis for horizontal alignment
- With strong magnet



PART NO.	THREAD TYPE	WEIGHS
5 263 000	5/8 x 11 inch	0.92 lb (0.42 kg)
5 263 001	Swiss-Style	0.79 lb (0.36 kg)
5 263 002	10 mm Stud	0.92 lb (0.42 kg)

- Column plate is made from anodized aluminum
- Three bottom anchor bolts are embedded in concrete during installation
- With 5/8 threaded stud for Tribrach adapter centered on the plate
- Weighs 2.29 lb (1.04 kg)



1 510 001 — Column Plate

- Anodized aluminum plate
- Three key holes for screws to mount the plate
- 5/8 inch threaded stud
- Tribrach adapter centered on the plate
- Weighs 1.81 lb (0.82 kg)

1 510 011 — Screw Mounting Column Plate

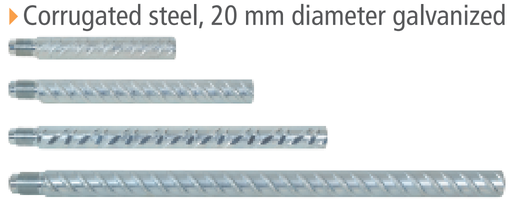
- Additional option for protecting the convergence measuring bolt
- The welded steel ring provides protection against mechanical damage of the measuring point
- Must be ordered in conjunction with convergence bolt
- Weighs 1.90 lb (0.86 kg)

5 114 500 — Steel Ring Protection for Convergence Measuring Bolt

- For concreting as measuring point
- Prisms and reflective target boards without any special adapter can be attached to the Swiss-Style system
- Stud is galvanized
- Diameter 20 mm, ribbed steel

PART NO.	LENGTH	DIAMETER	WEIGHS
5 114 150	150 mm	20 mm	0.88 lb (0.40 kg)
5 114 200	200 mm	20 mm	1.15 lb (0.52 kg)
5 114 270	270 mm	20 mm	1.50 lb (0.68 kg)
5 114 350	350 mm	20 mm	1.94 lb (0.88 kg)

- For concreting as measuring point
- For placing a prism or reflective target plate on the 3/8-inch thread, a plastic adapter is screwed in
- Supplied with a simple plastic cap
- Corrugated steel, 20 mm diameter galvanized



PART NO.	LENGTH	DIAMETER	WEIGHS
5 115 150	150 mm	20 mm	0.75 lb (0.34 kg)
5 115 200	200 mm	20 mm	1.01 lb (0.46 kg)
5 115 270	270 mm	20 mm	1.37 lb (0.62 kg)
5 115 350	350 mm	20 mm	1.81 lb (0.82 kg)

Accessory Newsletter – No. 5
Reflector Accuracy

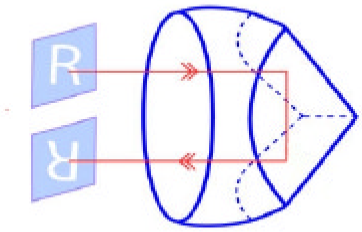
ACCURACY OF THE REFLECTOR

A circular prism is manufactured by cutting the corner from a solid glass cube. This creates three mutually orthogonal reflecting surfaces that reflect any light rays back towards their source.

The accuracy of a reflector is defined by various aspects that are detailed in this newsletter.

ANGULAR BEAM DEVIATION

The angular difference between the entering and exiting beam is known as Angular Beam Deviation. A high deviation significantly reduces the returned signal strength and hence the measurement range.



The GPR1/GPR121 Professional reflectors have the highest possible manufacturing accuracy with a beam deviation of less than 2 arc seconds. After manufacture, each prism is measured by inferometer to determine its beam deviation. Those prisms with a higher deviation, but still less than 8 arc seconds, are assembled as a GPR111 Basic reflector.

REFLECTIVE COATING

Leica prisms have a copper coating on the reflecting surfaces. Copper offers a very high reflectance of infrared beams. Being robust and resistant to corrosion it has a long useable life.

Many other prisms in the market do not have a coating on the reflective surface. This dramatically reduces the distance measuring, ATR and PowerSearch range by over 30%. In addition, incorrect measurements can result when moisture forms droplets on the reflecting surface.

An exception is the GPR112 monitoring reflector. Although this prism has no reflective coating, a patented gas-exchange valve prevents droplets from forming.

ANTIREFLEX COATING

The front surface of Leica prisms has an anti-reflection coating. This coating is remarkably hard and has the added feature of protecting the surface from scratches. Without this, the front face of a prism will reflect part of the EDM signal. At close ranges, this causes incorrect distance measurements.

The coating is optimised for the Leica EDM signal. Therefore other brands of coated prisms will still partially reflect and can cause incorrect measurements.

An exception is the GPH1P precision reflector. Although this prism has no antireflex coating, the prism is mounted at a slight tilt to prevent any direct reflection back to the EDM.

CENTRING ACCURACY

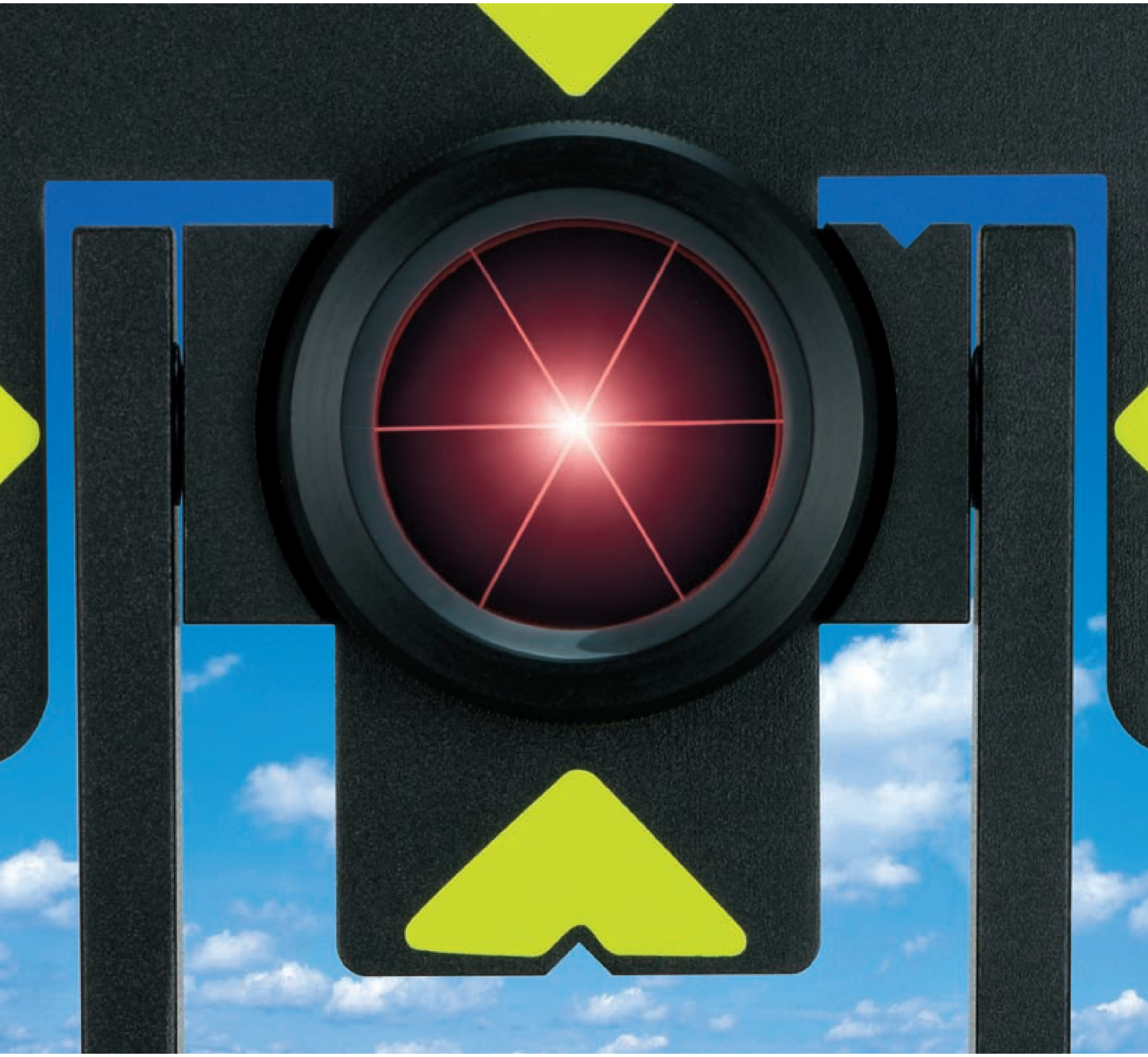
The centring accuracy is the precision with which the optical centre of the prism coincides with the mechanical axes of the holder. In combination with the carrier, force-centred in a tribrach, 3D centring accuracy over a measurement point can be defined.

LEICA REFLECTOR OVERVIEW

The table below gives an overview of the minimum specifications of Leica reflectors. The suitable reflector should be chosen depending on the required measurement range and accuracy. The centring accuracy is based on a combination with a SNLL121 Professional Carrier.

Prism Type	Beam Dev. Arc Sec.	Centring mm
PROFESSIONAL		
GPH1P	2	0.3
GPR1/GPR121	2	1.0
GMP101	6	1.0
GRZ4	6	2.0
GMP104	6	n/a
BASIC		
GPR111	8	2.0
GMP111	6	2.0
GRZ101	6	2.0
GPR112	6	n/a

Leica Geosystems
Original Accessories
The right selection



- when it has to be **right**

Leica Geosystems

Original Accessories
Become the best surveyor with Leica Geosystems equipment

Designed and built to the most stringent standards, Leica Geosystems instruments are of the highest quality, extremely reliable and designed to stand up to harsh environments. Original Accessories from Leica Geosystems, meet these same stringent standards. Our engineers design every accessory to perfectly integrate with your instrument so you always achieve the required performance and accuracy.

Quality & Reliability
Leica Geosystems accessories are known for their robustness and dependability in the field because they provide the best reliability over many years, even in extreme environments. The accessories are tested according to Leica Geosystems exacting standards for quality, accuracy and longevity.

Your benefit – Leica Geosystems Original Accessories provide you with the feeling of confidence you are used to getting from your instrument.

Replacement guaranteed
We are so sure of our quality that we replace any Original Accessory with a new, identical product if it fails during the warranty period.

One year warranty
The warranty period for all Leica Geosystems accessories is one year, except for batteries.

With accessories out of warranty, our worldwide service centres are mostly able to repair your product cost-effectively with a wide range of spare parts being available.





The right selection

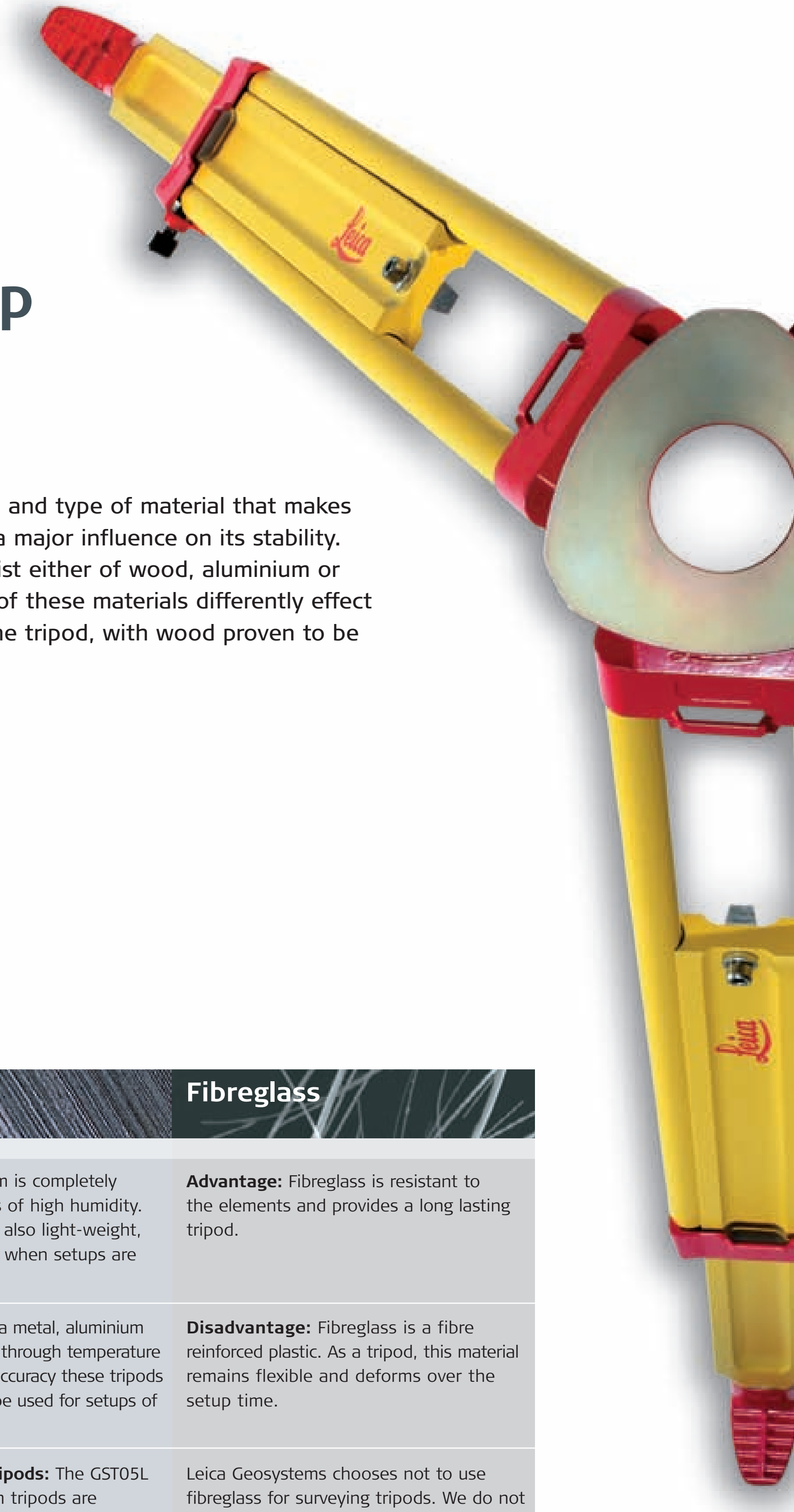
Original Accessories

To easily select the most suitable accessory to perform your survey task, Leica Geosystems divides its accessories into three distinctive price/performance groups.

	Professional	Basic	Choice
Price/ Performance	**Ultimate performance products meeting the highest demands.**	**Quality products for standard accuracy requirements.**	**Products with focus on price, for simple surveying applications.**
Accuracy	Built to the highest tolerances to achieve the best possible measurement accuracy. ★★★	For requirements where a 3 mm positioning accuracy is sufficient. ★★	For requirements where a 10 mm positioning accuracy is sufficient. ★
Environmental Specifications	For use even in extreme environments, from -20° C (-4° F) to 50° C (122° F). ★★★	For use even in extreme environments, from -20° C (-4° F) to 50° C (122° F). ★★★	Should only be used in normal environments, from 0° C (32° F) to 50° C (122° F). ★★
Spare Parts	Complete range of spare parts for repairs are available. These remain available for up to 5 years after product phase-out. ★★★	Limited spare parts and repairs are offered. These remain available for up to 5 years after product phase-out. ★★	No spare parts or repairs are offered for these products. The product will be replaced if failure occurs during the warranty period. ★



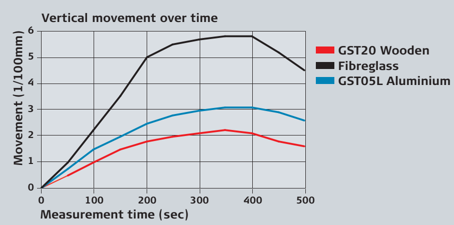
The right tripod
Accuracy starts from the ground up

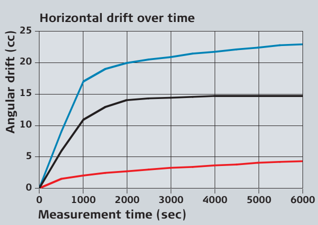


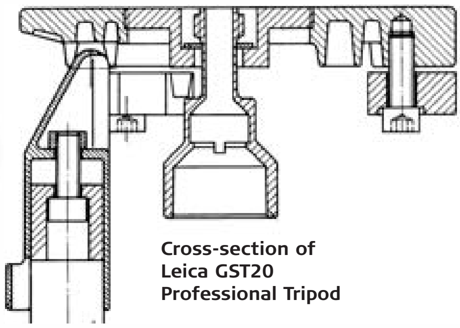
The construction and type of material that makes up a tripod has a major influence on its stability. Tripod legs consist either of wood, aluminium or fibreglass. Each of these materials differently effect the stabilty of the tripod, with wood proven to be the most stable.

Wood	Aluminium	Fibreglass
Advantage: Of all materials, wood is the most stable and less susceptible to expansion when exposed to the warming effects of the sun. Wooden tripods also have excellent vibration damping characteristics.	**Advantage:** Aluminium is completely resistant to conditions of high humidity. Aluminium tripods are also light-weight, providing convenience when setups are often changed.	**Advantage:** Fibreglass is resistant to the elements and provides a long lasting tripod.
Disadvantage: Wood is porous and absorbs water which causes it to deform. It is therefore vital that the wood be completely sealed.	**Disadvantage:** Being a metal, aluminium expands and contracts through temperature changes. To maintain accuracy these tripods should therefore only be used for setups of short duration.	**Disadvantage:** Fibreglass is a fibre reinforced plastic. As a tripod, this material remains flexible and deforms over the setup time.
Leica Geosystems tripods: The GST20 range of tripods are sealed with several layers of oil and paint and the GST05 is covered with a water-tight plastic wrap for complete protection.	**Leica Geosystems tripods:** The GST05L and CTP103 aluminium tripods are resistant to the elements and provide for long life in all environmental conditions.	Leica Geosystems chooses not to use fibreglass for surveying tripods. We do not consider them suitable to achieve reliable measurements with our modern motorized instruments.

The stability of tripods is primarily defined by their vertical movement and horizontal drift over time. The effect of different tripod materials can be clearly seen in the graphs. In both cases, the wooden tripods remain the most stable over the set-up time.







Cross-section of
Leica GST20
Professional Tripod

Quality counts
Leica Geosystems tripods are the industry leaders for over 80 years. Their design and materials are constantly being optimised. Using high quality components, these tripods provide a long life in all environments.

The right stand

Original tripods

Leica Geosystems offers a range of extremely stable and long lasting tripods to suit all instruments and surveying applications. In order to achieve the instrument specified accuracy it is vital that the correct tripod is selected.

Professional	Basic	Choice
GST20 Range	GST05 Range	CTP Range
■ The GST20 range of wooden tripods provide the highest stability over long periods. ■ Required for a maximum angular accuracy. ■ Strongly recommended for use with motorized instruments.	■ The GST05 wooden tripod is suitable for GPS and target stations. ■ The GST05L aluminium tripod is suitable for prism stations and levels. ■ Ideal for temporary GPS reference stations.	■ The CTP101 wooden and CTP103 aluminium tripods are low cost alternatives to the GST ranges. ■ Extremely rugged and therefore suitable for everyday construction surveys.

The right tribrach
For accurate positioning over the surveying point

The stability of the tripod and tribrach is the primary influence on the accuracy of measurements and therefore it is important to use reliable and stable equipment.

Perfectly suited to your instrument
Leica Geosystems tribrachs are designed to operate reliably even in extreme temperatures, humidity and dusty conditions. In all situations, the maintenance-free foot screws ensure a movement that is always smooth and free of play.

The support area of the tribrach is matched precisely to the base circumference of Leica Geosystems equipment. This provides extremely accurate forced centring.

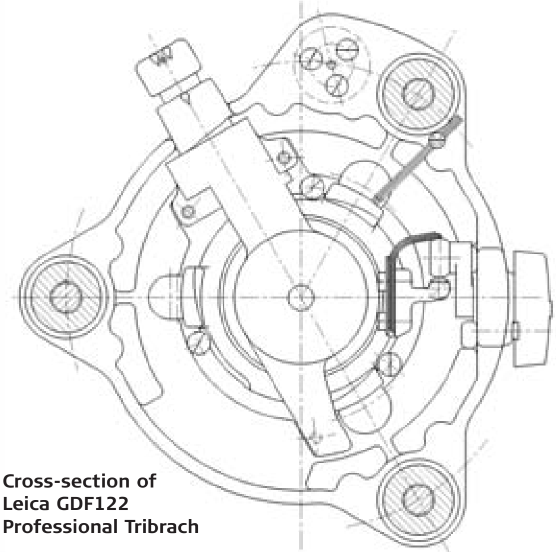
The optical plummet is of a robust construction, which virtually eliminates the need for adjustment during the lifetime of the tribrach. For tribrachs without optical plummet the innovative SNLL121 laser plummet provides for a convenient and rapid setup.

Torsional Stiffness
The top plate of the tribrach moves relative to the base plate when the mounted instrument is rotated. This force is most pronounced in motorized instruments, due to high acceleration and deceleration.

The accuracy with which the tribrach returns to its original position, once the instrument has stopped rotating, is known as hysteresis. Since the hysteresis of the tribrach has a direct influence on the angular accuracy of the instrument, choosing the correct tribrach is important.

Quality counts

The foot screw assembly is of the highest quality, providing an extremely stable support plate. After production, each tribrach is laboriously measured to determine its hysteresis. Only those tribrachs that are within specifications are supplied by Leica Geosystems.



Cross-section of Leica GDF122 Professional Tribrach

The right setup

Original tribrachs

Leica Geosystems offers a range of tribrachs to suit all accuracy requirements. The correct tribrach should be chosen to meet the requirements of the surveying application.

Professional	Basic	Choice
GDF121/GDF122	GDF111/GDF112	CTB101
■ The hysteresis of the Professional tribrachs is guaranteed to a maximum of 1" (3 cc). ■ The foot screws are maintenance-free, ensuring a movement that is always smooth and free-of-play, in all environmental conditions. ■ These tribrachs should be used with all applications where the required accuracy exceeds 3".	■ The Basic series tribrachs have a hysteresis to a maximum of 3" (10 cc). ■ The foot screws have a large diameter which permits fine adjustment even when wearing work gloves. ■ The GDF112 with optical plummet is ideal for GPS antennas and prism stations.	■ The CTB101 tribrach has a hysteresis to a maximum of 5" (15 cc). ■ The CTB101 is a low-cost tribrach which is suitable for use in normal environments. ■ It is the standard tribrach supplied with the Builder TPS and is suitable for light-weight instruments.

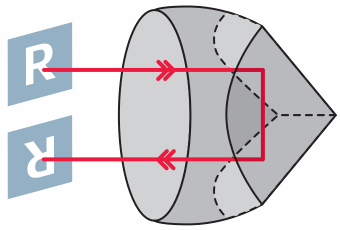
The right prism
For maximum accuracy and maximum range

Various aspects define the achievable measurement precision and distance range of prisms. The most significant of these are Reflective Coating, the Angular Beam Deviation and Anti-reflex Coating.

Reflective Coating
Leica Geosystems prisms have a copper coating on the reflection surfaces. Copper offers a very high reflectance of infrared beams. Being robust and resistant to corrosion, the coating has a long useable life.

Without a reflective coating, the distance measuring, ATR and PowerSearch range reduces by over 30%. In addition, incorrect measurements can result when moisture forms droplets on the reflecting surface.

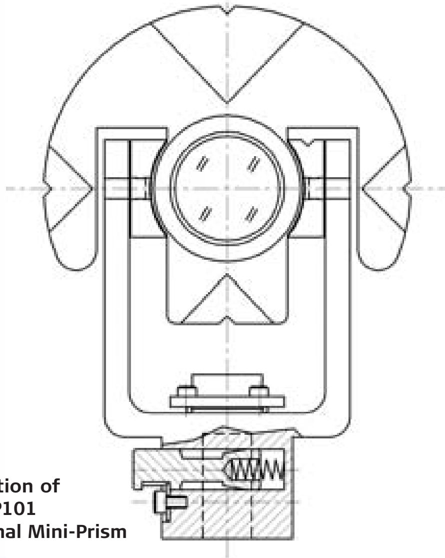
Angular Beam Deviation
The precision to which the prism glass is cut is measured in terms of the Angular Beam Deviation. This is the angular difference between the entering and exiting measurement beam. The higher this deviation, the weaker the returned signal strength to the EDM and hence the shorter the measuring range.



Anti-reflex Coating
The front surface of most Leica Geosystems prisms has an anti-reflection coating. Without this, the front face of a prism reflects a part of the EDM signal. At close ranges, this causes incorrect distance measurements. The coating is optimised for the frequency of the Leica Geosystems distance measuring signal. Therefore other brands of coated prisms still partially reflect and can cause incorrect measurements.

An additional feature of the coating is that it is remarkably hard and therefore protects the surface from scratches.

Quality counts
Leica Geosystems reflectors are produced to the highest possible accuracy. After manufacture, the reflecting surface of each prism is measured by Interferometer to determine its Angular Beam Deviation. Only those prisms meeting the required specifications are supplied to the market.



Cross-section of Leica GMP101 Professional Mini-Prism

The right target

Original prisms

Leica Geosystems prisms use the highest quality glass and are improved with optical coatings to achieve the longest possible measuring range at the highest accuracy. Circular prisms are available in 62 mm diameter for maximum range or as a convenient 24 mm diameter miniprism.

Professional	Basic	Choice
GPR121, GMP101	**GPR111, GMP111**	**CPR105**
■ Mounted in metal holders for the best centring accuracy, stability and longevity. ■ The Beam Deviation of the GPR121 is less than 2" and for the GMP101 is less than 6". ■ Ideal for precision and long range distance measurement.	■ Mounted in polymer holders which are unaffected by the elements, even when exposed for long periods. ■ The GPR111 has a Beam Deviation of less than 8". ■ These light-weight prisms provide sufficient accuracy for normal surveying appli-cations.	■ The CPR105 patented Flat Prism provides two back-to-back reflectors, both having 0-constants. ■ The unique Cat-eye reflector provides a RL measurement range of 250 m. ■ Ideal for traversing, since the prism can be measured from both sides without requiring rotation.

The right communication tools
Secure data for peace of mind

Losing data after a day's work is extremely frustrating and expensive. Leica Geosystems storage media and communication products are of the highest quality in order to achieve continuous reliability.

The right data

Compact Flash (CF) cards

Leica Geosystems memory cards are perfectly suited to the requirements of System 1200 sensors. These instruments operate differently to consumer devices which read or write individual files. The TPS or GPS creates a database on the card and constantly switches between different open files. A standard CF-card controller software is unable to perform this required multi-tasking and may cause communication problems with System 1200 instruments.

One of the primary causes of data loss is when a card is subject to shock, which can occur as a result of being dropped. The ruggedised industrial cards are rated to withstand up to a 3 metre drop to hard ground. In addition, these cards will operate reliably even in extreme temperatures and high humidity conditions.

Data cables

Most instruments have a data port for communication by cable. Connection to the external device can be made to a RS232 or USB port by using the appropriate cable. Cables provide extremely secure data transfer to and from the instrument. The highest specified wire and plugs are used which remain reliable even in extreme heat or cold.

Bluetooth® Wireless Technology

A **Bluetooth®** module can be integrated into the housing of the TPS1200 by local service centres.

An external **Bluetooth®** Kit (Art.No.8216666) is available which connects to all Leica Geosystems instruments. With this set-up, data can be transferred to or from any external device which has **Bluetooth®** wireless technology within a range of 100 m. The module is pre-programmed to be plug-and-play compatible.

Technical specifications

Professional | Basic | Choice

Tripods

Professional	Basic	Choice	Material	Max. Height	Min. Height	Weight
296632 GST20			Wood	180 cm	107 cm	6.40 kg
328422 GST40			Wood	170 cm	170 cm	6.00 kg
	399244 GST05		Wood	176 cm	107 cm	5.60 kg
	563630 GST05L		Aluminium	176 cm	107 cm	4.60 kg
		726831 CTP101	Wood	166 cm	104 cm	5.70 kg
		726833 CTP103	Aluminium	167 cm	105 cm	4.50 kg

Tribrachs

Professional	Basic	Choice	Hysteresis	Colour	Opt. Plummet	Weight
667304 GDF121			1“ (3cc)	Pale Green	No	780 grams
667307 GDF122			1“ (3cc)	Pale Green	2x magnific.	860 grams
	748888 GDF111-1		3“ (10cc)	Pale Green	No	780 grams
	667308 GDF112		3“ (10cc)	Pale Green/Red	2x magnific.	670 grams
		726839 CTB101	5“ (15cc)	Black	No	780 grams

Carriers

Professional	Basic	Choice	Centring Acc.	Plummet	Plate level	Rotatable
360532 GZR2			0.3 mm	No	60“ / 2 mm	No
428340 GZR3			0.3 mm	0.5 mm / 1.5 m	60“ / 2 mm	Yes
667316 SNLL121			0.3 mm	1.0 mm / 1.5 m	30“ / 2 mm	Yes
667313 GRT144			1 mm	No	No	No
	725566 GZR103		1 mm	0.5mm / 1.5m	45“ / 2 mm	Yes

Standard Prisms

Professional	Basic	Choice	Centring Acc.	Ang. Beam Dev.	Anti-reflex Coating	Target Plate
555631 GPH1P			0.3 mm	2“	No (Tilted)	No
641617 GPR121			1.0 mm	2“	Yes	Attached
362830 GPR1 with GPH1			1.0 mm	2“	Yes	362823 GZT4
639985 GRZ4			2.0 mm	6“	Yes	No
754384 GRZ122			2.0 mm	6“	Yes	No
	641618 GPR111		2.0 mm	8“	No	Attached
	753492 GPR113		2.0 mm	8“	No	362823 GZT4
	726295 GPR112		n / a	6“	No	No
		731346 CPR105	2.0 mm	n/a	No	Attached

Mini Prisms

Professional	Basic	Choice	Centring Acc.	Ang. Beam Dev.	Anti-reflex Coating	Target Plate
641662 GMP101			1.0 mm	6“	Yes	Attached
	641615 GMP111		2.0 mm	6“	Yes	Attached
	642534 GMP111-0		2.0 mm	6“	Yes	Attached
	641762 GMP104		n / a	6“	No	No
	644327 GRZ101		2.0 mm	6“	Yes	No

Telescopic Poles

Professional	Basic	Choice	Weight	Max. Prism Height	Min. Length	Bubble Sensitivity
385500 GLS11			0.94 kg	2.15 m	1.24 m	8‘
754391 GLS12			0.95 kg	2.00 m	1.39 m	8‘
667309 GLS111			1.48 kg	2.60 m	1.40 m	40‘
667310 GLS112			1.88 kg	3.60 m	1.47 m	40‘
752292 GLS30			0.73 kg	2.00 m	1.36 m	20‘
		748967 CPP105	0.89 kg	2.11 m	1.28 m	15‘

Batteries For specifications of batteries and chargers, refer to the separate brochure Chargers & Batteries (Art.No.722797)

Whether you want to monitor a bridge or a volcano, survey a skyscraper or a tunnel, stake out a construction site or perform control measurements – you need reliable equipment. With Leica Geosystems original accessories, you can tackle demanding tasks. Our accessories ensure that the specifications of the Leica Geosystems instruments are met. Therefore you can rely on their accuracy, quality and long life. They ensure precise and reliable measurements and that you get the most from your Leica Geosystems instrument.

When it has to be right.

SWISS Technology
by Leica Geosystems

TQM
ISO 9001 / ISO 14001

Total Quality Management – Our commitment to total customer satisfaction
Ask your local Leica Geosystems dealer for more information about our TQM program.

Laser plummet:
Laser class 2 in accordance with IEC 60825-1 resp. EN 60825-1
Laser class II in accordance with FDA 21CFR Ch.I § 1040

CAUTION
LASER RADIATION – DO NOT STARE INTO BEAM
620-690nm/0.95mW max.
CLASS II LASER PRODUCT

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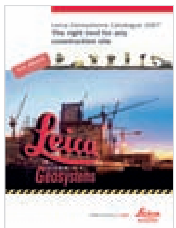
Original Accessories
Program 2007/2008

Chargers & Batteries
Product brochure



Instruments & Accessories for Construction
Catalogue

Leica Geosystems AG
Heerbrugg, Switzerland

www.leica-geosystems.com

- when it has to be **right**

Leica Geosystems

May 2002

Prism offsets

Question:
What do I need to enter as the prism constant if I'm using a non-Leica prism?

Answer:
When using a non-Leica prism, always DEFINE or select the USER setting and enter the Prism Constant in **millimeters** calculated from the following equation:

Prism Constant (**mm**) **= APC + 34.4**

APC is also referred to as the **Prism Offset** and is always NEGATIVE.

Example:

1) Using a prism with an offset of **– 40.0mm**, the Prism Constant is computed as:
   - 40.0 + 34.4 = - 5.6mm

2) Using a prism with an offset of **– 30.0mm**, the Prism Constant is are computed as:
   - 30.0 + 34.4 = + 4.4mm

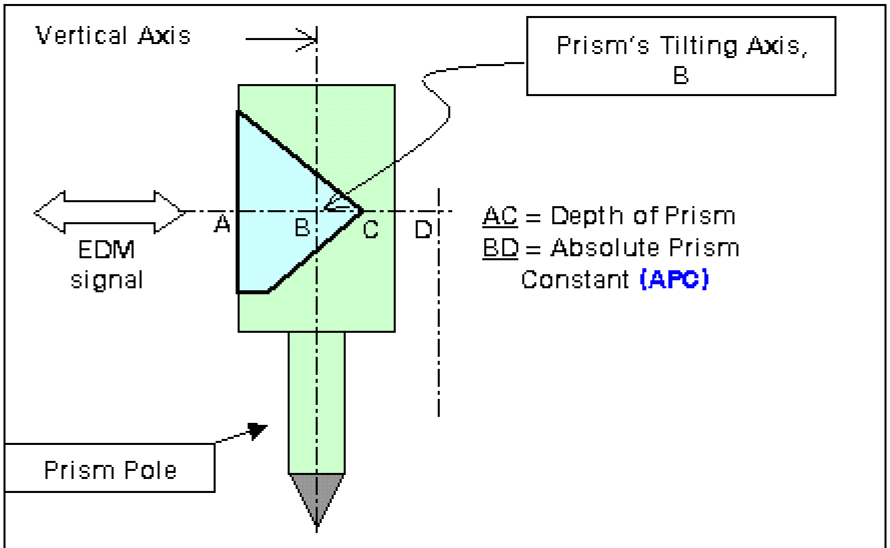
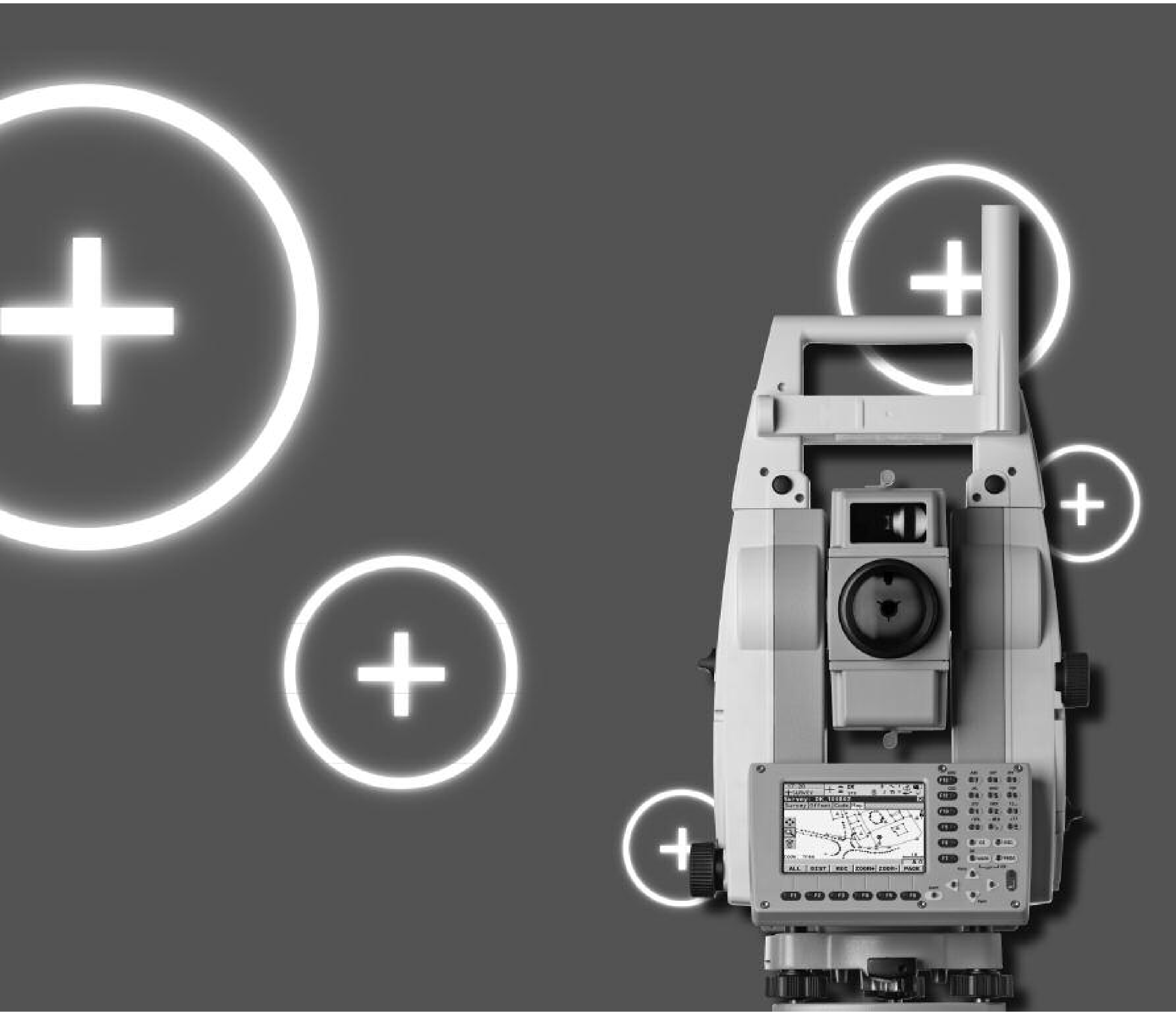


Figure 1: Characteristics of a Prism Assembly

Leica Geosystems

Leica TPS1200+ Series
Technical Data



- when it has to be **right**

Leica Geosystems

TPS1200+ Technical Data

Models and Options

	TC	TCR	TCRM	TCA	TCP	TCRA	TCRP
Angle measurement	●	●	●	●	●	●	●
Dist. meas. with Reflector (IR-Mode)	●	●	●	●	●	●	●
Dist. meas. without Reflector (RL-Mode)		●	●			●	●
Distance measurement – Long Range		●	●			●	●
Motorized			●	●	●	●	●
Automatic Target Recognition (ATR)				●	●	●	●
PowerSearch (PS)					●		●
Guide Light (EGL)	○	○	○	●	●	●	●
Remote Control Unit (RX1220)	○	○	○	○	○	○	○
Laser Guide GUS74				○		○	
SmartStation (ATX1230, ATX1230GG)	○	○	○	○	○	○	○

● Standard ○ Optional

Angle measurement

Description

The highly accurate and reliable angle measurement system consists of a static line-coded glass circle, which is read by a linear CCD array. A special algorithm determines the exact position of the code lines on the array and determines the precise measurement instantly. As the code on the glass circle is absolute and continuous, no initialization of the instrument is required prior to measurements.

A dual axis compensator constantly monitors both axes of the vertical axis tilt. The compensator consists of an illuminated line pattern on a prism, which is reflected twice by a liquid mirror forming the reference horizon. The reflected image of the line pattern is read by a linear CCD array and then used to mathematically determine both tilt components. These components are then used to immediately correct all angle measurements.

	Type 1201+	Type 1202+	Type 1203+	Type 1205+
Accuracy (std. dev. ISO 17123-3)				
Hz, V:	1" (0.3 mgon)	2" (0.6 mgon)	3" (1 mgon)	5" (1.5 mgon)
Display least count:	0.1" (0.1 mgon)	0.1" (0.1 mgon)	0.1" (0.5 mgon)	0.1" (0.5 mgon)
Method	absolute, continuous, diametrical			
Compensator				
Working range:	4' (0.07 gon)			
Setting accuracy:	0.5" (0.2 mgon)	0.5" (0.2 mgon)	1.0" (0.3 gon)	1.5" (0.5 mgon)
Method:	centralized dual axis compensator			

Distance measurement with Reflector (IR-mode)

Description

The IR mode EDM transmits an visible laser beam to specular targets such as prisms or reflector tapes. The reflected light is detected by a sensitive photo receiver and converted into an electrical signal. After digitizing and accumulating the signal, the distance is determined by means of modern phase measurement techniques. A modulation frequency of 100 MHz is the time base for the high distance accuracy. The coaxiality and the divergence angle of the laser beam together with the automatic target recognition (ATR), allo w dynamic tracking of targets quickly and accurately in 3 dimensions.

Range

	A	B	C
Standard prism (GPR1):	1800 m (6000 ft)	3000 m (10000 ft)	3500 m (12000 ft)
3 standard prisms (GPR1):	2300 m (7500 ft)	4500 m (14700 ft)	5400 m (17700 ft)
360° prism (GRZ4, GRZ122):	800 m (2600 ft)	1500 m (5000 ft)	2000 m (7000 ft)
360° mini prism (GRZ101):	450 m (1500 ft)	800 m (2600 ft)	1000 m (3300 ft)
Mini prism (GMP101):	800 m (2600 ft)	1200 m (4000 ft)	2000 m (7000 ft)
Reflector tape (60 mm x 60mm):	150 m (500 ft)	250 m (800 ft)	250 m (800 ft)
Shortest measuring distance:	1.5 m		

Atmospheric conditions:

A: Strong haze, visibility 5 km; or strong sunlight, severe heat shimmer
B: Light haze, visibility about 20 km; or moderate sunlight, slight heat shimmer
C: Overcast, no haze, visibility about 40 km; no heat shimmer

Accuracy (standard deviation ISO 17123-4) / Measure time

Standard mode:	1 mm + 1.5 ppm / typ. 2.4 s
Fast mode:	3 mm + 1.5 ppm / typ. 0.8 s
Tracking mode:	3 mm + 1.5 ppm / typ. < 0.15 s
Averaging mode:	1 mm + 1.5 ppm
Display resolution:	0.1 mm

Method

Principle:	Phase measurement
Type:	Coaxial, visible red laser
Carrier wave:	660 nm
Measuring system:	Special phase shift analyzer ~ 100 MHz

Distance measurement without Reflector

Description

The reflectorless EDM PinPoint R400 transmits an accurately collimated visible red laser beam to the target. The distance is measured by an optimally designed System Analyzer technique that allows measuring to targets at distances more than 400 m. The coaxiality of the measurement beam and its extremely small “diffraction limited” spot size allow the highest degree of pointing and measurement accuracy.

The reflectorless EDM PinPoint R1000 measures to targets more than 1000 m away. To measure to targets at such long distances with high measurement accuracy, a new measurement technology was developed. The main component of the EDM is a system analyzer, which uses modulation frequencies in the range of 100 MHz. The system analyzer properties are defined for each individual measurement for both the EDM beam and the target qualities. As a result of the system analysis, the parameters for every individual measurement are now known. The distance is calculated using modern signal processing based on the principle of maximum-likelihood. Besides the drastically increased sensitivity which leads to a sensational increase in reflectorless measurement range, the new EDM system provides many other advantages such as a very high measurement quality and reliability even when measuring in rain, fog, dust or snow. In addition the measurement system helps to prevent errors, by detecting if there are multiple targets within the measurement beam.

	D	E	F
Range PinPoint R400			
Kodak Gray Card, 90% reflective:	200 m (660 ft)	300 m (990 ft)	> 400 m (1310 ft)
Kodak Gray Card, 18% reflective:	100 m (330 ft)	150 m (490 ft)	> 200 m (660 ft)
Range PinPoint R1000			
Kodak Gray Card, 90% reflective:	600 m (1970 ft)	800 m (2630 ft)	> 1000 m (3280 ft)
Kodak Gray Card, 18% reflective:	300 m (990 ft)	400 m (1310 ft)	> 500 m (1640 ft)
Range of measurement:	1.5 m to 1200 m		
Display unambiguous:	up to 1200 m		

Atmospheric conditions:

D: Object in strong sunlight, severe heat shimmer
E: Object in shade, or sky overcast
F: Underground, night and twilight

Accuracy / Measure time

Standard mode (standard deviation ISO 17123-4)

0 m - 500 m:	2 mm + 2 ppm / typ. 3-6 s, max. 12 s
> 500 m:	4 mm + 2 ppm / typ. 3-6 s, max. 12 s
Atmospheric conditions:	Object in shade, sky overcast (E)
Display resolution:	0.1 mm

Tracking mode*)

5 mm + 3 ppm typ. 0.25 s

*) Accuracy and measure time depend on atmospheric conditions, target object and observation situation.

Laser dot size

At 30 m:	7 mm x 10 mm
At 50 m:	8 mm x 20 mm
At 200 m:	25 mm x 80 mm

Method

Type:	Coaxial, visible red laser
Carrier wave:	660 nm
Measuring system PinPoint R400/R1000:	System analyzer basis 100 MHz - 150 MHz

Distance measurement – Long Range

Description

The highly collimated red laser beam of the PinPoint R400 can also be used to measure to prism targets at distances between 1000 m and 12000 m or reflector tape at extended ranges. The visibility of the laser beam simplifies the search of far distant reflectors, because the reflected light is even visible at distances more than 5000 m. The distance is measured by the same phase measurement technique as for the infrared beam.

The accurately collimated red laser beam of the PinPoint R1000 is similar to that of the PinPoint R400, the ambiguity range is also 12000 m. The main module of the long range EDM is again a system analyzer (similar to the system analyzer used for reflectorless measurements) but with a reduced frequency set between 100 MHz and 150 MHz. The distance is calculated by an estimation method using modern signal processing incorporating the advantages such as high measurement quality and reliability when measuring in rain or snow positive and the detection of multiple targets within the measurement beam.

	A	B	C
Range			
Standard prism (GPR1):	2200 m (7300 ft)	7500 m (24600 ft)	> 10000 m (> 32800 ft)
Reflector tape (60 mm x 60mm):	600 m (2000 ft)	1000 m (3300 ft)	> 1300 m (> 4300 ft)
Range of measurement to prism:	1000 m to 12000 m		
Display unambiguous:	up to 12000 m		

Atmospheric conditions:

A: Strong haze, visibility 5 km; or strong sunlight, severe heat shimmer
B: Light haze, visibility about 20 km; or moderate sunlight, slight heat shimmer
C: Overcast, no haze, visibility about 40 km; no heat shimmer

Accuracy (standard deviation ISO 17123-4) / Measure time

Entire measurement range:	5 mm + 2 ppm/ typ. 2.5 s, max. 12 s
Display resolution:	0.1 mm

Method

Principle:	System analyzer
Type:	Coaxial, visible red laser
Carrier wave:	660 nm

Motorized

Maximum speed

Rotating speed:	45° / s

Automatic Target Recognition (ATR)

Description

The ATR sensor transmits an invisible laser beam, which is reflected by any standard prism (no active prisms emitting special signals are required) and is received by an internal high-resolution CMOS camera. The intensity and the "spot" characteristics of the reflected light are calculated in respect to the CMOS camera center. The offset components from this reference are computed in both the vertical and horizontal planes. These offsets are then used to control the motors of the telescope axes, which react immediately to position the instrument's crosshairs onto the prism. To minimize measurement time the crosshairs are only positioned within a 5 mgon tolerance (EDM mode IR-Fine) of the actual prism center. The remaining offsets are then mathematically applied to the Hz and V angles.

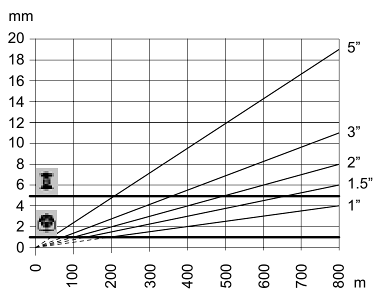
Range

	ATR mode	Lock mode
Standard prism (GPR1):	1000 m (3300 ft)	800 m (2600 ft)
360° prism (GRZ4, GRZ122):	600 m (2000 ft)	500 m (1600 ft)
360° mini prism (GRZ101):	350 m (1150 ft)	300 m (1000 ft)
Mini prism (GMP101):	500 m (1600 ft)	400 m (1300 ft)
Reflector tape (60 mm x 60mm):	55 m (175ft)	-
Shortest measuring distance:	1.5 m	5 m

Accuracy (std. dev. ISO 17123-3) / Measure time

ATR angle accuracy Hz, V:	1" (0.3 mgon)
Base Positioning accuracy:	± 1 mm
Measure time for GPR1:	3-4 s

The accuracy with which the position of a prism can be determined with Automatic Target Recognition (ATR) depends on several factors such as internal ATR accuracy, instrument angle accuracy, prism type, selected EDM measuring program and the external measuring conditions. The ATR has a basic standard deviation level of ± 1 mm. Above a certain distance, the instrument angle accuracy predominates and takes over the standard deviation of the ATR.
The following graph shows the ATR standard deviation based on two different prism types, distances and instrument accuracies.



Leica 360° prism
Leica circular prism
mm ATR accuracy [mm]
m Distance measurement [m]
" Instrument angle accuracy ["]

Maximum speed (LOCK mode)

Tangential (standard mode):	5 m / s at 20 m, 25 m / s at 100 m
Radial (tracking mode):	5 m / s

Searching

Search time in field of view:	Typ. 1.5 s
Field of view:	1° 30' (1.66 gon)
Definable search windows:	Yes

Method

Principle:	Digital image processing
Type:	infrared laser

PowerSearch (PS)

Description

This fast and reliable prism search uses a sender / receiver couple to detect prisms by means of digital signal processing algorithms. An invisible, vertical laser fan sized 40 gon in height and 0.025 gon in width is sent out while the instrument rotates around its standing axis. Once this fan comes across a prism, the reflected signal is evaluated on the fly to verify the target. If the specified signal patterns are matched, the horizontal position of the prism is determined and the rotation is stopped. Now an ATR search limited to the vertical line of the fan is launched, which precisely positions to the prism center. With this technique any standard prism (no active prisms emitting special signals are required) can be used.

Range

Standard prism (GPR1):	300 m (650 ft)
360° prism (GRZ4, GRZ122):	300 m (650 ft) (perfectly aligned to the instrument)
Mini prism (GMP101):	100 m (330 ft)
Shortest measuring distance:	1.5 m

Searching

Search time:	Typ. < 10 s
Default search area:	Hz: 400 gon V: 40 gon
Definable search windows:	Yes

Method

Principle:	Digital signal processing
Type:	infrared laser

Guide Light (EGL)

Range

Working range:	5 m - 150 m

Accuracy

Positioning accuracy:	5 cm at 100 m

General data

Telescope

Magnification:	30 x
Free objective aperture:	40 mm
Field of view:	1°30’ (1.66 gon) / 2.7 m at 100 m
Focusing range:	1.7 m to infinity

Keyboard and Display

Display:	¼ VGA (320*240 pixels), graphic LCD, colour, illumination, touch screen
Keyboard:	34 keys (12 function keys, 12 alphanumeric keys), illumination
Angle display:	360° ’ “, 360° decimal, 400 gon, 6400 mil, V%
Distance display:	meter, int. ft, int. ft/inch, US ft, US ft/inch
Position:	face I standard / face II optional

Data storage

Internal memory:	256 MB (optional)
Memory card:	CompactFlash cards (64 MB and 256 MB)
Number of data records:	1750 / MB
Interface:	RS232, Bluetooth™ (optional)

Laser plummet

Centering accuracy:	1 mm at 1.5 m (deviation from plumb line)
Laser dot diameter:	2 mm at 1.5 m

Endless drives

Number of drives:	1 horizontal / 1 vertical

Circular level

Sensitivity:	6' / 2 mm

Internal Battery (GEB221)

Type:	Lithium-Ion
Voltage:	7.4 V
Capacity:	3.8 Ah
Operating time:	Typ. 5 - 8 h

Dimensions

Tilting axis height:	196 mm above tribrach
Height:	345 mm
Width:	226 mm
Length:	203 mm

Weights

Total station:	4.8 - 5.5 kg (depending on type and options)
Battery (GEB221):	0.2 kg
Tribrach (GDF121):	0.8 kg

Environmental specifications

Working temperature range:	-20°C to +50°C
Storage temperature range:	-40°C to +70°C
Dust / water (IEC 60529):	IP54
Humidity:	95%, non-condensing

Onboard Software

User Interface

Graphics:	Graphical representation of points, lines and areas Application result plots
Icons:	Icons indicating the current status of measure modes, settings, battery etc.
Quick settings menu:	Quick settings menu for toggling reflectorless EDM, ATR, LOCK, EDM Tracking etc. on and off
Function keys:	Direct function keys for quick and easy operation.
User menu:	User menu for quick access of the most important functions and settings

Configuration

Configuration sets:	Ability to store and transfer all instrument and application configuration settings for different operators, survey tasks etc.
Displays masks:	User definable measurement display
User menu:	User definable menu for quick access to specific functions
Hot keys:	User configurable hot keys for quick access to specific functions

Coding

Free Coding:	Recording codes with optional attributes in between of measurements Manual code entry or selection from a user defined codelist
Thematical Coding:	Coding points, lines and areas with optional attributes when measuring Manual code entry or selection from a user defined codelist
Quick Coding:	Recording a measurement with a point, line, area or free code by entering an alphanumerical or a numerical quick code from a user defined codelist. Line and area quick codes automatically create line and area objects.
Smart Coding:	Provides another quick and easy way of selecting a code and measuring a point. Simply use the touch screen to select the code from a user defined listing. This feature is integrated with all existing coding, linework and point measurement functionalities.
Line Work:	Recording additional point information which effects creating lines, curves, splines, areas.

Data Management

Jobs:	User definable jobs containing measurements, points, lines, areas and codes Directly transferable to LEICA Geo Office software
Points, lines, areas:	Creating, viewing, editing, and deleting points, lines and areas and codes
Functions:	Sorting and filtering of points, lines and areas Averaging of multiple points within user defined averaging limits

Data Import & Export

Data import:	Character delimited ASCII files with point id, easting, northing, height and point code GSI8 and GSI16 files with point id, easting, northing, height and point code Direct onboard upload of DXF files for interactive maps and drawings
Data export:	User defined ASCII files with measurements, points, lines, codes

Standard application programs

Setup:

Setting up and orienting the instrument using various set-up methods. For all setup methods that require a known setup point the coordinates can be measured by GNSS whenever a SmartAntenna is connected.

- Set Azimuth:
  Setting up the instrument on a known point and orienting to a backsight with known or unknown coordinates. Once the coordinates of the backsight are known all measurements are automatically updated.
- Known Backsight Point:
  Setting up the instrument on a known point and orienting to a known backsight point.
- Orientation and Height Transfer:
  Setting up the instrument on a known point and setting the orientation by measuring angles or angles and distances to known targets points.
- Resection, Resection Helmert:
  Setting up the instrument on an unknown point and set the orientation and calculate the station coordinates by measuring angles or angles and distances to up to 10 known targets points.

Survey:

Measuring points, lines and areas with codes and offsets.

- Auto Points:
  Tracking 3D movements of the target by automatically logging points at a given time interval, minimum distance difference or minimum height difference.
- Remote Points:
  Determining the 3D coordinates of inaccessible points by measuring the distance to a base point directly underneath or above the target and then measuring the angles to the inaccessible point.

Stakeout:

3D Staking of points using various stakeout methods:

- Orthogonal:
  Displaying distances forwards / backwards, left / right from or to the station and cut / fill.
- Polar:
  Displaying direction, distance and cut / fill.
- Coordinate differences:
  Displaying coordinate differences and cut /fill.
- Stakeout direct from graphical map

COGO:

Computation of coordinates of points using various coordinate geometrical methods:

- Inverse: Compute bearing and distance between 2 points, point and line, point and arc and between point and the actual position.
- Traverse: Compute coordinates of points using bearing and distance from origin point
- Intersections: Compute coordinates of points using intersections created from other points
- Line Calculations: Compute coordinates of points based on distance and offsets along lines
- Arc Calculation: various arc related calculations, like arc center, offset-points related to an arc or segmentation of arcs
- Shift, Rotate and Scale: Compute coordinates of group of points based on a shift, rotate and scale from their existing coordinates. The shift, rotate and scale values can be manually entered or computed
- Area Division: Divide areas into smaller areas using a variety of methods

Determine Coordinate System:

GNSS coordinates are measured relative to the global geocentric datum known on WGS 1984. A transformation is required to convert the WGS 1984 coordinates to local coordinates. Three different transformation methods are available:

- Onestep
- Twostep
- Classic 3D (Helmert transformation)

GNSS Survey:

Measuring points with GNSS if a SmartAntenna is connected, optional entry of codes.

Optional application programs

Reference Line:

Defining lines and arcs, which can be stored and used for other tasks, using various methods:

- Measuring to a line / arc where the coordinates of a target point are calculated from its current position relative to the defined reference line / arc.
- Staking to a line / arc where a target point is known and instructions to locate the point are given relative to the reference line / arc.
- Gridstaking to a line / arc where a grid can be staked relative to a reference line / arc.
- Defining and staking slopes along defined lines and arcs.

DTM Stakeout:

- Staking out a Digital Terrain Model.
- Comparing actual and design height and displaying height differences.

RoadRunner:

Stake-out and as-built check of roads and any type of alignment related design (e.g. pipeline, cable, earthworks)

- Handles any combination of geometric elements in the horizontal alignment, from simple straights to different types of partial spirals
- Vertical alignment supports straights, arcs and parabolas
- Covers all working tasks including stake-out/check of lines, grades/slopes (e.g. road surface, cut & fill), DTMs and many more
- Visualization of cross-sections and planar view of design
- Graphical selection of elements to stake-out/check
- Smart project management of design data
- Support of multiple road layers (construction phases)
- Enhanced station equation capabilities
- Comprehensive, user definable log files and cut sheets
- Seamless data flow from all major design packages via PC conversion tool.

RoadRunner Rail:

Version of RoadRunner to stake-out and as-built check for rail construction and maintenance

- Stake-out of rails
- As-built checks of rails
- Superelevation (cant) supported
- Clearance (gauge) control
- View design data
- Reporting

RoadRunner Tunnel:

Version of RoadRunner to stake-out and as-built check for Tunnel construction and maintenance

- Stake-out of Tunnel Faces allows setting out at the point of excarvation (e.g. for Drill and Blast or excarvation using a roadheader)
- Stake-out of Tunnel Profiles for any point of the tunnel at the given chainage (e.g. after excavation to indicate the position of tunnel design elements or services such as lightning or ventilation.
- As-built checks of Tunnels by measuring profiles perpendicular to the centre line (Scan profile)
- As-built checks by measuring any point in the Tunnel and comparing the meassured point with the theoretical design point (Check profile)
- Support of multiple Tunnel layers (construction phases)
- View and edit design data
- Reporting

Sets of Angles:

Measuring directions and distances to targets in one or two faces in various measurement routines.

- Calculating the average directions and distances of all sets.
- Calculating the standard deviations for single directions / distance and average directions / distances.

Monitoring option to repeat measurements at given time intervals.

Traverse:

Measuring a traverse with unlimited number of legs:

- Measuring sets to angles to backsight and multiple foresights.
- Measuring topographic points from any station.
- Using known points during traverse to validate quality of traverse.
- Calculating traverse closure results for field checking.

Reference Plane:

Stake-out or measure points relative to a reference plane:

- Defining a plane by either measuring or selecting points.
- Calculate the perpendicular distance and height difference from a measured point to the plane.
- Scanning of points on a defined plane.

Cross Section Survey:

Survey cross sections (such as highway profiles, river profiles, beach profiles) using code templates. The appropriate code for the next point on the profile is always correctly suggested

- Also shows distance from last cross section
- Free, point, line or area codes can be used

Area Division	Area Division as an optional add on functionality of COGO Application ■ Divide areas into smaller areas using a variety of methods ■ Full graphical support
Volume Calculation	■ Defining and Editing of surfaces and boundaries ■ Calculating of Digital Terrain Models ■ Computation of Volumes of defined surfaces in relation of a defined reference height
Hidden Point:	Easily measures points that are not directly visibly by using a hidden point rod with 2 to 3 reflectors attached. The rod can be held at any angle and the spacing between reflectors is configurable. The program calculates the measurements to the hidden points as if they were observed directly.
Monitoring:	Monitoring is designed to assist you by automatically repeating measurements to defined targets at pre-defined measurement intervals. It is ideal for small scale monitoring applications without the need of a fixed PC set-up at the reference.

Remote Control Unit (RX1250T, or RX1250Tc with colour display)

Description

The RX1250T / Tc is a WinCE controller which uses the latest in spread spectrum 2.4 GHz radio technology to permitting total remote control of the TPS1200+ total station and GNSS Smart Antenna while at the Smart Pole. The RX1250 can be ordered with a next generation colour screen for bright, high contrast visibility in all conditions. Two different ways of remote controlling a TPS1200+ can be selected: the traditional concept mirrors the user interface of the TPS1200+ on the RX1250. This easy to learn and simple to use concept ensures that no valuable measurement data is relayed over the radio link totally eliminating the risk of data loss. With the second concept, the RX1250 takes over the master role. All applications are running on the RX1250, and all data are recorded into the database of the RX1250. Further more, the RX1250 is completely interchangeable with both the TPS1200+ and the GPS1200 giving the user an efficient and economic solution to all sensor control needs. Such features result in a system, which offers total remote data flexibility. The full QWERTY keyboard of the RX1250 makes it easy and fast to enter alphanumeric point numbers, select or enter codes or even short descriptions. The encrypted protocol and frequency band hopping technology used in the data transmission greatly reduce the cases of interference from any other 2.4 GHz transmitters. In addition, a number of user selectable ‘link numbers’ can be configured easily in cases where more than one RX1250 is being used in the same area.

Communication

Communication:	via integrated radio modem

Control unit

Display:	¼ VGA (320*240 pixels), graphic LCD, touch screen, illumination, grey scale or colour
Keyboard:	62 keys (12 function keys, 40 alphanumeric keys), illumination
Interface:	RS232

Internal Battery (GEB211)

Type:	Lithium-Ion
Voltage:	7.4 V
Capacity:	1.9 Ah
Operating time:	RX1250T: typ. 9h RX1250Tc: typ. 8h

Weights

RX1250T/Tc:	0.8 kg
Battery (GEB211):	0.1 kg
Reflector pole adapter:	0.25 kg

Environmental specifications

	RX1250T	RX1250Tc
Working temperature range:	-30°C to +65°C	-30°C to +50°C
Storage temperature range:	-40°C to +80°C	-40°C to +80°C
Dust / water (IEC 60529):	IP67	IP67
Waterproof (MIL-STD-810F):	temporary submersion to 1m	temporary submersion to 1m

SmartStation (ATX1230, ATX1230 GG)

Description

SmartStation is a TPS1200+ with ATX1230 or ATX1230GG 72 channel L1+L2 Smart Antenna. All GNSS and TPS operations are controlled from the TPS keyboard, all data are in the same database, all information is shown on the TPS screen. RTK GNSS fixes the position to centimeter accuracy, then the setup routine is completed using the total station. SmartAntenna can also be used independently on a pole with a GX1230 and a RX1210 controller or as a smart pole with the RX1250 Windows CE controller.

Important Note

Measurement precision and accuracy in position and accuracy in height are dependent upon various factors including number of satellites, geometry, observation time, ephemeris accuracy, ionospheric conditions, multipath etc. Figures quoted assume normal to favourable conditions. Times can also not be quoted exactly. Times required are dependent upon various factors including number of satellites, geometry, ionospheric conditions, multipath etc.The following accuracies, given as root mean square, are based on real-time measurements.

Accuracy

Position accuracy:	Horizontal: 10mm + 1ppm Vertical: 20mm + 1ppm When used within reference station networks the position accuracy is in accordance with the accuracy specifications provided by the reference station network.

Initialisation

Method:	Real time (RTK)
Reliability of initialisation:	Better than 99.99%
Time for initialisation:	Typically 8 sec, with 5 or more satellites on L1 and L2
Range:	Up to 50 km, assuming reliable data-link is available

RTK Data Formats

RTK Data Formats for data reception:	Leica proprietary format, CMR, CMR+, RTCM V2.1/2.2/2.3/3.0

ATX1230 SmartAntenna

Receiver technology:	SmartTrack - patented. Discrete elliptical filters. Fast acquisition. Strong signal. Low noise. Excellent tracking, even to low satellites and in adverse conditions. Interference resistant. Multipath mitigation.
No. of channels ATX1230:	14 L1 + 14 L2
No. of channels ATX1230GG:	72, 14 L1 +14 L2 GPS, 2 SBAS, 12 L1 + 12 L2 GLONASS
Groundplane:	Built-in groundplane
Dimensions (diameter x height):	186mm x 89mm
Weight:	1.12kg

Leica Geo Office Software

Description

Easy, fast and comprehensive, automated suite of programs for TPS, GNSS and Level data. View and manage TPS, GNSS and Level data in an integrated way. Process independently or combine data – including post processing and support of real-time GNSS measurements.
Manages all data in an integrated manner. Project management, data transfer, import/export, processing, viewing data, editing data, adjustment, coordinate systems, transformations, codelists, reporting etc.
Consistent operating concepts for handling GNSS, TPS and level data, based on Windows standards. An embedded help system includes tutorials with additional information.
Runs on Windows™ 2000 and XP platforms.

User Interface

Intuitive graphical interface with standard Windows™ operating procedures. Customizable built-in configuration options allow users to set up the software exactly to suit their specific needs and preferences.

Standard components

Data and Project Management:	Fast, powerful database manages automatically all points and measurements within projects according to well-defined rules to ensure data integrity is always maintained. Projects, coordinate systems, antennas, report templates and codelists all have their own management. Numerous transformations, ellipsoids and projections, as well as user-defined geoid models and country specific coordinate systems which are based on a grid of correction values are supported. Six different transformation types are supported, giving the flexibility to select the approach which suits the project needs best. Antenna management system for offsets and correction values. Codelist management for code groups / code / attributes.
Import & Export:	Import data from compact-flash cards, directly from receivers, total stations and digital levels, or from reference stations and other sources via the Internet. Import of real-time (RTK), DGPS coordinates.
ASCII Import & Export:	Import coordinate lists as user-defined ASCII files using the import wizard. Export results in any format to any software using the ASCII export function. Transfer point, line, area, coordinate, code and attribute data to GIS, CAD and mapping systems.
View & Edit:	The various graphical displays form the basis for visualizing data and giving an instant overview of the data contained within a project. Point, line and area information may be viewed in View/Edit together with coding and attribute information. Editing functionality is embedded allowing to query and clean up the data before processing or exporting it further.
TPS Processing:	Re-calculate TPS setups to update station coordinates and orientations Define setups and traverses and process with preferred parameters Display traverse results in HTML-based reports
Codelist Manager:	Generation of codelists with code groups, codes, and attributes. Management of codelists.
Reporting:	HTML-based reporting provides the basis for generating modern, professional reports. Measurement logs in field book format, reports on averaged coordinates, various processing log files and other information can be prepared and output. Configure reports to contain the information that are required and define templates to determine the presentation style.
Tools:	Powerful Tools like Codelist Manager, Data Exchange Manager, Format Manager and Software Upload are common tools for GNSS receivers, total stations and also for digital levels.

GNSS Options

L1 data processing:	Graphical interface for baseline selection, processing commands etc. Automatic or manual selection of baselines and definition of processing sequence. Single baseline or multi-baseline batch processing. Wide range of processing parameters. Automatic screening, cycle-slip fixing, outlier detection etc. Automated processing or user-controlled processing.

L1 / L2 data processing:	Graphical interface for baseline selection, processing commands etc. Automatic or manual selection of baselines and definition of processing sequence. Single baseline or multi-baseline batch processing. Wide range of processing parameters. Automatic screening, cycle-slip fixing, outlier detection etc. Automated processing or user-controlled processing.
GLONASS data processing:	Allows processing of GLONASS data in addition to GPS data processing.
RINEX Import:	Import of data in RINEX format.

Level Options

Level data processing:	View the data collected from the Leica digital level in the Geo Office level booking sheet. Select the preferred processing settings and process the level lines. Processing runs quickly and automatically. Use Results Manager to inspect and analyze the leveling results and generate a report. Finally, store the results and/or export them as required.
Design & Adjustment 1D:	Powerful MOVE3 Kernel with rigorous algorithms for 1D adjustment. Furthermore, network design and analysis is supported.

General Options

Datum & Map:	LEICA Geo Office supports numerous transformations, ellipsoids and projections, as well as user-defined geoid models and country specific coordinate systems, which are based on a grid of correction values. The optional Datum/Map component supports the determination of transformation parameters. Six different transformation types are supported, giving the flexibility to select the approach which suits the project needs best.
Design & Adjustment 3D:	Combine all measurements in a least-squares network adjustment to obtain the best possible set of consistent coordinates and check that the measurements fit with the known coordinates. Use adjustment to help identify blunders and outliers based upon the extensive statistical testing. Using the powerful MOVE3 Kernel, the algorithms are rigorous and the user can choose between whether a 3D, 2D or 1D adjustment is computed. Furthermore, the component supports network design – allowing to design and analyze a network before actually going into the field.
GIS / CAD Export:	Permits export to GIS/CAD systems such as AutoCAD (DXF / DWG), MicroStation
Surfaces & Volumes:	Assign measured points of surfaces and calculate Digital Terrain Models Use automatic boundary creation or define boundaries manually Introducing breaklines will automatically update the model Visualize the surface in a 2D or 3Dview Calculate volumes above the reference heights or between surfaces

System requirements

Recommended PC configuration:	Pentium® 1GHz processor or higher 512 MB RAM or more Microsoft® Windows 2000 or XP Microsoft® Internet Explorer 5.5 or higher

Whether you want to survey a parcel of land or a construction site, a facade or indoors to create as-built plans or carry out high-precision measurements of bridge and tunnel constructions – Leica Geosystems' surveying instruments provide the right solution for all measuring tasks.

The System 1200 Series instruments as well as the software are designed to meet the daily challenges of modern surveying. They all have outstanding, easy to read and user-friendly interfaces. Their straightforward menu structures, their clearly outlined scope of functions and high technology perfectly mate GNSS and TPS applications in the field. Whether you use the advantages of both technologies combined or each separately – due to the exceptional flexibility of Leica Geosystems instruments, reliable and productive surveying is assured.

When it has to be right.

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TQM
ISO 9001 / ISO 14001

Total Quality Management – our commitment to total customer satisfaction.

Ask your local Leica Geosystems dealer for more information about our TQM program.

Distance meter (Prism), ATR and PowerSearch:
Laser class 1 in accordance with IEC 60825-1 resp. EN 60825-1

Laser plummet:
Laser class 2 in accordance with IEC 60825-1 resp. EN 60825-1

Distance meter (Non-Prism):
Laser class 3R in accordance with IEC 60825-1 resp. EN 60825-1

3R

Leica Geosystems AG
Heerbrugg, Switzerland

www.leica-geosystems.com

- when it has to be **right**

Leica Geosystems

Leica DNA digital levels
Advantages that move you ahead

- when it has to be **right**

Leica
Geosystems

Leica DNA digital levels –
Advantages that move you ahead

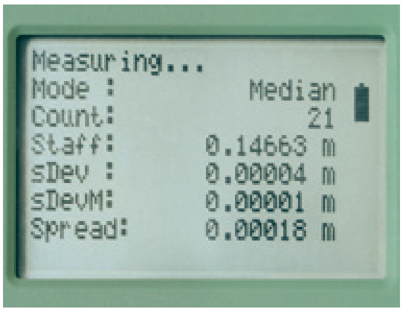
With the Leica DNA digital levels you may discover a whole new world of advantages which facilitate your daily work and save your time. The new "Meas & Rec" function lets you easily measure and record height differences, while the line levelling applications program guides you securely through the different possibilities of measuring whole level lines. Compare the closing height quickly with a known point using "Quick-Closure", or use the complete onboard Line-Adjustment to erase errors – what ever your task may be, experience the advantages of the Leica DNA digital levels.

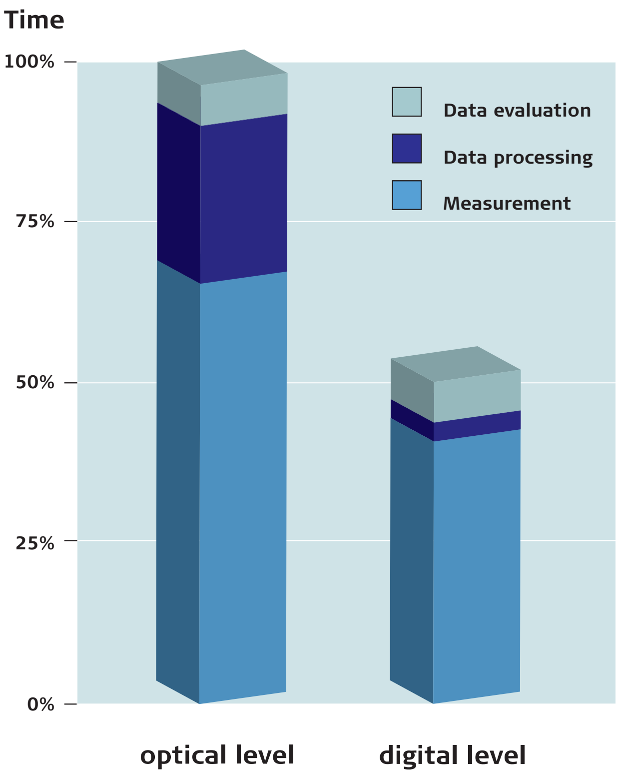
Advantages in numbers
Save up to 50% in time

Experience shows that with Leica digital levels there is up to a 50% time saving when compared with conventional levels. The main reasons are the faster data capture as well as the shorter time and safer means of data processing, thanks to saving measured data on storage devices.

Measuring without mistakes or fatigue

Leica digital levels measure and save the height and the distance to the staff at the press of a button, and calculate the height of the point. Advantage: no readings required, no copying or writing down and no calculation by hand.





Leica DNA digital levels – Practical advantages

Leica digital levels DNA10 and DNA03 cover the entire range of applications from the construction site to the 1st order levelling tasks. The practice oriented solutions in the integrated measurement programs, the large liquid crystal display and the alphanumeric keyboard help to keep track of your work, make it faster and more productive.

Area levelling

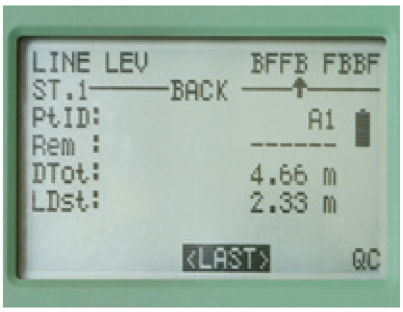
All components required for appropriate levelling jobs are at your disposal. The program "Meas & Rec" is suited for elementary staff reading and distance measurements or to survey a lot of points.

Land surveys and line levelling

Thanks to the extensively automated processes, the observer has been relieved of much of the work at the keyboard. Adjustable tolerance checks for the measured data add safety to the measurements taken. In addition the Quick Code function provides for measurement and point coding by simply entering the Quick Code number.

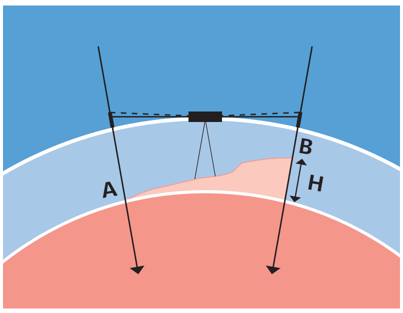
Levelling at construction sites

Height determination and stake out: Thanks to the easy-to-use measuring program "Meas & Rec" the experienced construction site operator can quickly and reliably measure height differences, perform line levelling or stake outs. The display "Point to Point" continuously provides the height difference between each measured point if profile points or many intermediate points are measured.



Advance at a glance

During line levelling the clear menu guidance is outstanding. Important measured data are displayed immediately which allows easily to check the rightness of the data and the progress made.



Earth curvature correction

If this is activated in a Leica DNA digital level, then the measurements made are automatically free of the influence of the earth's curvature.

More practical advantages

Correction of collimation error: Can be reliably determined and saved using the four integrated Check and Adjust procedures or it can be entered manually.

Measurement modes: Leica DNA digital levels can make: single measurements, average or median out of multiple measurements with a definable standard deviation and repeated single measurements.

Reduced field of view: For a fine measurement a field of view of about 1.1° is required. This corresponds to 38 cm staff code per 20 m of target distance.

Data output format: For printouts similar to those used in field books. Up to four user formats can be stored in the instrument. User-definable formats bring outstanding flexibility into the data export. Generate your own protocol files or create import formats for your PC postprocessing software.

Staffs and accessories: Leica Geosystems offers a rich palette of staffs and other accessories.

External control: The DNA10 and DNA03 models are suited for mobile or stationary measurement configuration, where an external field computer collects and processes the data. External commands configure the instrument and trigger measurements.

Office and evaluation software

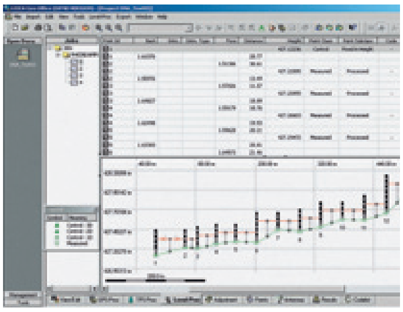
Leica Geo Office Tools

This program is included in the delivery. It controls data exchange, the configuration of the instrument, creates code lists and stake out height lists and maintains the system software. A special feature is the creation of user-defined output formats for a field book like data export.

Leica Geo Office

The level option processes your levelling data in a professional manner. The optional program contains functions such as line calculation, adjustment and the creation of reports.

A second level option allows to adjust a complete Level Line Network.



Technical data	LEICA DNA03	LEICA DNA10
Area of use	– Quick measurements of heights, height differences and stake outs	– Quick measurements of heights, height differences and stake outs
	– I. and II. order levelling	– Cadastral levelling
	– High precision measurements	– Precision measurements
Accuracy	Standard deviation height measurement per 1km double-run (ISO 17123-2)	
Electronic measurements:		
with Invar staffs	0.3 mm	0.9 mm
with standard staffs	1.0 mm	1.5 mm
Optical measurements	2.0 mm	2.0 mm
Distance measurement (standard deviation)	(electr.) 1 cm/20 m (500 ppm)	
Range		
Electronic measurement	1.8 m – 110 m	
Optical measurement	from 0.6 m	
Electronic measurement		
Resolution height measurement	0.01 mm, 0.0001 ft, 0.0005 inch	0.1 mm, 0.001 ft
Time for single measurement	typically 3 seconds	
Measurement modes	Single, average, median, repeated single measurements	
Measurement programs	Measure & Record, staff height/distance, intermediate BF, aBF, BFFB, aBFFB, onboard adjustment, quick closure, stakeout	
Coding	Remark, Free code, Quick code	
Data storage		
Internal memory	6000 measurements or 1650 station	
Backup	PCMCIA card (ATA-Flash/SRAM/CF)	
Online operations	GSI format via RS232	
Data exchange internal memory	GSI8/GSI16/XML/flexible formats	
Telescope magnification	24x	
Compensator		
Type	Pendulum compensator with magnetic damping	
Slope range	±10'	
Compensator setting accuracy (standard deviation)	0.3"	0.8"
Display	LCD, 8 lines at 24 characters	
Battery operated		
GEB111	12 h operation	
GEB121	24 h operation	
Battery adapter GAD39	Alkaline battery, 6x LR6/AA/AM3, 1.5 V	
Weight	2.8 kg (incl. battery GEB111)	
Environmental conditions		
Working temperature	–20° C to +50° C	
Storage temperature	–40° C to +70° C	
Dust/water (IEC60529)	IP53	
Humidity	95%, non condensing	

Leica DNA digital levels – Advance at a glance

Keep all information in sight
The generous LC-display presents all important measured data at a glance and shows the next step to take. You always have the workflow under control.

Double your data safety
From now on, save your work automatically in the internal memory and additionally, after the measurements have been taken, on a PC-card. In this way, measured data can easily be loaded into a computer.

Optimal operating comfort
The alphanumeric keyboard and the operating concept provide the highest levels of efficiency at work, optimum comfort and rapid familiarization.

Extensive range of applications and reliability in two classes of accuracy
The DNA10 and DNA03 provide a solution for all jobs of height determination for topographic and construction surveys, up to first order levelling and monitoring.

Whether you want to determine heights of fix points, roads, tunnels or buildings, or you want to stake out height differences – Leica Geosystems' surveying instruments provide the right solution for every application.

They unite reliable results with easy operation and user-friendly applications. They are designed to meet your specific requirements. Modern technology enables you to work fast and productively, thanks to the straightforward and clearly structured range of functions.

When it has to be right.

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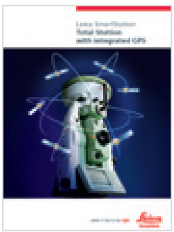
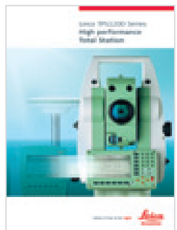


Leica SmartStation
Product brochure

Leica GPS1200
Product brochure

Leica System 1200 Software
Product brochure



Leica TPS1200
Product brochure

Leica Geosystems AG
Heerbrugg, Switzerland

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