ISSUED

WP 09-ES4001

Revision 10

Subsidence Survey Data Acquisition Report

Technical Procedure

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CHANGE HISTORY SUMMARY

REVISION NUMBER	DATE ISSUED	DESCRIPTION OF CHANGES
9	10/03/2023	• Refined steps in Section 5.2, Office Procedure. • Clarified data input format in Section 5.1, Field Procedure. • Updated figure in Attachment 1, Individual Loops, Total Survey, and Underground Excavations.
10	09/15/25	• Updated Section 1.3, Records. • Updated Section 2.0, References. • Updated Section 3.1, Precautions, to match new JHA. • Added Step 5.1.9. • Editorial corrections throughout.

1.0 INTRODUCTION

1.1 PURPOSE

This procedure provides the instructions for acquiring data and generating a report on the subsidence monuments at the Waste Isolation Pilot Plant (WIPP) repository.

The annual subsidence survey, a subsidence database, and a yearly report are required by Title 40 CFR Part 194, Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations.

1.2 SCOPE

The method described in this document involves level surveys whose error of closure are less than the Federal Geodetic Control Subcommittee (FGCS) standards for Second Order Class II surveys. The level surveys are accomplished by using the Leica LS15 digital level and bar-code rods.

1.3 RECORDS

Any records generated from the performance of the procedure are maintained per WP 15-RM, WIPP Records Management Program Plan.

1.3.1 Quality Assurance Records

- Annual Subsidence Report
- Data file for each leveling loop
- EA09ES4001-1-0, Digital Leveling Log Sheet (Loop)
- Level Report file for each leveling loop

1.3.2 Non-Quality Assurance Records

- None

2.0 REFERENCES

DOCUMENT NUMBER AND TITLE	BASELINE DOCUMENT	REFERENCED DOCUMENT	KEY STEP
Title 40 CFR Part 194, Criteria for the Certification and Re-certification of the Waste Isolation Pilot Plant's Compliance with the 40 CFR Part 191 Disposal Regulations	✓		
DOE/CBFO-94-1012, Quality Assurance Program Document	✓		
FGCS Specifications and Procedures to Incorporate Electronic Digital/Bar-Code Leveling Systems, FGCSVERT (ver. 4.0 7/15/94) 1	✓		
Leica LS10/LS15 User Manual, 2020 Version 5.0, English		✓	
WP 04-AD3030, Pre-Job Briefings and Post-Job Review		✓	
WP 09-ES.01, WIPP Underground and Surface Surveying Program		✓	
WP 12-IH.02-4, Hazard Communication and Hazardous Materials Management Plan		✓	
WP 12-IH.02-7, WIPP Industrial Hygiene Program – Lasers, Lighting, Pest Control, and Sanitation		✓	
WP 12-IH1200, Thermal Stress		✓	
WP 12-IS.01-4, Personal Protective Equipment		✓	
WP 12-IS.01-8, Vehicle Safety		✓	
WP 12-IS.01-10, Fall Protection		✓	
WP 13-1, Waste Isolation Pilot Plant Quality Assurance Program Description	✓		
WP 15-HS02-2, Biological Hazard Control Plan		✓	
WP 15-RM, WIPP Records Management Program Plan		✓	
EA09ES4001-1-0, Digital Leveling Log Sheet (Loop)		✓	
EA12IH1200-1-0, Heat Stress Mitigation Plan		✓	
09-ES4001-JHA, Subsidence Survey Data Acquisition Report	✓		

3.0 PRECAUTIONS AND LIMITATIONS

3.1 PRECAUTIONS

- **BIOLOGICAL HAZARDS** exist when working in the brush. Don proper personal protective equipment (i.e., snake leggings, gloves). Attempt to avoid desert animals and insects; however, if bit or stung, contact the Central Monitoring Room, Health Services, or Emergency Medical Technicians per WP 15-HS02-2, Biological Hazard Control Plan.
- **CHEMICAL USE/CHEMICAL SAFETY HAZARDS** exist when spray painting. At a minimum, safety glasses or goggles are required per WP 12-IH.02-4, Hazard Communication and Hazardous Materials Management Plan .
- **THERMAL STRESS** exists when working on the surface during extreme high/low temperatures. Water or fluids shall be provided, radios will be used to receive Industrial Safety/Industrial Hygiene (IS/IH) communications of extreme heat modes, and proper attire will be worn per WP 12-IH1200, Thermal Stress.
- **LASER USE HAZARDS** exist when using Electronic Distance Measuring instruments. Avoid looking directly into laser beam per WP 12-IH.02-7, WIPP Industrial Hygiene Program – Lasers, Lighting, Pest Control, and Sanitation.
- **FALLS FROM ELEVATED WORK HEIGHT HAZARDS** exist when crossing fences. Personnel will complete ladder use training per WP 12-IS.01-10, Fall Protection.
- **EYE, FOOT, HEAD, HAND HAZARDS** exist when opening and setting up on monuments, crossing fences, and material handling. Personnel will wear leather gloves and appropriate footwear per WP 12-IS.01-4, Personal Protective Equipment.
- **SLIPS/TRIPS HAZARDS** exist throughout the surveying process. Use caution when walking on sand, gravel, spilled liquids, rocks, uneven surfaces, snow, or ice. Situational awareness is required and slip-resistant footwear must be worn. If a hazard cannot be avoided, approach and maneuver it with short and deliberate steps.
- **VEHICLE TRAFFIC/HEAVY EQUIPMENT HAZARDS** exist when working near/crossing roads or in parking lot. Personnel will wear reflective clothing and use situational awareness when crossing the road per WP 12-IS.01-8, Vehicle Safety.

3.2 LIMITATIONS

- The survey crew consists of two rod persons and one level person. The level person must be proficient in the operation of the LS15 digital level.
- Work shall not be performed during precipitation.

4.0 PREREQUISITE ACTIONS

4.1 Prior to performing a leveling loop, **CHECK** the environmental conditions for that day.

- Acceptable results cannot be obtained when the weather is exceedingly hot or windy.
  - Cloudy days are preferred.

4.2 **VERIFY** the LS15 digital level used in gathering data has been checked per the design specifications and maintenance schedule.

4.3 **CONDUCT** a Pre-Job Briefing per WP 04-AD3030, Pre-Job Briefings and Post-Job Review.

NOTE

Equipment does not require periodic recalibration but will be sent to the original equipment manufacturer (OEM) or a WIPP Metrology-approved facility for a check that it is still performing at its design specifications. The specifications check is performed on a biennial basis.

4.4 Equipment List

- LS15 digital level
- Digital bar-code leveling rods
- Leveling plates
- Fiberglass 200 ft tape
- Leica Infinity (LIN) surveying system software

5.0 PERFORMANCE

NOTE

1. The instructions in this procedure are intended to supplement, not replace, the LS15 User Manual. Refer to the LS15 User Manual, as needed.
2. The subsidence monuments have been divided into 15 groups with each group requiring one day to traverse with a level survey loop (see Attachment 1, Individual Loops, Total Survey, and Underground Excavations, for level loop number and survey path). The loops may be surveyed in any order. Each loop can be processed only after a current elevation is established for the starting monument of that loop.

5.1 FIELD PROCEDURE

NOTE

1. The digital level stores the collimation result from this test and applies it to all subsequent measurements. Users may refer to the LS15 User Manual for instruction on this procedure.
2. The Julian date is to be used for the job name on the peg test.

5.1.1 Level person:

[A] **INITIATE** EA09ES4001-1-0for this loop
AND ENTER collimation, instrument, and other loop information as it becomes available.

[B] **PERFORM** the two-peg test upon arriving at the starting point for each loop to ensure the instrument is in proper adjustment.

[1] **SELECT** Tools

[2] **SELECT** Adjust

[3] **SELECT** Line of Sight (F1)

[4] **FOLLOW** prompt on screen

[5] **SELECT** method (AxxB)

[C] **IF** absolute collimation error is greater than or equal to 40 seconds,
THEN SEND instrument to the OEM or a WIPP Metrology-approved facility for a check that it is still performing at its design specifications.

NOTE

The survey is conducted so that Rod 1 is always used on the subsidence monuments while both Rods 1 and 2 are used on turning points.

5.1.2 Rod 1 person:

[A] **GO TO** the starting subsidence monument
AND PLACE the rod on the leveling point on monument.

[B] While holding as still as possible,
PLUMB rod to the vertical using the bull's-eye bubble.

[C] **ROTATE** rod so the sunlight will not be reflected into instrument, but the rod faces the instrument to within about ±30 degrees.

5.1.3 Level person:

[A] With instrument mounted on tripod,
START at starting monument
AND PACE about 100 ft toward next monument.

NOTE

Precise leveling is not required because the instrument has an automatic compensator and once the bubble is inside the circle, the instrument is level.

[B] **SPREAD** instrument tripod legs
AND STOMP solidly into the earth, while ensuring the instrument is at an appropriate height and as level as possible.

[C] **LEVEL** instrument with adjusting screws until bubble in the bull's-eye bubble is roughly centered.

5.1.4 Rod 2 person:

[A] **PACE** from the starting monument to instrument and **PACE** an equivalent distance toward next monument.

[B] **PLACE** leveling plate on ground at that point **AND STOMP** it into the earth until it is solid and stable.

[C] **PLACE** rod on knob of leveling plate.

[D] **FACE** toward the instrument, turning it so the sun does not reflect into the instrument **AND PLUMB** the rod.

NOTE

The following settings will be stored in the instrument until changed.

5.1.5 Level person:

[A] **PRESS** Home button.

[B] **PRESS** Settings.

[C] **SELECT** Mode.

[D] **ENSURE** the following settings:

- Meas-Mode: Mean S
- n min.: 5
- n max.: 10
- SDevM/20: 0.0003 ft

[E] **SELECT** Continue.

[F] **PRESS** Home button.

NOTE

The loop name is to be entered using the following convention:

Lxxdddyy, where L is loop, xx is loop number, ddd is the Julian day the level run was completed, and yy is the year of survey.

5.1.6 Level person:

[A] **SELECT** Programs.

[B] **SELECT** Line Level.

[C] **PRESS** F1 to set Job.

[D] **SELECT** New.

[E] **ENTER** Job Name using the format Lxxdddyy.

[F] **SELECT** OK.

[G] **SELECT** <Cont>.

5.1.7 Level person:

[A] **PRESS** F2 to set Tolerances.

[B] **ENSURE** the following setting:

- TDist Bal: On
- All other settings off

[C] **SELECT** Values tab.

- **ENSURE** TDist Bal is set to 10.00 ft.

[D] **SELECT** <Cont>.

[E] **PRESS** F4 to start.

NOTE

All monument numbers have a dash (-) between the letter and the number.

[F] **ENSURE** the following settings:

- Meth: BF
- PtID: Enter the starting monument number (i.e., S-30)
- **PRESS** Continue
- **PRESS** F3 ENH
- **ENTER** Height 0.0
- **PRESS** OK
- **PRESS** Continue
- Staf1: **ENTER** the letter of staff 1
- Staf2: **ENTER** the letter of staff 2

[G] **SELECT** <Set>.

[H] **CHECK** Level and Tilt.

[I] **SELECT** <Cont>.

NOTE

The program will now automatically continue to the leveling routine.

5.1.8 Level person:

[A] After being prompted for back sight reading,
POINT to rod on the back sight,
FOCUS AND PRESS the measure button (red button near focusing knob).

NOTE

Standard deviation readings within the acceptable range are automatically recorded.

[1] **IF** a measurement is not attainable,
THEN RESTART measuring by pressing the red button.

[B] After being prompted for the foresight measurement:

[1] **IF** foresight is a turning point,
THEN ACCEPT the automatically incremented turning point number.

[2] **IF** the foresight is another monument,
THEN ENTER the monument number (i.e., S-30).

[C] **POINT** to rod on the foresight,
FOCUS AND PRESS the measure button (red button near focusing knob).

NOTE

Performance of Step 5.1.8 [C] [1] will complete measurements at that setup.

[1] **IF** a measurement is **NOT** attainable,
THEN RESTART measuring by pressing the red button.

[D] **LIFT AND CARRY** instrument forward approximately 100 ft past the forward rod person to the next setup point.

5.1.9 Level Person:

[A] **IF** the DBal is negative (i.e., -28.4),
THEN the rodman needs to return to the level.

[B] **IF** the DBAL is positive (i.e., 28.4),
THEN the rodman needs to move away from the level.

[C] To reshoot the failed measurement:

- F1 Remeasure the last station to reshoot your last backsight shot.
- F2 Repeat last measurement to reshoot the shot you just took that resulted in a tolerance exceeded message.

OR

- F3 Accept the shot.

5.1.10 Back rod person:

[A] **LIFT AND CARRY** turning plate and rod about 100 ft past the level person.

[1] **IF** this is the end of loop or at another monument, and the rod person has Rod 1,
THEN PLACE the rod on the monument leveling point.

[2] **IF** this is **NOT** the end of loop or at another monument,
THEN PLACE turning plate solidly on the ground
AND PLACE rod on it as described in Steps 5.1.4[B] through 5.1.4[D].

5.1.11 Level person:

[A] **IF** this is the end of the loop or at another monument,
THEN ENTER monument number when prompted for foresight (i.e., PT-31).

5.1.12 **REPEAT** Steps 5.1.8 through 5.1.10[A][2]until loop is completed.

NOTE

Final point number will be the same as starting point number. The instrument will display the amount of error in the level loop. Refer to WP 09-ES.01, WIPP Underground and Surface Surveying Program, for acceptable limits.

Allowable error is less than FGCS specifications for Second Order Class II leveling survey.

[A] **SELECT** F4.

[B] **SELECT** F4 again.

[C] **SELECT** F3 to close.

[D] **COMPARE** displayed amount of error to allowable error **AND DETERMINE** if results of survey are acceptable.

[1] **IF** amount of error is **NOT** acceptable, **THEN REPEAT** survey.

[2] **IF** amount of error **IS** acceptable, **THEN PROCEED** to Step 5.1.122[E]

NOTE

Step 5.1.12[E] may be performed in the office.

[E] **TRANSFER** loop survey data to a USB Stick.

[1] **ENSURE** a USB Stick is installed in the level.

[2] **PRESS** Transfer.

[3] **SELECT** Export.

- To: USB Stick
- Data Type: Measurements
- Job: Single Job

[4] **SELECT**

- Current Job Name

[5] **SELECT** Cont.

[6] **SELECT** Cont again.

[7] **ENSURE** format is XML.

[8] **ENTER** the file name to be exported.

[9] **ENSURE** the extension is XML.

[10] **SELECT** Cont.

5.1.13 **CONDUCT** a Post-Job Review per WP 04-AD3030.

5.2 OFFICE PROCEDURE

NOTE

1. The person performing the office portion of this procedure must be proficient in the use of LIN surveying system software.
2. Data stored in the USB Stick must be downloaded to the computer. Once this is done, it must be processed into a format that can be placed into the Annual Subsidence Report. This is accomplished by using LIN.

5.2.1 Survey Technician or Engineer:

[A] **OPEN** Windows Explorer.

[B] **CREATE/OPEN** folder c:\Subsidence.

[C] **CREATE** a subfolder named the current year (e.g., 2023).

[D] **CREATE** another subfolder below the year named Level Files.

[E] **COPY** the level loop data file(s) from the USB stick to the subfolder named Level Files.

[F] **OPEN** Infinity.

[G] **SELECT** the new project tab.

[1] **ENSURE** template name is US Feet.

[2] **ENSURE** distance is US survey feet: 0.0001.

[3] **CHANGE** project name to the current year (e.g., 2023).

[4] **CHANGE** project location to c:\Subsidence\current year (e.g., 2023).

[5] **CHECK** Create Project Subfolder.

[6] **SELECT** Create.

[H] **SELECT** File, Info & Settings, Data Processing, Level Tab.

[1] **ENSURE** the following parameters are set.

- Adjustment Method: by equally
- Misclosure is selected:
  a = 0.0066 ft, b = 0.0164 ft
- Distance Balance is selected: 32.8083 ft

[2] **SELECT** Home.

[I] **SELECT** Import from tool bar.

[1] **SELECT** the level file from the newly created subfolder.

[2] **SELECT** Import.

[3] Once the level line is added,
THEN SELECT the Inspector tab.

[4] **SELECT** the Level tab.

[5] **SELECT** the Level File
AND CLICK the drop down arrow.

NOTE

The current year's elevation data is used for all loop starting points except for Loop 2. Subsidence point S-37 is held constant from year to year, so the elevation of starting point must be such that S-37 does not change.

[6] **PICK** the first line **AND ENTER** the adjusted Ortho Height in the Property Grid window
AND CLICK Apply.

[7] From the source window,
HIGHLIGHT AND RIGHT CLICK the Level Line.

[8] **SELECT** Adjust line level.

[9] **ENSURE** data processing parameters are set as follows for the Line Level tab:

- Adjustment Method: by equally
- Misclosure is selected:
  a=0.0066 fts, b=0.0164 fts
- Distance Balance is selected: 32.8083 fts

[10] **SELECT** next.

[11] **CLICK** the pencil
AND HIGHLIGHT starting point.

[12] **SELECT** OK.

[13] **SCROLL DOWN AND HIGHLIGHT** the ending point.

[14] **SELECT** OK.

[15] **SELECT** next.

[16] In the line level results, **SELECT** finish.

NOTE

The green check mark in the source window denotes the level line is adjusted.

[J] **RIGHT CLICK** in the bottom panel **AND GO TO** Select Columns.

[1] **CHECK** these required columns:

- Point ID
- BS [ftUS]
- FS [ftUS]
- Hz Dist {ftUS]
- Total Distance [ftUS]
- Ortho Height [ftUS]

[K] **SELECT** OK.

[L] **RIGHT CLICK** the top line
AND SELECT Level Report.

[M] **SAVE** the summary report as a .pdf in the level loop data file using the naming format Lxxdddyy.

[N] **PRINT** a hard copy of the .pdf file.

[O] **SELECT** all lines.

[1] **RIGHT CLICK AND PICK** Save As.

[2] **NAVIGATE** to the correct folder.

[3] **SAVE** the file as Lxxdddyy.csv.

5.2.2 **REPEAT** Step 5.2.1 for each loop.

5.2.3 **COPY** last year's subsidence report
AND EDIT to include current year's data.

5.2.4 **RENAME** report to current year's survey.

5.2.5 **PRINT** two draft reports.

5.2.6 **ENSURE** level person and Cognizant System Engineer are given a copy for review.

5.2.7 **WHEN** comments have been received,
THEN RESOLVE all comments
AND INCORPORATE into document, as necessary.

5.2.8 **PRINT** a final hard copy.

5.2.9 **OBTAIN** Cognizant System Engineer's signature and Cognizant Engineering Manager's signature.

5.2.10 **PRINT** hard copies of the level loop data file and Level Report for each loop.

5.2.11 **PLACE** each set with the Digital Leveling Log Sheet for each loop.

5.2.12 **TRANSMIT** one electronic copy of the final subsidence report to the Document Services designee.

5.2.13 **TRANSMIT** one hard copy of the final subsidence report to the Mine Engineering records coordinator for filing and retention per RIDS.

5.2.14 **TRANSMIT** one electronic copy of the final subsidence report to the U.S. Environmental Protection Agency Compliance Programs Manager.

5.2.15 **TRANSMIT** one electronic copy of the final subsidence report to Librarian at the WIPP Technical Library.

5.2.16 On the survey computer, **CREATE** a new folder under c:\Survey Jobs\Surface\Subsidence Surveys.

5.2.17 **NAME** the folder "yyyy S-Cap Leveling," (yyyy is the year of the survey).

5.2.18 **SAVE** all files, including final subsidence report for current year's survey, in this folder.

5.2.19 **SAVE** a copy of final subsidence report on the network in the Dune\Archives\Report.

Attachment 1 - Individual Loops, Total Survey, and Underground Excavations

