

Method for Calibrating Water-Level
Measurement Equipment Using the
Reference Steel Tape

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Technical Detailed Procedure HP- 26
NNWSI Project Quality Assurance Program

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Method for Calibrating Water-Level
Measuring Equipment Using the Reference Steel Tape

1.0 Purpose

- 1.1 The procedure is intended to assure the continuing applicability, validity, and acceptance standard for activities performed for the exploration for a nuclear-waste repository by the U. S. Geological Survey (USGS).
- 1.2 To establish a method capable of consistent and accurate calibration of water level measuring equipment, and to provide for the modification of that method when it is necessary.
- 1.3 Provide a field guide for all USGS personnel performing water-level measurements using calibrated equipment, such as the iron horse, Dodge logging van, trailer mounted hoists, and steel tapes.

2.0 Scope

- 2.1 This procedure applies to those equipment calibrations carried out by a Project Chief, or a designated representative, assigned to the Nevada Nuclear-Waste Storage Investigations (NNWSI) of the USGS.
- 2.2 The procedure shall be followed by all USGS personnel assigned to the investigations who make such calibrations.
- 2.3 The procedure shall also be followed by any contractor performing such tasks for the USGS if the contractor does not have a quality assurance program that is acceptable to the USGS Quality Assurance Manager.

3.0 Modifications

If during the course of calibration it is necessary to deviate from the approved procedures, the USGS Project Chief shall be informed and the procedure modification shall be documented. The documentation shall describe the modification, the affected section or sections of this procedure, and shall be dated and signed in ink

by the hydrologist or a USGS designated responsible person. If it is necessary to correct a written error, the error shall be crossed out with one line, dated, and signed.

4.0 Principle

Periodic calibration of measuring equipment is required for continued accuracy in measuring water levels at the Nevada Test Site (NTS) vicinity which range in depth from a few hundred feet to nearly 2,500 feet. Water-level measuring equipment is required to be calibrated against the reference steel tape for a minimum of three different depths to water spanning the use range for the equipment. Once a variance has been established between the steel tape and the equipment being calibrated a correction factor or curve for the equipment shall be generated.

4.1 A reference steel-tape measuring system is designated from the following components.

4.1.1 A composite steel tape spliced together from two lengths calibrated by Brunson Instrument Company, Denver. The composite is of Lufkin Canyon Line (Pat No. 04500B), one-eighth inch wide.

4.1.2 Two reels containing the tape:

a) Two thousand feet of tape is mounted on an AC-powered reel controlled by a powerstat (variable auto transformer).

b) Five hundred feet of tape is mounted on a small, hand operated reel and can be attached to the other reel of tape.

4.1.3 The tape is marked at one-foot intervals. In addition, the one-foot interval extending below the zero point is divided into hundredths of a foot.

4.1.4 Lead weight is attached to the bottom end of the steel tape to cause the tape to hang tautly and facilitate lowering the tape down a well. Other weight arrangements may be used for this purpose.

- 4.1.5 Blue carpenter's chalk or color paste, reel clamps, and protective tubing for tape (optional).
- 4.2 The power reel has the following features:
 - 4.2.1 110-volt AC-power source is required;
 - 4.2.2 Powerstat controls the rotational speed of the reel;
 - 4.2.3 Two control switches:
 - a) Power switch for the motor (ON/OFF)
 - b) Rotation direction switch for the reel (FORWARD/REVERSE)
- 4.3 The Project Chief or designated representative will be required to:
 - 4.3.1 Calibrated and determine correction factors for all water-level measuring equipment (such as the Dodge logging van, trailer-mounted hoists, and iron horses), at three-year intervals or at other times or frequencies if needed.
 - 4.3.2 Exhibit a thorough knowledge of the steel-tape system operation as well as the operation of the equipment being calibrated.
 - 4.3.3 Achieve an error level not to exceed 1:1000 or 0.1%.
 - 4.3.4 Record calibration data and any modifications of calibration procedure on the appropriate form.
 - 4.3.5 Maintain proper care of the reference steel-tape system while in use, while being transported, and while in storage.

5.0 Method

Establish the depth-to-water range for the equipment to be calibrated. For example, if depths-to-water range from 700 to 2500 feet below land surface (such as Yucca Mountain), a minimum of three wells with water levels spanning that range shall be

selected for use in calibration. A series of water-level measurements shall be made in each well using both the reference steel tape and the equipment being calibrated. Depths to water determined by the steel tape and the equipment shall be repeated until measurements agree to within one part in 1000 and a representative value has been selected for each. A correction factor or curve shall be determined using the form (Appendix A) after determining the differences between the selected steel-tape values and selected equipment values.

5.1 Equipment Needed

- 5.1.1 Steel tape measuring system
- 5.1.2 110-volt AC power source
- 5.1.3 Water-level measurement equipment to be calibrated.
- 5.1.4 Pocket tape measure and adhesive flagging tape.
- 5.1.5 Forms for recording information and data (see Appendix A), and pen.
- 5.1.6 This detailed technical procedure for calibration (NWM-USGS-HP-26, R0) and appropriate operating procedure for water-level measuring equipment being calibrated.

5.2 Procedure

- 5.2.1 Operate the reel preferably from the bed of a pickup truck in the following manner:
 - a) Position the truck so that the back edge of the lowered tailgate is centered directly over the well.
 - b) Position the reel on the tailgate so that the tape will extend vertically into the well.
 - c) Unreel approximately 6 feet of tape and chalk it heavily with blue carpenter's chalk or apply color paste. If needed, install protective tubing to the part of the tape containing the chalk or paste. Feed the chalked tape into the well by hand.

5.2.2 Supply power to the reel:

- a) Position the ON/OFF switch in the power line to OFF. Position the speed-control lever on the powerstat to the full-counter-clockwise (OFF) position.
- b) Plug in power-line cord to power source.
- c) Position ON/OFF switch in power-line to ON position. Position direction-of-rotation switch on motor to FORWARD.

5.2.3 Lower steel tape into the well:

- a) Gradually turn the powerstat control clockwise to slowly lower tape down the well. Stop tape descent when the 20-foot marker on tape is about to enter the well by returning the powerstat control to fully clockwise (OFF) position. Apply adhesive flagging tape to the steel tape at the 20-foot mark.

CAUTION: If tape becomes lodged while going down the well, stop the reel immediately or the tape might unspool from the reel and become tangled.

- b) Again turn powerstat control slowly clockwise to gradually lower tape the next 100 to 200 feet.
- c) Below a depth of 100 to 200 feet, reel speed may be increased with caution. The operator should monitor approximate depths by sensing with a gloved hand the splices of tape of 500-foot intervals. In addition, approximate depths are marked on the side of the reel.

5.2.4 Lower tape to the expected depth to water:

- a) From previous water-level records, determine last measured depth-to-water and reference point. Adjust depth-to-water to current measuring point, if needed. Ideally, round

off the depth-to-water value to the nearest foot less than the depth-to-water below the current measuring point. This will allow the water-cut to fall on the 1-foot interval of tape extending below the zero point. This 1-foot interval is divided into 100 divisions.

- b) Using the rounded number generated in the previous step, lower the tape until that value on the tape approaches the measuring, or reference point, of the well. Stop the tape. The last 2 or 3 feet of tape are then to be lowered by hand until the tape value above is aligned with the measuring point with an error of no more than 0.01 feet.

5.2.5 Remove tape from the well:

- a) Position the direction control switch on the motor to REVERSE. Rotate powerstat control in a clockwise direction and operate the reel at full speed to remove tape to within 200 feet of land surface. From a depth of 200 feet to the flagging tape at 20 feet, operate reel at half-speed. At the 20-foot depth attach Clamps over flange-edge of reel to prevent unspooling of cable during the next step.
- b) Remove by hand the last 20 feet from the well allowing the tape to accumulate on the ground. While removing the tape from the well, have it positioned in such a way that the numbered side of the tape does not rub against the side of the well casing or tubing. CAUTION: To avoid smearing water-cut point, do not handle chalked part of the tape. Immediately

and quickly identify the water-cut point and read its distance from zero on the tape. The pocket tape measure may be useful in measuring the interval. Read and record the measured DTW to nearest 0.01 feet.

- 5.2.6 Repeat steps 5.2.1c through 5.2.5b until difference between any of the water-level measurements is less than one part of 1,000.
- 5.2.7 Use the appropriate form (Appendix A) to make calculations of depth to water. Provide all necessary information on the form before leaving the site (example, Appendix B). Note any modifications of equipment and notify Project Chief of any modification in calibration procedure.
- 5.2.8 Securing Equipment
 - a) Reel in the last 20 feet of tape, and apply clips to the flange edge of the reel. (Clean tape and reel as needed.)
 - b) Unplug power cord.
 - c) Place powerstat on the left side of the reel frame and place power cords within the reel framework.
 - d) Position and secure power reel in the pickup truck and close the tailgate.
 - e) While transporting reel, use caution to avoid damage.
 - f) Tape and reel shall be stored in a clean, dry area to avoid damage or deterioration. Note: Tape is to be used only for calibration purposes. No other kinds of field measurements are to be made with this tape.

5.3 Calculation of correction factor or curve

5.3.1 Only systematic variations of the correction or curve are acceptable unless the variations result in a potential error in measurement of less than one part in 1,000.

5.4 Correction factors be posted on calibrated measuring equipment. The graph of the correction curve should be taken to the field along with this QA operation procedure when measurements are being made.

6.0 Calibration Frequency:

6.1 Logging van - after each 1,000 measurements, but at least every 12 months, and when cable or counter sheave are replaced.

6.2 Iron Horse - after one year of use; and when cable or counter sheave are replaced.

6.3 Trailer-mounter hoist - after one year of use and when cable or counter sheave are replaced.

Appendix A. -- Calibration of water-level measurement equipment
 using the reference steel tape

Calibrator(s)	_____	Measuring point	_____
Date	_____	MP above LSD	_____ ()
Wall used	_____	Expected DTW:	_____ ft
Procedure	_____		

Reference-tape Measurements

	#1	#2	#3	#4	#5	
Held at MP (ft)	_____	_____	_____	_____	_____	(1)
Wet (ft.) ¹	_____	_____	_____	_____	_____	(2)
DTW (ft.)	_____	_____	_____	_____	_____	(1-2)
Quality of cut ²	_____	_____	_____	_____	_____	

Procedure for
 selection of
 DTW value:

Uncorrected DTW value _____ ft. (3)

Thermal expansion correction for reference tape (ft.)

UE 5n - 0.005

UE 25 B-1 + 0.10

USW H-3 + 0.15

Reference tape DTW

_____ ft. (4)

_____ ft. (3+4)

1. Show cuts below zero point as a negative number (and add)

2. Use: excellent, good, fair, poor

Other notes:

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 —
 —
 —

Equipment Calibration _____

	#1	#2	#3	#4	#5	
_____ ()	_____	_____	_____	_____	_____	(6)
_____ ()	_____	_____	_____	_____	_____	(7)
_____ ()	_____	_____	_____	_____	_____	
_____ ()	_____	_____	_____	_____	_____	
_____ ()	_____	_____	_____	_____	_____	

Difference to DTW ratio:

_____ ÷	_____ / :	_____ #	_____, #	_____
	_____ / :	_____ #	_____, #	_____
	_____ / :	_____ #	_____, #	_____
	_____ / :	_____ #	_____, #	_____
	_____ / :	_____ #	_____, #	_____

Procedure for selection of DTW value using equipment being calibrated:

Calculation of DTW: ^{1/}

Equipment DTW: _____ ()
_____ ft. (11)

Reference tape DTW _____ ft. (5)

Difference _____ ft² (11-5=12)

Calculation of correction factor for equipment being calibrated:

(12÷11) _____ ^{3/}

Footnotes:

1. Differences between values used to calibrate should be less than DTW X 0.001.
2. If reference tape value is smaller than equipment value, record a negative difference.
3. Use proper sign for computed factor.

Remarks:

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