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Environmental Programs Directorate
Corrective Actions Projects

Standard Operating Procedure

For **PRESSURE TRANSDUCER INSTALLATION, REMOVAL, AND MAINTENANCE**

APPROVAL SIGNATURES:

Subject Matter Expert:	**Organization**	**Signature**	**Date**
Tim Goering	ET-EI	/s/Tim Goering	11/07/11
Responsible Line Manager:	**Organization**	**Signature**	**Date**
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1. PURPOSE AND SCOPE

This standard operating procedure (SOP) states the responsibilities and describes installation, removal, and maintenance procedures for the pressure transducers that are placed in groundwater monitoring wells, piezometers, or surface water locations for monitoring and recording water-level and/or water quality data at Los Alamos National Laboratory (LANL), Environmental Programs Directorate (ADEP).

2. BACKGROUND AND PRECAUTIONS

2.1 Background

Transducer equipment is used to periodically to measure water levels in individual wells or surface water locations at user-specified intervals and record these values in computer memory for later retrieval.

Two types of pressure transducer equipment are currently used in monitoring wells at LANL.

- “Compensated” or “gauged” pressure transducers have pressure sensors that are compensated for atmospheric pressure. One side of the pressure sensor diaphragm is vented to the atmosphere, thus compensating for changes in atmospheric pressure and measuring water pressure only (psig). When transducers are used calculations of water depth above the transducer exclude atmospheric pressure considerations. These transducers employ a tube in the cabling to vent the transducer to the atmosphere and are used in most shallow monitoring wells and single-completion deep monitoring wells. Examples of “compensated” or “gauged” transducers include: standard In-Situ, Inc. MiniTroll and Level Troll transducers.
- “Absolute” or “uncompensated” pressure transducers measure absolute pressure (psia) and are not compensated for atmospheric pressure. Pressure measurements from this type of transducer include atmospheric pressure as a component; therefore, atmospheric pressure must be subtracted from the absolute measurement to determine the pressure from water. All transducers used with the Westbay MP multiple port monitoring system measure absolute pressure. Additionally, other manufacturers, including In-Situ, Inc., produce absolute pressure measuring transducers; thus, personnel must be aware of the type of transducer used so that data can be processed accordingly.

In addition to the two types of pressure transducers, transducers that are also capable of recording multiple water quality parameters, or 'multiple parameter' transducers may also be utilized in monitoring wells. These transducers have the additional capability of measuring conductivity of groundwater or surface water; the conductivity measurements can be used to calculate supplementary water quality parameters such as resistivity, salinity, total dissolved solids, and density.

2.2 Precautions

Project personnel and contractors who work with pressure transducer equipment require training before implementing this procedure.

The work specified in this procedure shall be conducted in accordance with applicable Integrated Work Documents, in accordance with LANL IMP 300-00-00, Integrated Work Management for Work Activities.

Project personnel using this procedure should become familiar with the contents of the following documents to properly implement this SOP:

- SOP-5223, *Manual Groundwater Level Measurements*

3. EQUIPMENT AND TOOLS

Suggested equipment for **installing and removing transducers** in monitoring wells or surface water locations:

- Transducer(s)
- Transducer cable
- Cable landing hardware (e.g., docking ring)
- Spool or rack for transducer cable
- Tripod and anchoring equipment where necessary
- Data logger (if required)
- Manufacturer operating manual
- Portable computer and appropriate transducer direct-cable connection
- Memory stick or other removable electronic media for data storage (Note: thumb drive or other removable storage devices are prohibited in security areas.)
- Extra batteries for transducers, water-level tape, and laptop computer
- Silicon lubricating grease
- Waterproof ink pen(s)
- Water level meter
- Groundwater Level Program Field Form (Attachment 3)
- Well construction information
- MP diagrams
- Water level history of well (if known)
- Generator with ground fault circuit interrupt (where necessary)
- Electric extension cord (where necessary)
- Tripod or well head roller for installations with cable greater than 100 feet
- Deionized water
- Paper towels
- Nitrile gloves
- Trash bags
- Keys to wells & access gates where necessary
- Site-specific equipment permit (ESA)

Suggested equipment for **transducer maintenance and calibration performance check**:

- Pressure transducer
- Transducer cable
- Portable computer and appropriate transducer direct-cable connection
- Tape measure graduated in 0.01 feet
- Water Quality and Hydrology In Situ Transducer Performance Check and Maintenance Form (Attachment 1)
- Marking pen
- Silicon grease for O-ring lubrication
- Batteries for transducer equipment
- 100-feet steel measuring tape
- Standard conductivity solutions for performance checking multiple parameter transducers
- Capped polyvinyl chloride pipe or clear (acrylic polycarbonate) pipe (approximately 4 to 5 feet in length)

4. STEP BY STEP PROCESS DESCRIPTION

4.1 General Requirements for Transducer Installation or Removal

Field Team Member(s)

1. Before departing for the well site, check data loggers and transducers for functionality.

   NOTE: Refer to Section 4.2, *Calibration and Maintenance of Pressure Transducer Equipment*, of this procedure.

2. Prepare water level meter according to SOP-5223, *Manual Groundwater Level Measurements*

3. Transducer equipment is typically installed in a specific well and dedicated to that well; therefore, minimizing the potential for cross-contamination.

   - If transducer equipment must be installed in a different well, thoroughly wipe the cable and transducer with a clean cloth soaked in deionized water as the transducer is installed/removed to prevent cross-contamination.

4. Transducer software clocks and internal clocks in the portable computer used with the transducer equipment must have the time set to Mountain Standard Time (MST) at all times, without any daylight-savings time adjustment in the spring and fall.

   - Disable the automatic daylight savings time adjustment setting in Microsoft Windows-based computers used with transducer equipment to prevent the clock from changing to daylight savings time.
   - Check the clocks on all portable computers before each use to ensure the time and date on the computer is appropriate and set the MST.
   - Disable the daylight savings time function in transducer software.

4.2 Calibration and Maintenance of Pressure Transducer Equipment

Field Team Member(s)

1. Ensure that pressure transducer equipment is properly maintained according to the manufacturer's instructions.

NOTE: All calibration of pressure transducers is performed by the manufacturer. A transducer is considered to be properly calibrated as long as the transducer returns values that are within pre-determined measurement accuracy and precision specifications (See Attachment 4) (Regardless of calibration date). How long a transducer will maintain calibration depends how regularly the transducer is used, whether or not the transducer was exposed to environmental extremes, and how the transducer was handled during use, transportation, and storage.

- Before first installing a transducer perform a bench test as described in Section 4.3:
- Before re-installing transducers, check that the instrument measures 0.00 ± 0.1% gauged psi in air. For any offsets smaller than 0.2% reset the transducer to air pressure. Record the pressures measured before and after resetting on the Groundwater Level Program Field Form (Attachment 3).

  If the offset is larger than 0.2%, clean the transducer with a DI-soaked paper towel and reset to 0.000 psi and re-measure the pressure in air. If the transducer still measures an offset larger than 0.2%, replace the transducer and perform a performance test on the transducer that recorded the erroneous measurement (See Section 4.3).

  For multiple parameter transducers, check that the conductivity and associated measurements are within specifications according to manufacturer instructions.
- Record transducer calibration date(s) on the In Situ Transducer Performance Check and Maintenance Form (Attachment 1) and on the transducer inventory.
- Perform transducer performance checks if a transducer is suspected of malfunctioning (See Section 4.3).
- Document the performance check on the In Situ Transducer Performance Check and Maintenance Form (Attachment 1). Maintain equipment maintenance records and calibration data with project records to provide defensible quality data from transducer equipment.

Field Team Member(s) (cont.)

2. Follow the requirements of each equipment manufacturer (Attachment 2) to maintain transducer equipment.
   - Document maintenance on the In Situ Transducer Performance Check and Maintenance Form (Attachment 1).
   - Perform routine checks each time a transducer is installed or removed from a well, and conduct maintenance on an as-needed basis. Routine checks and maintenance activities include the following:
     - Check/change batteries
     - Check/lubricate O-rings
     - Check cables and vent lines
     - Keep equipment clean and work area uncluttered
     - Wipe cable and transducers with a clean cloth soaked in deionized water during removal from well; cap all connections to prevent damage from rust and corrosion
     - Complete a performance check if needed
     - For vented transducers ensure desiccant capsule is not saturated, and replace if necessary to prevent vent line from clogging.
     - Disconnect components and package appropriately for transport and storage if the transducer is being removed.

3. Ensure that saturated transducer cable desiccants are dried and re-used.
   - Dry desiccant capsules in the drying oven at a temperature no greater than 125 degrees Fahrenheit.

   NOTE: An off-the-shelf commercial-grade thermometer is of sufficient accuracy and precision for measuring the temperature of the oven. Most capsules will be dry within 3 days, but times will vary with saturation.

4.3 Performance Check

Field Team Member(s)

1. Bench Test

   Bench test transducer equipment prior to installing new equipment and annually if transducer equipment has not been in use.
   - Connect the transducer to the cable to be used, if appropriate, or to a spare cable and secure the transducer in air.
   - Program the transducer to record the pressure measurements in air at least every one minute for at least 15 minutes or preferably over night while recording at a maximum of 15-minute intervals.

Field Team Member(s) (cont.)

- Determine the error tolerance of the transducer by multiplying the pressure rating of the transducer (psi) by 0.001 (0.1%).
- Download the Bench Test data from the transducer and save the test data file for the specific transducer serial number.
- Determine that measurements are within the error tolerance and determine if steady drift in any direction is present.
- Record the transducer make, model, and serial number, cable serial number, cable length, bench test start and stop times and the results of the bench test on the Transducer Bench Test Form (Attachment 5).
- For multiple parameter transducers, insert the transducer into standard solutions of known conductivity while obtaining conductivity measurements according to manufacturer instructions. Record the measurements on the Transducer Bench Test Form (Attachment 5).
- If measurements are not within error tolerance, or a noticeable drift occurs:
  - Perform additional bench testing measurements as needed.
  - If the transducer does not measure within specifications, return transducer to manufacturer for calibration and/or repair.
- Save the bench test data file(s) for reference and record results on the Bench Test Form (Attachment 5) and in the forms maintained in the transducer files.

If there is a suspected malfunction with a transducer (See Section 4.2.1) additional performance checks may be performed, Perform a depth test (Step 2) and/or a drift test (Step 3) to conduct additional performance checks on a pressure transducer.

2. Depth Test

For compensated transducers, obtain a pressure measurement with the transducer in the air.

- Ensure that the transducer measurement in air is 0 [pounds per square inch (psi)], within the measurement precision of the transducer.

  NOTE: Measurements that are not 0 psi may be caused by using a cable that has a blocked vent line.
- If the transducer is not measuring 0 psi, use another cable to determine if the problem is with the transducer or the cable.
- Record the air measurement on the In Situ Transducer Performance Check and Maintenance Form (Attachment 1).

Place the transducer in the well or water column at the first position by performing the following steps:

- Temporarily position the transducer 1 to 2 feet below water level.
- Record the water depth [PH1 (feet)] on the In Situ Transducer Performance Check and Maintenance Form (Attachment 1).
- Secure the cable and mark the transducer cable at the top of casing or at another convenient measuring point.

Field Team Member(s) (cont.)

- Measure a specific length of the remaining cable that extends from the well using the 100 feet steel tape.
- Use a measured length that is within the rated capacity of the transducer

  NOTE: Refer to the Section 4.4, *Transducer Selection and Installation*, within this document.
- Record the length measured on the cable [Cable Length (feet)]
- Use the full range of the transducer for the calibration check if the well/water column depth allows.

Place transducer in the well or water column at the second position by performing the following steps:

- Lower the transducer and cable in the well or water column the measured length as determined above.
- Position the measured mark on the cable at the top of the casing/water column at the previously used measuring point.
- Record the measured water depth [PH2 (feet)] provided by the transducer on the Water Quality and Hydrology In Situ Transducer Performance Check and Maintenance Form (Attachment 1).

Verify that the difference between the transducer depth measurements [PH2 – PH1] corresponds with the length measured on the cable within the measurement precision of the transducer.

NOTE: Refer to Attachment 4, Guidance for Maximum Water Depths of Transducers.

- If not, check the cable or transducer to ensure that it hangs freely in the well or water column and repeat the calibration check.
- If the transducer does not pass the depth test, discontinue use and ship the transducer to the manufacturer for calibration.

3. Drift Test

- Secure the transducer at a known depth in a contained water column.
- Record the pressure measurements every one minute for at least 15 minutes (preferably over night).
- Determine the error tolerance of the transducer by multiplying the pressure rating of the transducer (psi) by 0.001 (0.1%).
- Check measurements for measurements beyond the error tolerance or steady drift in one direction.
- If measurements are not within error tolerance, or a noticeable drift occurs:
  - Recheck the pressure measurements.
  - If there is a possibility that the water column was disturbed during the drift test, repeat the test.
  - If the transducer does not pass the drift test, return transducer to manufacturer for calibration and/or repair.
- Record results on the In Situ Transducer Performance Check and Maintenance Form (Attachment 1).

Field Team Member(s) (cont.)

4. Multiple Parameter Performance Check

- Follow manufacturer recommendations for performance checking multiple parameter instruments; multiple parameter instruments such as the In Situ AquaTroll 200 measure conductivity as the primary measurement.
- According to the manufacturer, "the conductivity cell of the In-Situ AquaTroll 200 does not require a user calibration to achieve the highest degree of instrument accuracy."
- At the beginning and end of critical deployments, conduct a quick performance check to ensure the instrument is performing to its specifications. A simple one-point or two-point check is performed by measuring a conductivity standard using the default factory calibration. Performance checks are often used after instrument cleaning to measure instrument drift
- Prepare one to three solutions of known conductivity that are within the range of fresh water applications known to be present at LANL, typically <2000 uS/cm.
- Insert the transducer into the solution(s) according to manufacturer recommendations and gently stir or shake to remove any air bubbles from the sensors and to allow the temperature of the sensor and solution to equilibrate
- Record the specific conductivity measurements on the Transducer Bench Test Form (Attachment 5).
- Check that measurements are within the combined theoretical error of the calibration solution and the instrument.
- If measurements are not within error tolerance, or a noticeable drift occurs:
  - Recheck the conductivity measurements.
  - If the transducer does not measure appropriate values, return transducer to manufacturer for calibration and/or repair.

4.4 Transducer Selection and Installation

NOTE: Do not submerge transducers in water pressures greater than the specific pressure rating of the transducer. The pressure rating is provided by the manufacturer for each transducer. At standard pressures and temperatures in water, a general pressure-depth conversion is 2.31 feet/psi. Attachment 4 provides guidance for maximum water depths of transducers and indicates the measurement precision characteristic of different pressure rated transducers.

Field Team Member

1. Before installing a transducer in a well:

- Obtain the groundwater level
- Consider the range of expected water level fluctuations in the well or surface water location
- Determine the depth below water surface that the transducer will be placed to measure the full range of expected fluctuation.

Field Team Member(s) (cont.)

2. Use a transducer with the lowest pressure rating possible for the specific application because measurement precision decreases with higher pressure ratings (see Attachment 4).

   NOTE 1: In monitoring wells open to the atmosphere at LANL, annual water level fluctuations may be less than 15 feet, which would indicate installation of a transducer with a pressure rating of 15 psi at a depth of 15 to 17 feet below the water level. Shallow alluvial wells may experience water level fluctuations of 30 feet or more. However, use of 30 psi rated transducers in wells with less than 20 ft of groundwater level variability provides adequate accuracy and provides additional flexibility of use of the transducer equipment in other deeper wells as needed.

   NOTE 2: In monitoring wells adjacent to water supply wells or in water supply wells, the daily water level drawdown might be 100 to 150 feet or more. Given an anticipated drawdown of 150 feet, a transducer with a pressure rating of 100 psi should be installed at a depth of 170 to 200 feet below the water surface.

3. Manually measure the static groundwater level using a water level meter according to SOP-5223, and perform the following steps:
   - Record the date, time, and measured depth to water on the Groundwater Level Project Field Form (Field Form) (Attachment 3).
   - Calculate the groundwater elevation on the Field Form (Attachment 3).
   - Record the groundwater elevation on the Field Form (Attachment 3).
   - If possible, measure the total depth of the well and record the depth measured on the Field Form (Attachment 3).

4. Apply silicone lubricant to O-rings on transducer connections following manufacturer instructions.

5. Connect transducer cable to transducer and to data logger/portable computer according to manufacturer instructions.

6. Check for appropriate communications with transducer

7. Check the date and time on the portable computer, and on the transducer.
   - Ensure that the transducer or data logger is recording the correct date and time and that the time is MST.

8. Record the information above “Manual Depth to Water Measurement” except file name and file comments on the Field Form as well as any comments (Attachment 3).

9. Carefully lower transducer into the well:
   - Lower the transducer **slowly**, in a controlled manner, into the water.
   - Do not allow the cable to rub against the sharp edge of metal casing.

Field Team Member(s) (cont.)

- Do not allow the transducer to contact the water level at a high rate of speed; this will damage the pressure sensor.
- Do not submerge the transducer to a water depth pressure greater than the pressure rating of the transducer.

10. Install pressure transducer:
    - Install pressure transducer at an appropriate depth to monitor the full range of expected water level fluctuation (see Attachment 4).
    - For multiple parameter transducers, install the transducer within the screen interval, do not install in the sump if possible. After installation, gently shake the transducer at the location to be installed to dislodge any air bubbles from the conductivity sensor.
    - Affix and secure the transducer cable at the top of the casing to prevent cable slippage. Following manufacturer's instructions.
    - Do not kink or pinch the vent tube in a compensated transducer cable.
    - Ensure that the cable desiccant is dry (blue) and in good condition; replace desiccant (pink), if necessary.
    - If possible, mark the transducer cable to indicate cable placement and to aid in detecting cable slippage or tampering

11. Initialize measurement software/data logging software according to manufacturer instructions:
    - Program the software for appropriate measurement sampling interval for the intended purpose and use of the data.
        - Record the measurement interval on the Field Form (Attachment 3).
    - Program the transducer reference level with the groundwater elevation measurement obtained before installation of the transducer as the reference level.

      NOTE: The reference level should be entered to an accuracy of 0.01 feet.
        - Monitor water level to ensure the well has equilibrated to the displaced water due to transducer installation.
    - Program software to begin measurements on one minute after the next hour after the water level measurements stabilize (i.e. 12:01).
    - Record the transducer test name and start date/time on the Groundwater Level Program Field Form (Attachment 3).

12. For deep well installations where manual water levels are not possible after transducer is installed, watch for cable straightening and groundwater equilibration.
    - Record the transducer measurement(s) every few minutes during this time on the Field Form (Attachment 3). If using Win-Situ 5, activate the polling function and monitor for water level changes.

Field Team Member(s) (cont.)		• Water level is considered stable when water level is no longer trending in one direction. After water level is stable, program the transducer to the measured groundwater elevation (reference level). **NOTE:** This is especially important in the lower Baski system screens where stabilization of the water in the gage tubes may take up to 1 hour to equilibrate after transducers are removed and installed. If stabilization is difficult to achieve in an intermediate or regional well it is possible that the well is experiencing drawdown or recharge in response to activity at another nearby well.
	13.	For multiple parameter instruments, record conductivity measurements every few minutes, along with the water level measurements, to ascertain that the measurements are stable.
	14.	Replace caps and locks on well shelter.
	15.	Properly dispose of contact waste generated during installation according to requirements in the Waste Characterization Strategy Form (WCSF) or Waste Profile Form (WPF) for each well.
4.5 Transducer Data Retrieval		
Field Team Member (s)	1.	Retrieve transducer data from wells as scheduled to insure the continued quality of the transducer data. **NOTE:** The frequency of retrievals will be determined by the work plan under which the data is collected.
	2.	Connect portable computer to data logging equipment or transducer cable and start manufacturer provided software specific for the transducer equipment.
	3.	Record the current transducer measurements on the Field Form (Attachment 3) prior to stopping or downloading a test.
	4.	Extract the transducer data set according to manufacturer instructions. **NOTE**: If a new data file is going to be started, stop logging to the current file prior to downloading if possible. Document data retrieval information on the Field Form (Attachment 3), including: • All fields above “Manual Depth to Water Measurement” as well as new test information and reinstall information if a new test is started. Record any comments in the comments field.
	5.	View the data collected since transducer installation. • Ascertain that appropriate data have been collected.

Field Team Member(s) (cont.)	6.	Copy the data file to removable electronic media (thumbdrive) once out of the field. **NOTE:** Only delete the transducer data after insuring that the data file has been properly transferred and stored to the portable computer, and has been backed up on a removable electronic media.
	7.	If a manual groundwater level is going to be obtained, go to step 8, or if a manual groundwater level is not going to be obtained, go to Step 11.
	8.	Manually measure the groundwater level according to SOP-5223.
	9.	If the well construction allows manual groundwater level measurement without disturbing the transducer (separate access ports), perform the following steps: • Manually measure the groundwater level. • Record the groundwater elevation measurement on the Field Form (Attachment 3) or in the field notebook. • Compare the groundwater elevation obtained from the manual measurement with the groundwater elevation measurement from the transducer. • If these values are off by more than the measurement precision of the transducer (See Attachment 4 for measurement precisions), reset the level reference to the new groundwater elevation value obtained during the manual measurement provided the values are off by less than the maximum amount defined in Section 4.2. If the transducer values are off by at least the amount requiring a performance check as defined in Section 4.2 and 4.3, replace the transducer as soon as possible and follow the guidance in Section 4.3 to evaluate the potentially faulty transducer.
	10.	If the well does not have separate access tubes for the transducer and the water level meter, perform the following steps if the well is due for a manual measurement: • Remove the transducer from the well. • Manually measure the groundwater level. • Record the groundwater elevation measurement on the Field Form (Attachment 3) or in the field notebook. • Reinstall the transducer following the Transducer Installation procedure.
	11.	Check that the transducer clock is the correct time (MST), with no correction for daylight savings.
	12.	If logging was stopped or the transducer measurement is not accurate, or if current test has been running for approximately six months or more: • Restart the data logger software following the transducer installation procedure and use the newly obtained groundwater elevation as the reference level. • Document activities on the Field Form (Attachment 3).

Field Team Member(s) (cont.)	13.	Check cable desiccant. • If desiccant is saturated (pink), replace desiccant capsule with a dry desiccant (blue).
	14.	Properly dispose of contact waste generated during data retrieval according to requirements in the WCSF or WPF for each well.
	15.	Transmit data file to a backed up server for safe keeping. • Ensure that data file is secured and data transmittal is completed. • Do not remove data file from portable computer or removable media before data is backed up on a server.
4.6 Transducer Removal		
Field Team Member	1.	Discontinue the data logging program per manufacturer instructions.
	2.	Retrieve transducer data from data logger as described in the Transducer Data Retrieval section above. • Record the same information on the Field Form (Attachment 3).
	3.	For a shallow installation, manually measure the groundwater level according to SOP-5223. • For deep well installations, go to Step 4 within this section first, then take a manual water level.
	4.	Remove the cable and transducer(s) from the well: • Use cable-pulling system if cable is longer than 500 feet. • Ensure that the cable does not scrape against the sharp edges of well casing. • Clean and maintain transducer equipment as described in the Transducer Equipment Maintenance section of this procedure. • Package transducers appropriately for transportation according to the manufacturer instructions.
	5.	Replace well caps and locks.
	6.	Properly dispose of contact waste generated during transducer removal according to requirements in the WCSF or WPF for each well.

4.7 Records Management		
Field Team Leader	1.	Maintain and submit the following records and/or documents, generated as a result of this procedure, to the Records Processing Facility in accordance with the *Records Management Procedure for ADEP Employees*, EP-DIR-AP-10003. Records include the following: • In Situ Transducer Performance Check and Maintenance Form (Attachment 1) • Groundwater Level Project Field Form (Attachment 3) • Transducer Bench test Form (Attachment 5) • Raw water level data electronic file on electronic media (data transfer) • Other associated information

5. DEFINITIONS

Absolute pressure – The total or absolute pressure measured by a sensor without correction for atmospheric pressure. A pressure measurement that includes atmospheric pressure is and absolute pressure. Units are expressed in psia (pounds per square inch absolute).

Bench test - A brief test performed to ensure that transducer equipment is working properly before installation in a monitoring well.

Conductivity - a measurement parameter of multiple parameter transducers, which report two conductivity measurements, actual conductivity and specific conductivity. Actual conductivity is a measure of the ability of an aqueous solution to carry an electric current. Actual conductivity is temperature dependent; as water becomes less viscous at high temperatures, ions move more easily. Specific conductivity is a means of expressing what the actual conductivity of a solution would be at a standard reference temperature, which is usually at 25 C.

Depth test – A test performed to evaluate the accuracy of a pressure transducer in which the actual known depth under the surface of water a transducer is placed is compared to the reading given by the transducer.

Drift test – A test performed to evaluate the stability of a pressure sensor. A transducer is suspended at a known depth below water surface, and is set to record values over a set period of time. Data are then evaluated to ensure the transducer has recorded stable water pressure values for the duration of the test. Any variation in values must be within the measurement precision of the instrument.

Gage pressure – The pressure measured relative to atmospheric pressure. Measurements exclude atmospheric pressure and are said to be compensated or gauged for atmospheric pressure. A vented or gage pressure transducer sensor uses a vent tube in the cable that exposes one side of the pressure sensor to atmospheric pressure, measuring pressure of the water column only. Units are expressed in psig (pounds per square inch gauged).

Ground elevation – The elevation of the ground surface of the well expressed in feet above mean sea level. If the well has a concrete surface pad, usually the elevation of the top of the concrete pad is used. If a brass cap is present to identify a well, usually the elevation of the brass cap in the concrete pad.

Field team member – LANS or subcontractor personnel trained to this procedure and authorized to conduct the work prescribed in this procedure.

Performance check – A check of the performance of the transducer to ensure the transducer is still within calibration. Performance checks consist of a drift test and/or a depth test.

Pressure head – The pressure measured by the transducer in a well which can be used to calculate the height of the column of water above the transducer.

Pressure transducer **(Transducer)** – A device that measures pressure. There are two types of pressure transducers, those that measure absolute pressure, and those that measure gage pressure.

psi – Unit of pressure measurement in pounds per square inch.

psia – Unit of pressure measurement in pounds per square inch absolute (see absolute pressure).

psig – Unit of pressure measurement in pounds per square inch gauged (see gauge pressure).

Raw data files – Electronic pressure transducer data files that are obtained from pressure transducers or data loggers at a well site. Raw data files are usually binary computer files that can be opened, read, and interpreted only by software developed by the transducer manufacturer. The raw data files must be stored and archived appropriately to protect the original data recorded by the pressure transducer. Raw data files contain the raw pressure measurements and date/time stamp from the transducer and may also contain information entered into the transducer software program at the time of installation, such as well name, date/time, measurement interval, reference water elevation at the time of installation, etc.

Reference level – The elevation of the surface of the water in a well at the time of installation of the transducer is installed. Determined by manual measurement of the groundwater elevation according to SOP-5223.

Water elevation **(GWE)** – The elevation of the surface of the water in a well, expressed in feet above mean sea level.

Water level – (1) Depth to water in a well below ground surface expressed in feet, or (2) the water elevation expressed in feet above mean sea level. Refer to SOP-5223 for information about measuring groundwater level in a well.

6. PROCESS FLOW CHART

Not applicable.

7. ATTACHMENTS

Attachment 1 In Situ Transducer Performance Check and Maintenance Form

Attachment 2 Manufacturer Operating Manuals

Attachment 3 Groundwater Level Project Field Form

Attachment 4 Guidance for Maximum Water Depths of Transducers

Attachment 5 Transducer Bench Test Form

8. REVISION HISTORY

Revision No. *(Enter current revision number, beginning with Rev.0)*	Effective Date *(DCC inserts effective date for revision)*	Description of Changes *(List specific changes made since the previous revision)*	Type of Change *(Technical [T] or Editorial [E])*
0	5/05	New document. Supersedes ENV-WQH-SOP-16.3.	T
1	3/06	Incorporated references to ENV-DO procedures and ECR QA review comments. Procedure updated, minor changes made, steps were added to accommodate new pressure transducer equipment.	T
2	4/07	Document was revised to reflect organizational changes. Procedure for changing out desiccants was added. Requirements for one week transducer checks were removed. Removed references to single completion wells, as this procedure is appropriate for use in some multicompletion wells.	T
0	10/29/08	New document; supersedes ENV-DO-201.	0
0	11/08/11	New document control number issued; Supersedes SOP-5227, R0; Revised procedure to include operations for multiple parameter transducers.	T/E

ATTACHMENT 1

EP-DIV-SOP-10010-1

In Situ Transducer Performance Check and Maintenance Form

Records Use Only

Los Alamos NATIONAL LABORATORY EST.1943

Los Alamos National Laboratory

In Situ Transducer Performance Check and Maintenance Form

						Performance Check							
Date	Time	Well Name	Inspector Name	Serial Number	Battery Voltage Check/ replace	Factory Calibration Date	Air Pressure (psi)	PH 1 (ft)	Cable Length (ft)	PH 2 (ft)	PH 2 - PH 1 (ft)	Check OK?	Equipment Condition, Comments, Describe Maintenance, Calibration Check

Example

Note: To convert pressure measurements to ft, use conversion factor: 2.31 ft/psi

ATTACHMENT 2	
EP-DIV-SOP-10010-2 **Manufacturer Operating Manuals**	Records Use Only 

1. In Situ Operations Manuals for Pressure Transducers
2. MiniTROLL Operator's Manual for MiniTROLL Model SSP-100
3. WinSitu 4.0 User's Guide
4. Hermit 3000 Data Logger Operator's Manual
5. In-Situ Inc. Data Manager Software Operator Manual
6. Solinst Level Logger Manual
7. In Situ Aqua Troll 200 Operator's Manual
8. In Situ Aqua Troll 200 Conductivity Performance Check

ATTACHMENT 3

EP-DIV-SOP-10010-3

Groundwater Level Project Field Form

Records Use Only

Los Alamos NATIONAL LABORATORY EST. 1943

Well Name:		Date:	Time onsite (MST):	Water Level Tape Mfgr Serial #:	
Personnel:			Cable SN:	Cable Length:	Computer #
Connect Time:	Connect to transducer SN#:		MT LT	In-Situ Version:	
WL Reading Time:	WL (ft)	AD (ft)	Battery Capacity:	Storage Capacity Remaining:	
T [C]	PH (psi)	Stop Test Prior to DL	File Name:		
Pull Transducer for DTW Measurement? Yes NO		File Comments / Start Date of Data File:			
Manual Depth to Water Measurement					
Measuring Point: TOC (outer w/cross bar) TIC (inner)			Stick-up Measured on Site MP Diagram Used		
Time (MST):		Approximate DTW Calculation		Measurements in feet	
DTW (ft bMP):		MP elev		LSD:	
TD (ft bMP):		- WL Read	-	+ MP Height:	
Time (MST):		= appx. DTW	=	= MP Elevation:	
DTW (ft bMP):				-- DTW:	
Time (MST):				= Groundwater Elevation (GWE)	
DTW (ft bMP):					
DTW Comments:			Synchronized Clocks:	Computer time:	Transducer time:
-Calibrated to Surface Pressure:		ps			
Transducer Measurement of Groundwater Level Elevation					
Readings at time of initial connect:		Add New Test Reset Ref. Level		Readings after transducer reinstall	
Time (MST):		Time (MST):		Time (MST):	
Transducer Reading (ft):		New Test Name:		Transducer Reading (ft):	
GWE from MM		Reference Level (calculated GWE):		GWE from MM	
Difference in value:		Meas. Interval:		Difference in value:	
Error tolerance of transducer:		Start date/time:		Error tolerance of transducer:	
Within Error Tolerance		Deleted Tests?		Within Error Tolerance	
Outside Error Tolerance				Outside Error Tolerance	
Comments:			Stabilization after transducer installation (list time and reading):		
OFFSITE (mst):					

Example

Transducer Pressure Tolerance:

PSI:	Tolerance:	Max Depth:
15	0.03	34.7 ft
30	0.07	69.3 ft
100	0.23	231 ft

ATTACHMENT 4

EP-DIV-SOP-10010-4

Guidance for Maximum Water Depths of Transducers

Records Use Only

Los Alamos NATIONAL LABORATORY EST. 1943

Pressure Rating (psi)	Maximum Depth Below Water Surface (feet)	Measurement Precision (feet) (±0.1% Full Scale)
15	34.7	0.03
30	69.3	0.07
50	115.5	0.12
100	231.0	0.23
200	462.0	0.46
250	577.5	0.58
300	693.0	0.69
500	1155.0	1.16
1000	2310.0	2.31

Example

ATTACHMENT 5	
EP-DIV-SOP-10010-5 **Transducer Bench Test Form**	Records Use Only 

Transducer Bench Test Form	
DATE:	
Transducer Serial Number:	
SN Calibration Date	
Cable Serial Number:	
Cable Length (ft):	
Transducer Make and Model:	
Transducer Pressure rating (PSI):	
Transducer Accuracy (% Full Scale)	0.1%
Transducer pressure error tolerance (PSI):	
Transducer pressure error tolerance (FT)	
Bench Test Start Date Time:	
Bench Test End Date Time:	
Bench Test Time (Hr):	
Bench Test data Rate (min):	
Bench Test Data File Name:	
Variation in pressure (PSI):	
Temperature variation (C)	
Variation in temperature reasonable:	
Pressure/Temperature Pass or Fail:	
Reason for Fail:	
Conductivity in Air (uS/cm)	
Standard Solution Concentration (uS/cm)	
Conductivity in Standard Solution (uS/cm)	
Conductivity Pass or Fail	
Tester:	

Example

If you don't have A-level access, contact creichelt@lanl.gov

Click here for "Required Read" credit.

Document Action Request

Section 1 – Originator Request

Document No.: EP-DIV-SOP-10010	Revision No.: 0
Title: Pressure Transducer Installation, Removal, and Maintenance	Page 1 of 1

Description of requested action (Attach numbered additional sheets if needed.):
New document control number assigned; Revised procedure to include operations for multiple parameter transducers

Originator Name (print):	Z#:	Organization:	Date:
Tim Goering	140890	ET-EI	9/8/11

Section 2 – Responsible Manager Approval for Processing

☐ New Document ☐ Minor Revision ☐ Deactivation ☐ Perform Concurrent Periodic Review?
☒ Major Revision ☐ Cancellation

Superseded Document(s) and Revision Number: SOP-5227, R0

☒ Approved ☐ Disapproved (return to originator) | Comments:

Signature:	Print Name, Title:	Z#:	Date:
	Craig Douglass	216051	10/4/11

Section 3 – Hazard Grading

Hazard Determination: ☐ Low ☒ Moderate ☐ High/Complex

Document is authorized to serve as IWD? ☐ Part I only ☐ Full IWD ☐ N/A

Section 4 – Required Reviews (see P315, Ch 16, Section 16.5.3)

Discipline:	Name:	Signature:	Date:
ET-ER	Alan MacGregor		10.24.11
CM-STRS	John Wilcox		10/24/11
PMFS-DO	Steven Paris		10/24/11
QA-IQ	Paul Lowe		10/24/11

Validation Required (SME): ☒ Yes ☐ No ☐ Waive | Comment:

Scope of Validation: ☐ Entire Procedure ☒ Change Only

Validation Method: ☐ Walkdown ☐ Simulation ☒ Tabletop ☐ First Time Use

Training Determination completed?: ☒ Yes ☐ N/A | Completed by: Craig Douglass

USQ/USI Number (if needed):	Signature:	Z#:	Date:
WDPNES-11-514-D	/s/James Selan	087596	10/5/11
Derivative Classifier: ☒ Unclassified ☐ OUO ☐ UCNI ☐ Classified	Signature:	Z#: 92293	Date: 10/25/11
☐ DUSA DUSA #	Signature	Z#	Date

Section 5– Final Approvals

☐ Release ☐ Hold | Details:

Responsible Manager Signature:	Print Name, Title:	Z#:	Date:
	Craig Douglass	216051	11/7/11
Additional Approval Signature'	Print Name, Title:	Z#:	Date: