

WESTBAY[®] PRESSURE TRANSDUCER INSTALLATION, REMOVAL, AND MAINTENANCE

Purpose This procedure describes installation, removal, and maintenance, of the Westbay[®] brand water level recording pressure transducers that are placed in groundwater monitoring wells.

Scope This procedure applies to all ENV-WQH, ENV-ECR, and contractor personnel authorized to operate or maintain the water level recording pressure transducers, or assist with these tasks.

In this procedure This procedure addresses the following major topics:

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

CONTROLLED DOCUMENT

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Signatures First authorization review date is one year from group leader signature below; subsequent authorizations are on file in group office.

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General Information About This Procedure

Attachments This document has the following attachments:

Number	Attachment Title	No. of pages
1	Westbay® Transducer Calibration Check and Maintenance Form	1
2	MOSDAX Probe String Installation/Removal Field Form	1
3	Manufacturer Operating Manuals	1

History of revision This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	01/05	New document.
1	11/05	Incorporated changes resulting from procedure walk-down.

Who requires training to this procedure ENV-WQH staff, ENV-ECR staff, and contractors who work with Westbay® pressure transducer equipment require training before implementing this procedure.

Training method The training method for this procedure is both **read-training** and **on-the-job** training. Training is provided in accordance with group-specific procedures for training. Annual refresher training to this procedure is “self-study” (reading).

Prerequisites In addition to training to this procedure the following training is also **required** prior to performing this procedure:

- Westbay® Operations Manuals for MOSDAX Pressure Probes read-training and Westbay® operations training

References The following documents were referred to in preparation of this procedure:

- ENV-WQH-QAPP-GWLMP, Quality Assurance Project Plan for the Groundwater Level Monitoring Project
- Westbay® Operations Manuals for MOSDAX Pressure Probes
- Westbay® Operations Manual for MOSDAX Handheld Controller

General Information About This Procedure, continued

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

Calibration: pressure transducers are factory calibrated. Calibration checks can be done to determine the accuracy of a pressure transducer reading against a known value.

Gage pressure: the pressure measured relative to atmospheric pressure. Measurements exclude atmospheric pressure and are said to be compensated or gaged for atmospheric pressure. A vented or gage pressure transducer sensor utilizes 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 gage).

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. If a brass cap is present to identify a well, usually the elevation of the brass cap in the concrete pad is used.

Pressure Head: The height in feet of a column of water that can be supported by the gage pressure measured at a point in a well.

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.

Pi: Pressure inside the Westbay[®] casing. Pi measured above the deionized water column in the Westbay[®] casing is equal to atmospheric pressure at a given port elevation; calculated piezometric elevation will approximate the elevation of the port. Pi measured below the deionized water level inside the Westbay[®] casing will be the pressure head of the deionized water column; calculated piezometric elevation will be that of the elevation of the top of the deionized water column.

Po: Pressure in the formation outside the Westbay[®] casing at a specific monitoring port. Po of 'dry' monitoring ports will approximate Pi at that port if the port is above the DI water column. Po of 'wet' monitoring ports should not normally equal the Pi of the port. Calculated piezometric elevation represents the piezometric water level at the location of the monitoring port.

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

psia: Unit of pressure measurement in pounds per square inch absolute, see absolute pressure.

General Information About This Procedure, continued

Terminology, continued psig: Unit of pressure measurement in pounds per square inch gage, see gage 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 in order to protect the original data from 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.

Water Elevation: The elevation of the surface of the water in a well, expressed in feet above mean sea level.

Water Level: 1) Depth to water (DTW) in a well below ground surface expressed in feet, or 2) The Water Elevation expressed in feet above mean sea level. Refer to ENV-DO-202, *Manual Groundwater Measurements*, for information about measuring groundwater level in a well.

Westbay[®] MP System

The Westbay[®] MP (Multi-Port) System is a modular multi-level groundwater monitoring system that consists of plastic casing components that are permanently installed in selected monitoring wells at LANL to monitor multiple zones of saturation and/or multiple zones within the regional aquifer. The plastic casing components utilize monitoring ports at specific depths in the well to access pressure information (water level data) and to collect groundwater samples. Deionized water is placed inside the Westbay[®] plastic casing below the level of the regional aquifer to prevent collapse at depth due to formation water pressure and to reduce buoyancy of the plastic casing. The well completion reports provide detailed information about the construction and installation of the each of the Westbay[®] MP Systems.

A MOSDAX transducer probe is used to access the monitoring ports and obtain pressure data. Individual MOSDAX transducers may be connected to each monitoring port for extended periods to collect relatively continuous pressure/groundwater level data. When multiple transducers are deployed, a single cable connects all transducers to a Westbay[®] or MAGI data logger at surface.

Operation of the Westbay[®] MP System equipment should only be undertaken by authorized personnel.

General Information About This Procedure, continued

Pressure transducer equipment

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

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

- ‘Compensated’ or ‘gaged’ 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 (pounds per square inch gaged or psig). Using these transducers, 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 ‘gaged’ transducers include the standard In-Situ, Inc. miniTroll[®] and Troll[®] transducers.
- ‘Absolute’ or ‘uncompensated’ pressure transducers measure absolute pressure (pounds per square inch absolute, 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 due to 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 that is used so that data can be processed accordingly.

Note

Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

General Requirements for Transducer Installation or Removal

Equipment	<p>Suggested equipment for installation and removal of Westbay® transducers in monitoring wells</p> <ul style="list-style-type: none">• Transducer(s)• Transducer cable(s)• Data logger• Manufacturer operating manuals• Portable computer and RS-232 direct-cable connection for communicating with transducer equipment and retrieving water level data• Floppy disk(s), or other removable electronic media for data storage backup• Silicon lubricating grease• Waterproof ink pen(s)• Well construction diagram• MP casing installation report• Previous transducer installation and removal field records• Installation/Removal Field Form• Mast or Monopod with transducer wheel• Westbay® transducer winch• Generator with ground fault circuit interrupt (GFCI)• Electric extension cord• Deionized water• Paper towels• Trash bags• Keys to well
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Equipment check	<p>Before departing for the well site, test data loggers and transducers for functionality, see Calibration and Maintenance of Pressure Transducer section of this procedure.</p>
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Required personnel	<p>Two people, one supervising operator and one assistant, are required to install or remove a Westbay® pressure transducer from a monitoring well.</p> <p>A single operator is adequate to retrieve data from the recording data logger if approved by the Team Leader and only when using Enhanced Communications Procedures. Reference the Working Alone Policy in RRES-WQH-SOP-002, <i>General Field Work</i>, and RRES-ES-Field, <i>General Field Safety for All</i>.</p>
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Calibration and Maintenance of Pressure Transducer Equipment

Policy Pressure transducer equipment must be properly maintained and calibrated according to manufacturer instructions. Equipment maintenance and calibration records must be maintained to insure the quality of data from transducer equipment. Westbay transducers are factory calibrated by Westbay personnel.

Transducer maintenance Westbay Transducer Maintenance
Perform routine maintenance each time a transducer is installed or removed from a well. Routine maintenance includes:

- Check/lubricate O-rings
- Check cables
- Perform surface check of transducer arm and shoe functions
- Keep equipment clean, work area uncluttered
- Wipe transducers with clean cloth soaked in deionized water during removal from well, and wipe dry before storing in cases.
- Cap all connections after wiping dry to prevent damage from rust and corrosion
- Record any maintenance problems on the Westbay Transducer Calibration Check and Maintenance Form (Attachment 1)

Avoiding cross-contamination Transducer equipment is typically installed in a specific well and dedicated to that well, therefore minimizing cross contamination issues. If it is necessary to remove a transducer from a well, label the transducer equipment with the well number for future reinstallation.

If transducer equipment must be installed in a different well, wipe the cable and transducer housing with a clean cloth soaked in deionized water prior to installation to prevent potential cross contamination.

Automatic daylight savings time adjustment Transducer software clocks and internal clocks in portable computer used with 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. This will prevent the clock from changing to daylight savings time.

Calibration and Maintenance of Pressure Transducer Equipment, continued

Transducer calibration

A transducer may be considered to be properly calibrated as long as the transducer returns values that are within pre-determined measurement precision specifications. The measurement precision of a Westbay® MOSDAX transducer is 0.1% of the pressure rating. How long a transducer will maintain calibration depends on the amount of regular use the transducer has experienced, whether or not the transducer was exposed to environmental extremes, and how the transducer was handled during use, transportation, and storage.

Transducer calibration is performed by the manufacturer.

Calibration checks

To conduct a calibration check on the Westbay MP System Transducer, bench check atmospheric pressure measurements of each transducer by comparing transducer atmospheric pressure measurements with a local meteorological station. This check must be done at the TA-64 ENV-WQH compound, using meteorological data from the TA-6 meteorological station, to get an accurate result. Other locations must be evaluated prior to use.

Step	Action
1	Record the calibration check location, time, and the transducer barometric measurement in psi on the Westbay® Transducer Calibration Check and Maintenance Form (Attachment 1).
2	Record the local barometric pressure, station location, and the date and time of the measurement on the Westbay® Transducer Calibration Check and Maintenance Form (Attachment 1). The barometric pressure recorded at TA-6 can be found on the LANL weather web page, http://weather.lanl.gov/data_request.asp . (Measurements are not available on the web site for one to two hours after being recorded.) Convert pressure in millibars (mb) to psi by multiplying the pressure in mb by 0.01450 psi/mb. Record the atmospheric pressure in psi on the Westbay® Transducer Calibration Check and Maintenance Form (Attachment 1).
3	Add 0.026 psi to the TA-6 meteorological station pressure value to compensate for the elevation difference between the TA-6 station and the TA-64 ENV-WQH Compound Building.
4	Determine the error tolerance of the transducer by multiplying the pressure rating of the transducer (psi) by 0.001 (0.1%). Record the error tolerance on the Westbay Transducer Calibration Check and Maintenance Form (Attachment 1).

Table continued on next page.

Calibration and Maintenance of Pressure Transducer Equipment, continued

Calibration checks, continued

Step	Action
5	Determine the acceptable range of atmospheric pressure measurements by adding/subtracting the error tolerance determined in Step 3 to/from the atmospheric pressure obtained from the corrected meteorological station value. Record the acceptable range on the Westbay Transducer Calibration Check and Maintenance Form (Attachment 1).
6	Compare the atmospheric pressure measured by the transducer with the acceptable range. Verify that measurements are within the acceptable range and document on the Westbay Transducer Calibration Check and Maintenance Form (Attachment 1). If atmospheric pressure measurements do not compare with meteorological values, <ul data-bbox="535 982 1372 1085" style="list-style-type: none">• Recheck the pressure measurements.• If necessary, return transducer to manufacturer for calibration and/or repair.

Transducer Selection and Installation Guidance

Transducer selection and installation guidance for Westbay® transducers

Do not submerge transducers to water depths with 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 ft/psi. Table 1 provides guidance for maximum depths a transducer can go below the surface of the water before the pressure sensor is damaged. Westbay MP casings are often filled with deionized water to compensate for outside formation water pressure and to reduce buoyancy of the plastic casing. The depth below ground surface of this deionized water varies in each well.

A pressure profile of each port is compiled at the time of MP casing installation. This pressure profile includes the formation water pressures outside of each measuring port (P_o), and the corresponding pressure inside of the casing (P_i). This information is needed to select the appropriate transducer for each port.

Table 1

Pressure Rating (psi)	Maximum Water Depth (ft)
100	231.0
250	577.5
500	1155.0
1000	2310.0

Before installing a transducer in a well:

- Determine the pressure outside of the MP casing for each port in which a transducer will be installed.
- Determine the pressure inside of the MP casing for each port in which a transducer will be installed.
- Determine the range of expected water level fluctuations in the zone

The pressure rating on the transducer must be greater than the pressure outside of the MP casing, and the pressure inside of the MP casing to avoid damaging the pressure sensor. Use a transducer with the lowest pressure rating possible, because measurement precision decreases with higher pressure ratings.

Westbay® Transducer Installation

Prepare for transducer installation

To prepare for transducer installation, perform the following steps:

Step	Action
1	Set up transducer winch and mast or monopod at well site. Ensure mast is securely bolted to well riser plate.
2	Inspect O-rings; ensure good quality of O-rings.
3	Apply silicone lubricant to O-rings on transducer connections following manufacturer instructions, if necessary.
4	Connect transducer cable to MOSDAX pressure probe and to MOSDAX data logger/portable computer according to manufacturer instructions. NOTE: Do not connect data cable to data logger until both transducer cables are attached to the transducer. Failure to disconnect data logger can cause electric shock.
5	Connect data cable to data logger and transducer winch.
6	Check for appropriate communications with transducer.
7	Perform surface check of arm out, shoe out, shoe in, and arm in functions.
8	Record the transducer serial number and well information on the MOSDAX Probe String Installation/Removal Field Form (Attachment 2)

Install transducer

To install the Westbay® transducer(s), perform the following steps:

Step	Action
1	Carefully lower the MOSDAX transducer string into the well. <ul style="list-style-type: none"> Do not allow cable to rub against sharp edge of metal casing Do not allow the transducer to contact deionized water at high rate of speed; this will damage the pressure sensor. NOTE: Always have a spotter outside trailer to help winch operator when raising sample string to ensure sample string is not raised more than 3 inches below the mast wheel.
2	Trip in sampler probe and bottles using the MP Casing Log and Depths of Key Items Table as reference.

Table continued on next page.

Westbay® Transducer Installation

**Install
transducer,
continued**

Step	Action
3	Land each transducer at desired port. Transducers should be landed manually, one at a time. Document P(i) of MP casing and the P(o) outside the monitoring port on the Mosdax Probe String Installation/Removal Field Form (Attachment 2).
4	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. At minimum, set logger to collect readings one minute past every hour; for example, 10:01.
5	Replace caps and locks on well shelter.
6	To verify that the transducer is functioning correctly, check transducer installation within 1 week of installation. <ul style="list-style-type: none">• Check measurement data for signs of sensor drift.• If indications of data problems exist, reinstall the transducer, if problems persist, replace the transducer.

Westbay® Transducer Data Retrieval

Westbay Transducer Data Retrieval Retrieve transducer data from wells at least **quarterly** to insure the continued quality of the transducer data. To retrieve data from transducer equipment, perform the following steps:

Step	Action
1	Connect portable computer to data logging equipment and start manufacturer provided software specific for the transducer equipment.
2	<p>NOTE: This step should only be performed quarterly, or prior to transducer removal. Do not perform this step during the one week check.</p> <p>Stop the data logging program. Note the time and date in a field logbook.</p>
3	<p>Retrieve transducer data set according to manufacturer instructions. Document data retrieval information in a field logbook, including:</p> <ul style="list-style-type: none"> • Transducer operating condition • Battery power • Logger storage remaining • Beginning and ending dates/times of retrieved data in MST • Raw data file name. Name the raw digital data file appropriately to include the well name and date of data retrieval.
4	View the data collected since transducer installation. Ascertain that appropriate data have been collected.
5	Copy the data file to floppy disk or other removable media for safe keeping.
6	<p>NOTE: This step should only be performed quarterly, or prior to transducer removal. Do not perform this step during the one week check.</p> <p>Delete the data from the transducer or data logger using the manufacturer software.</p> <p>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 disk.</p>
7	Check that the transducer clock is the correct time (MST). Restart the data logging
8	<p>Transmit data file to the Groundwater Level Project Leader.</p> <ul style="list-style-type: none"> • Insure that data file is secured and data transmittal is completed. • Do not remove data file from portable computer or removable media until data is backed up on a server.

Westbay® Transducer Removal

Westbay Transducer Removal

To remove the transducer(s) from a multiple completion well, perform the following steps:

Step	Action
1	Retrieve transducer data from data logger as described in the Transducer Data Retrieval section above.
2	Disconnect MOSDAX pressure probes from monitoring ports by following Westbay® operation manual procedures. Record P(o) and P(i) pressure data on the Westbay® MOSDAX Pressure Probe Installation/Removal Form (Attachment 2).
3	Remove the cable and transducer(s) from the well. <ul style="list-style-type: none"> • Disconnect data cable from data logger prior to connecting or disconnecting transducer cables. • The cable should not scrape against sharp edges of well casing. • Rinse transducers with deionized water and wipe dry with a paper towel prior to storing in a transport case. • Package transducers appropriately for transportation according to manufacturer instructions. • Ensure that spools of cable are properly labeled. • <p>NOTE: Always have a spotter outside trailer to help winch operator when raising sample string to ensure sample string is not raised more than 3 inches below the mast wheel.</p>
4	Replace well caps and locks.

Records Resulting From This Procedure

Records

The following records generated as a result of this procedure shall be permanently stored with ENV-WQH:

- MOSDAX Probe String Installation/Removal Field Record (Attachment 2)
- Westbay[®] Transducer Calibration Check and Maintenance Form (Attachment 1)
- Raw water level data electronic file on electronic media
- Field logbook summary of individual installations/removals, and data retrievals with dates

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WESTBAY TRANSDUCER CALIBRATION CHECK AND MAINTENANCE FORM

Los Alamos National Laboratory Water Quality and Hydrology Westbay Transducer Calibration Check and Maintenance Form												
Transducer Serial Number: _____				PSI Rating: _____			Error Tolerance (psi): _____					
Date	Meteorological Station					Calibration Check					Inspector Name	Equipment Condition, Comments, Describe Maintenance, Calibration Check
	Station Name	Time of Reading (MST)	Barometric Pressure (mb)	Barometric Pressure (psia) (1mb = 0.01450 psia)	Add 0.028 psia for Calibration Check at TA-64	Calibration Check Location	Time of Reading (MST)	Transducer Barometric Pressure (psia)	Acceptable Range (psia)	Calib Check Passed?		

Note: To convert millibar (mb) pressure measurements to psi, use conversion factor: 0.01450 psi/mb

RRES-WQH-SOP-016

MANUFACTURER OPERATING MANUALS

- 1) Westbay Operations Manuals for MOSDAX Pressure Probes
 - Pressure Profiling with the MOSDAX Pressure Probe – Model 2523, Operations Manual
 - Mprofile Quick Reference Guide
 - MOSDAX Datalogger – Model 2524A, Operations Manual
 - MAGI MOSDAX Automated Groundwater Interface, Rev 1.4, Operations Manual
 - MOSDAX Handheld Controller – Model 2525, Operations Manual
 - Westbay[®] MLOG Software Manual
 - Westbay[®] WinGT Software Manual

- 2) In-Situ Operations Manuals for Pressure Transducers
 - MiniTROLL Operator's Manual for MiniTROLL Model SSP-100
 - WinSitu 4.0 User's Guide
 - Hermit 3000 Data Logger Operator's Manual
 - In-Situ Inc. Data Manager Software Operator Manual