



**NYE COUNTY NUCLEAR WASTE  
REPOSITORY PROJECT OFFICE**

**TECHNICAL PROCEDURE**

<b>TITLE:</b>  <b>PROCEDURES FOR OPERATING WESTBAY® MOSDAX® GROUNDWATER MONITORING EQUIPMENT IN NYE COUNTY WELLS</b>		<b>REVISION: 2</b>  <b>DATE: 3/16/05</b>  <b>Page: 1 of 21</b>
<b>TECHNICAL PROCEDURE NUMBER:</b>  <b>TP-9.2</b>	<b>SUPERSEDES:</b>  <b>Page 4</b>	

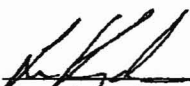
**CHANGE NOTICE NO. 1**

**EFFECTIVE DATE:** August 18, 2008

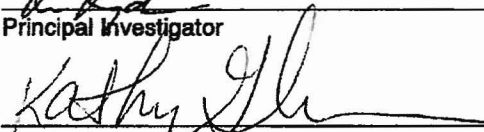
**PURPOSE:** Add requirement to use Pacific Standard Time (PST) for all logging, calibrations and verifications.

**Page 4 Section 5.0:** Add "Pacific Standard Time (PST) shall be used in logging, calibrations, and verifications to avoid problems with daylight saving time changes and data logger synchronization."

**CONCURRENCE:**

  
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Geoscience Manager 8/19/08  
Date


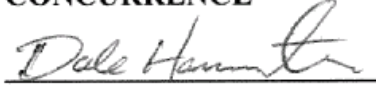

  
\_\_\_\_\_  
Principal Investigator 8/19/08  
Date

  
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Quality Assurance Officer 8/19/08  
Date



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<b>PROCEDURE No.:</b>  <p align="center"><b>TP-9.2</b></p>	<b>SUPERSEDES:</b>  <b>Revision 01, 6/30/03</b>	
<b>APPROVAL</b>   <p align="right">3-21-05</p> <hr/> <b>David Swanson,</b> <b>Interim Project Manager</b>	<b>CONCURRENCE</b>   <p align="right">3/24/05</p> <hr/> <b>Dale P. Hammermeister,</b> <b>Principal Investigator</b>	
<hr/> <p align="right">Date</p>	 <p align="right">3/21/05</p> <hr/> <b>Doug Davis, Project Quality</b> <b>Assurance Officer</b>	

**1.0 PURPOSE**

This procedure provides detailed instructions for the operation of Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater monitoring equipment in wells included in the Nye County Nuclear Waste Repository Project Office (NWRPO) Independent Scientific Investigations Program (ISIP). The implementation of this procedure helps to ensure that data collected and processed from wells containing this equipment meet Nye County NWRPO Quality Assurance (QA) Program requirements. The user shall refer to the most current revision of all referenced NWRPO technical procedures, work plans, and Quality Administrative Procedures.

**2.0 SCOPE**

Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater monitoring equipment is specifically designed to be compatible with Westbay<sup>®</sup> multiple port (MP) monitoring well systems that isolate formation zones and permit access to these isolated zones for groundwater sampling and in situ monitoring of groundwater parameters. This procedure addresses the use of this equipment in specially designed multiple screen Nye County wells containing Westbay<sup>®</sup> MP-55 zonal isolation and monitoring access systems.

In addition, some of the Mosdax<sup>®</sup> equipment, specifically stand-alone module (SAM) pressure probes and data loggers, can be used independently of the Westbay<sup>®</sup> MP55 system. This procedure therefore also addresses a specific example of the use of this stand alone equipment, that is, its use in both aquifer test pumping wells and associated observation wells.

More specifically, this procedure describes the following: installation and removal of multiple zone Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater pressure probes (i.e., pressure probe strings) in wells containing Westbay<sup>®</sup> MP55 systems; use of other Mosdax<sup>®</sup> equipment to open and close MP55 hydraulic ports for water sampling and manual water level measurements; factory calibration, bench and field calibration verification and field operation verification of Mosdax<sup>®</sup> equipment containing pressure transducers and temperature sensors; the use of stand alone Mosdax<sup>®</sup> pressure probes and data loggers in aquifer test pump wells and observation wells; and the downloading and processing of data from Mosdax<sup>®</sup> data loggers.

## **2.1 Applicability**

This procedure applies to the NWRPO principle investigators, task managers, technical staff, and contractors responsible for directing and implementing the groundwater monitoring related activities described herein. These individuals will be collectively referred to as NWRPO personnel in the following.

## **2.2 Training**

NWRPO personnel shall be trained in Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater monitoring equipment operating procedures described herein before conducting work with this equipment and shall document that they have completed this training. Personnel performing the tasks described in this technical procedure shall be professional geoscientists or engineers with applicable previous experience. Moreover, these personnel shall undergo “hands on” training with procedures and all applicable monitoring related equipment. In addition, personnel involved in the processing of data shall be trained in the use of the software programs used.

## **3.0 DEFINITIONS**

Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater monitoring equipment includes the following:

- 3.1** Handheld Controller – The user interface between pressure probes and the Mosdax<sup>®</sup> personal computer interface box.
- 3.2** Hydraulic Pumping Port – A sleeved opening (approximately 4 in.<sup>2</sup>) in the Westbay<sup>®</sup> MP55 casing in a packer isolated monitoring zone that can be sampled or pumped.
- 3.3** Manual Water Level – Depth-to-water measurement taken in the isolated zone of the Westbay<sup>®</sup> MP55 system or in a conventional well or piezometer with an electric well sounder using TP-9.9, *Measurement of Groundwater Levels*.

- 3.4** Measurement Port – The seat and opening for the pressure probe to connect to the formation hydrostatic pressure in an isolated zone.
- 3.5** MLog Software – Software used to communicate with Mosdax<sup>®</sup> monitoring equipment.
- 3.6** Mosdax<sup>®</sup> Data Logger (MDL) – The data collection module for the Mosdax<sup>®</sup> pressure probes or SAMs. It also contains a pressure transducer and temperature sensor to monitor air pressure and temperature at the ground surface.
- 3.7** MPCI – Mosdax<sup>®</sup> personal computer interface box.
- 3.8** Pressure Probe – An electronic pressure transducer containing a resistor related temperature sensor that is lowered to and connected with monitoring ports in the Westbay<sup>®</sup> MP55 casing.
- 3.9** Pressure Probe String – Two or more pressure probes attached in series by a data and power cable.
- 3.10** Pressure Probe Water Level – Water elevation (ft, amsl [above mean sea level]) in a Westbay<sup>®</sup> isolated zone calculated from the pressure probe measurement (lb/ft<sup>2</sup>) below the water table by: subtracting the atmospheric pressure measurement (lb/ft<sup>2</sup>) at the ground surface from the pressure measurement, dividing the result by the specific weight (lb/ft<sup>3</sup>) of the water at 15°C, and adding to this result the elevation (ft, amsl) of the probe. This calculation is made prior to submitting a QA processed data file to the Quality Assurance Records Center (QARC).
- 3.11** RSB Splitter Box – The conversion box that allows one or more pressure probe strings to be connected to the same MDL.
- 3.12** SAM – A Stand-Alone Module (SAM) pressure transducer containing a resistor related temperature sensor that can be lowered into a conventional well without Westbay<sup>®</sup> MP55 casing, or used in the saturated zone at elevations above Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater monitoring equipment in wells containing MP55 casing.
- 3.13** Sampler Bottle – A cylindrical canister that carries charged nitrogen and water down to the hydraulic sleeve to open or close the hydraulic sampling port and/or collect a discrete sample from just outside the port.
- 3.14** Sampler Probe – A pressure transducer designed to land and seat in the hydraulic port and control the sampler bottle via the handheld controller and MPCI.
- 3.15** Sampling Wireline Winch – Winch with gray case used primarily when opening and closing hydraulic ports.
- 3.16** Spool Winch – Winch with wooden base and metal spools used for installation and removal of pressure probe strings.

#### **4.0 RESPONSIBILITIES**

The project QA Officer shall be responsible for the coordination of the internal review of this technical procedure. The principal investigator (PI) or designee shall be responsible for the preparation and modification of this procedure, oversight of the performance of this procedure, and the analysis and interpretation of data collected under this procedure. The Geoscience Manager shall be responsible for directly supervising NWRPO personnel, who in turn shall be responsible for the implementation of this procedure.

#### **5.0 PROCESS**

This procedure provides instructions for the following:

- Scheduling and documenting calibrations for Westbay<sup>®</sup> Mosdax<sup>®</sup> equipment containing pressure transducers and associated temperature sensors.
- Installation and removal of Westbay<sup>®</sup> Mosdax<sup>®</sup> pressure probe strings in wells containing Westbay<sup>®</sup> MP55 systems.
- Use of Mosdax<sup>®</sup> equipment (i.e., sampler bottles and sample probes) to open and close MP55 hydraulic ports for various purposes including water sampling, aquifer pump testing, and manual water level measurement.
- Use of Mosdax<sup>®</sup> SAM pressure probes and data loggers in aquifer test pump and observation wells.
- Bench and field calibration verification and field operation verification of Mosdax<sup>®</sup> equipment containing pressure transducers and temperature sensors.
- Collection and processing of pressure and temperature data collected from boreholes using Mosdax<sup>®</sup> groundwater monitoring equipment.

Pacific Standard Time (PST) shall be used in logging, calibrations, and verifications to avoid problems with daylight saving time changes and data logger synchronization.

The performance of the tasks specified in this procedure shall be documented in scientific notebooks. All documentation shall meet the requirements of QAP-3.2, *Documentation of Technical Investigations*.

##### **5.1 Scheduling and Documenting Calibrations of Mosdax<sup>®</sup> Pressure and Temperature Sensors**

Mosdax<sup>®</sup> equipment scheduled for field use which contains pressure and temperature sensors (i.e., pressure probes, SAMs, sample probes, and data loggers) must be factory calibrated every three years or upon failure of the bench or field calibration verification procedures described in Sections 5.5 and 5.6. Between two successive factory recalibrations, bench calibration verifications (Section 5.5) or field calibration verifications (Section 5.6) must be conducted every 12 months. Generally, bench calibration verification will be conducted immediately before a pressure and temperature sensor is installed in the field, and field calibration verifications will be conducted while the probe is in the field. These calibration verifications are necessary to ensure factory calibration tolerances are maintained over the 3-year period between factory calibrations.

Mosdax<sup>®</sup> equipment containing pressure and temperature sensors not scheduled for field use are exempt from the above calibration requirements. This equipment will be stored at the NWRPO with calibration status tags in accordance with QAP-12.1, *Control of Measuring and Test Equipment*. Note that the equipment should be calibrated as necessary before use. These calibration requirements are subject to change by the PI if technical justification is provided and documented.

Documentation and control of all calibration data from Westbay<sup>®</sup> Mosdax<sup>®</sup> monitoring equipment will be in conformance with QAP-12.1, *Control of Measuring and Test Equipment*.

## **5.2 Installation and Removal of Westbay<sup>®</sup> Mosdax<sup>®</sup> Pressure Probe Strings in MP55 Wells**

### **5.2.1 Installation of Pressure Probe String**

Items needed in the field to install the pressure probes in a well are listed in Attachment 1. Prior to going in the field, consult the “Pressure Profile” in the Westbay<sup>®</sup> Well Completion Report to determine the required pressure range for the pressure probes being installed in each isolated zone of the well.

Once field personnel are at the specific well site, the spool winch, cables on metal spools, monopod, and generator (Figure 1) can be set up to lower the pressure probes into the well, starting with the lowest zone and moving to the top zone of the multi-port system.

Refer to completion diagrams in the Westbay<sup>®</sup> Well Completion Report for specific depths of pressure probe ports, magnetic collars, and other downhole components of the MP55 system required for probe installation.

Prior to installing the probes, connect all the probes with all the cables in the order they will be in the well. The lowest probe needs a metal end cap to seal the electronics from water intrusion. Apply silicone dielectric grease to all connectors on the probes to ensure a watertight seal. Connect the string of probes to the data logger for a surface check.

#### **5.2.1.1 Surface Check**

Set up the data logger by installing all the probes through the “Install” menu.

1. Enter required header information in the data logger regarding the project, well, schedule and thresholds per Attachment 2.
2. Verify that the data logger time is correct.
3. Verify that the arms and shoes of the probes work by extending and retracting the arm and shoe, and recording the number of motor rotations for each command. When exposed to air only, the motor rotations should be as follows:
  - a. arm motor rotations: approximately 15-17
  - b. shoe motor rotations: approximately 23

4. Verify that pressure and temperature values are reasonable and record them in the scientific notebook.

### **5.2.1.2 Installation**

1. Attach the lowest cable on a metal spool to the spool winch.
2. Run the cable and probe over the monopod wheel and into the well and ensure that the cable connector passes over the monopod in the notch on the outside of the wheel (Figure 1).
3. When at the end of the cable, clamp it off at the wellhead and connect the next probe and cable.
4. Continue until all the probes are in the well.
5. While installing the last cable, hook up a data cable from the winch to the data logger, 12-volt battery, and solar charger.
6. Hook up the laptop and log onto the datalogger through the MLog software to communicate with the probe string.
7. Go into the “Install” menu, select the lowermost uninstalled probe, and watch for a “collar detect” response from the data logger while lifting the cable string up and down to locate the magnetic collar on the MP55 casing.
8. Once the collar is detected, raise the pressure probe string a minimum of 3 ft, extend the probe arm, land the lowest probe into the measurement port, and then record pressure ( $P_i$ ) with the shoe retracted, where  $P_i$  is the pressure inside the MP55 casing.
9. Extend the probe shoe to complete the probe installation into the monitoring port and record pressure ( $P_o$ ) with the shoe extended, where  $P_o$  is the pressure outside the MP55 casing (i.e. formation pressure).
10. After the lowest probe is installed, go to the “Install” menu and select the lowermost non-installed probe. Remove the slack in the cable and extend the probe arm and land the next lowest probe. Record  $P_i$ . Repeat step 9.
11. Repeat step 10 to install subsequent probes from bottom to top.
12. When all the probes are installed, disconnect the probe string cable from the winch, secure the remaining cable to the wellhead, hook up the RSB splitter box to the probe string cable and the datalogger, connect power to a 12-volt dedicated battery and solar charger, and then begin data logging.

### **5.2.2 Removal of Pressure Probe String**

NOTE: Attachment 1 lists the equipment needed to remove Westbay<sup>®</sup> assemblies from the well.

1. At the well site hook the laptop computer to the data logger, log onto the datalogger, stop logging on the data logger, and download the data.
2. Clamp the probe string cable off at the wellhead.
3. Uninstall the probes from the measurement ports through the “Install” menu (retract shoe, then retract arm) in the MLog software. Uninstall the probes from bottom to the top to reduce the strain on the cables.
4. Once the probes are uninstalled, disconnect the probe string and set up the spool winch, monopod, and generator to pull the probes out of the well (Figure 1).
5. Attach the cable from the spool winch to the top cable and start pulling up; ensure that the cable connector passes over the monopod in the notch on the outside of the wheel.
6. When the first probe is at the top of the well, clamp off the cable just below the probe, remove the probe, and set up the winch for the second cable.
7. Continue these steps until all of the probes are removed.

### **5.3 Opening and Closing Hydraulic Ports**

Items needed in the field to open and close the hydraulic ports in a well are listed in Attachment 3. This section assumes that the Westbay<sup>®</sup> Mosdax<sup>®</sup> pressure probe string is not installed. If the assembly is installed, please refer to section 5.2.2 to uninstall the probe string.

#### **5.3.1 Opening Hydraulic Ports**

1. Set up the generator, wireline winch, and monopod with notched wheel (Figure 1).
2. Fill the sampler bottle half full with water then charge it with 600 psi of nitrogen.
3. Install faceplate “A” onto the sampler probe.
4. Connect the sampler probe to sampler bottle with connecting hose (black hose containing plastic tube).
5. Surface check the sampler probe using the handheld controller and MPC1 by going through the arm and shoe in/out command. Record the number of motor rotations and ensure the arms and shoes fully extend and retract. (For the correct number of motor rotations during surface checks, refer to section 5.2.1).
6. Send sampler bottle and probe down to land in hydraulic port.
7. Find the magnetic collar in the zone, and then extend the arm.
8. Land the probe approximately 8 ft lower and record Pi.



9. Extend the shoe and record Po (Po is casing pressure, not isolated zone formation pressure).
10. Open the sampler valve with the hand held controller.
11. After the pressure ramps up and stabilizes indicating that the hydraulic sleeve is open, close the sampler valve, retract shoe, and record Pi.
12. Add 2 ½ gal. of water to verify open port (pressure should increase slightly and then stabilize back to or below the Pi recorded after the shoe was retracted).
13. Retract the arm and trip sampler bottle and sample probe out of the well.

### **5.3.2 Closing Hydraulic Ports**

1. Set up the generator, wireline winch, and monopod with notched wheel (Figure 1).
2. Fill the sampler bottle half full with water then charge the bottle with 600 psi of nitrogen.
3. Install faceplate “B” onto the sampler probe.
4. Follow steps 4 through 10 from section 5.3.1.
5. After the pressure ramps up and stabilizes indicating hydraulic sleeve closing, close valve, retract shoe, and record Pi.
6. Add 2 ½ gal. water to verify closed port (pressure should increase and then stabilize). Record new Pi.
7. Retract arm and trip sampler bottle and sampler probe out of the well.

## **5.4 Monitoring Aquifer Pump Tests with SAMs**

This section addresses the use of Westbay<sup>®</sup> Mosdax<sup>®</sup> SAMs to monitor pressure in the pump well and/or in observation wells. Refer to specific QA test plans for details regarding SAM pressure ranges and depths of placement in wells and required equipment list.

Procedures described for the aquifer pump well also are applicable in cases where it is necessary to monitor water levels in wells being pumped to collect groundwater samples.

### **5.4.1 Pump Well Monitoring**

1. Prior to running the pump into the well, attach a SAM of the correct pressure range to the pump-delivery tubing assembly at a specified distance above the pump.
2. Accurately measure and document the placement of the SAM above the pump in the scientific notebook or on a Tubing and Casing Record.

3. Set up the data logger and conduct a surface check as detailed in Section 5.2.1.1. with the exception of step 3.
4. Run the pump assembly and SAM into the borehole to the required depth. Strap the SAM cable to the delivery tubing at regular depth intervals to protect it from damage.
5. Once the pump has been set at its prescribed depth in the well, hook up the cable to the RSB splitter box, data logger and 12-volt battery.
6. Prior to starting the pump, begin datalogging. Verify that pressure and temperature values are reasonable and record them in the scientific notebook.
7. When the pump is started, view the pressure graphically through the data logger/laptop computer.

#### **5.4.2 Observation Well Monitoring**

Determine the submersion depth of the SAM and pressure range needed for each observation well. Install the SAMs with a cable long enough to put the probe at the correct depth and have enough length to reach the Mosdax<sup>®</sup> data logger wherever it may be located on the site. Up to three SAMs can be logged with one Mosdax<sup>®</sup> data logger and a RSB splitter box. If more wells are being monitored, additional equipment will be needed.

#### **5.5 Bench Calibration Verification of Mosdax<sup>®</sup> Pressure and Temperature Sensors**

If Mosdax<sup>®</sup> pressure and temperature sensors are scheduled for field use, NWRPO bench (laboratory) calibration verifications will be conducted every twelve months between successive Westbay<sup>®</sup> factory calibrations to ensure that their calibrations are still valid. Mosdax<sup>®</sup> pressure and temperature sensors include those in pressure probes, SAMs, sampler probes, and data loggers.

The pressure sensor inside a Mosdax<sup>®</sup> data logger dedicated to bench and field calibration verifications is assumed to measure the true air pressure inside the NWRPO laboratory. This pressure sensor (referred to as the reference pressure sensor in the following) must be factory calibrated every year to National Institute of Standards and Technology (NIST) standards. The true laboratory air pressure measured by the reference pressure sensor then serves as a calibration standard for other Mosdax<sup>®</sup> pressure sensors requiring bench calibration verification.

A dedicated digital thermistor (factory calibrated to NIST standards) attached to a laptop computer is assumed to measure the true air temperature inside the laboratory environment, and thereby provides a calibration standard for Mosdax<sup>®</sup> resistor based temperature sensors located on all Mosdax<sup>®</sup> pressure sensors. The Mosdax<sup>®</sup> temperature sensors measure temperature on the pressure transducer diaphragm, which is then used as a correction factor for the pressure measurement. It should be noted that temperature on the pressure transducer diaphragm may differ slightly from the ambient laboratory temperature.

Bench calibration verification data collection involves simultaneously collecting pressure and temperature data from the dedicated calibration equipment (reference pressure sensor and digital thermistor) and the Mosdax<sup>®</sup> equipment assigned to field use. Data collection with the data logger and the digital thermistor shall start within the same minute (i.e., both at 10:30, not 10:30 and 10:31). Pressure and temperature data will be collected at a frequency of one measurement every 20 minutes, for a minimum of 60 measurements, or at the discretion of the PI. After data collection is complete, the individual pressure and temperature measurements from the Mosdax<sup>®</sup> equipment assigned to field use will be compared with the true pressure and temperature measurements collected by reference pressure sensor and the digital thermistor, respectively.

The absolute value of the average pressure difference ( $\Delta P$ ) between the field sensor in question and the reference sensor is assumed to be equal to the error in pressure and should be less than 0.1% of the full range of the pressure sensor. If  $\Delta P$  for the bench calibration verification exceeds 0.1% of the full range of the pressure sensor, the field pressure sensor will be assumed to be out of calibration. The out of calibration field sensor will then either be sent to the factory for recalibration or stored at the NWRPO with an appropriate calibration status sticker.

Acceptable pressure error tolerances are dictated on Westbay<sup>®</sup> factory calibration data sheets that accompany each sensor and are submitted to the QARC upon arrival at the NWRPO. These tolerances are reported as percent of the full scale of the pressure sensor. For all Westbay<sup>®</sup> pressure sensors, the acceptable pressure error tolerance is 0.1%.

The error in temperature is assumed to be the absolute value of the average temperature difference between the field sensor and digital thermometer. Error tolerances for the temperature sensors associated with pressure sensors are not reported on Westbay<sup>®</sup> factory calibration data sheets. However, Westbay<sup>®</sup> has reported to the NWRPO that they believe that the error is less than 1°C at the point of measurement on the pressure transducer diaphragm. In the experience of the NWRPO, the error in measuring ambient air temperature at a point several ft away from the equipment in question is generally less than 3°C. Based on this information, the acceptable error tolerance calculated in the above described bench calibration verifications is assumed to be 3°C. If the calculated error exceeds 3°C, the field temperature sensor will be assumed to be out of calibration, and either be sent to the factory for recalibration or stored at the NWRPO with an appropriate calibration status sticker.

All bench calibration verification calculations (Microsoft<sup>®</sup> Excel spreadsheets) shall be submitted together with metadata to the QARC.

## **5.6 Field Verification of the Calibration and Operation of Mosdax<sup>®</sup> Pressure Sensors**

Field calibration verifications are used to identify significant changes that may occur in the original factory calibration of pressure and temperature sensors over time in a borehole environment. Field operation verifications are a means to check that the sensors are operating as designed in a borehole environment.

The Mosdax<sup>®</sup> pressure probe string is assumed to be in place and coupled with the downhole MP55 measurement ports prior to the application of this procedure. These verifications shall in most cases be conducted every 12 months between factory calibrations when equipment is installed in the well. However, the PI may vary the frequency of field verifications. All data downloaded from data loggers as part of these field verifications together with required metadata are submitted to the QARC.

### **5.6.1 Field Verification Data Collection Procedures**

NWRPO personnel shall carry all items listed in Attachment 4. The following steps should be followed to collect field verification data:

1. Remove the borehole cover to access the borehole's dedicated data logger and check and record the 12-volt battery's voltage.
2. Log onto the data logger with the laptop and monitor the output from all downhole probes and the data logger atmospheric sensor. Verify the pressure and temperature values are reasonable and record them in the scientific notebook.
3. Stop datalogging, download the latest set of data according to Section 5.7, and clear the memory in the data logger.
4. Clamp off the pressure probe string at the wellhead.
5. Start with the lowest installed probe in the borehole and record the pressure and temperature with the shoe extended (Po and To).
6. Retract the shoe, monitor the data logger output using the "Install" menu for the uninstalled probe, and record Pi and Ti.
7. Retract the arm and follow the Step 5 and 6 above for all probes in the borehole.
8. Raise the entire pressure probe string several feet to ensure that the string is under tension and hanging freely in well. Verify that the pressure readings from each probe are stable through several measurement cycles.
9. Lift the entire pressure probe string exactly 5 ft. (Note that this distance may be decreased by the PI or task manager if the probe is less than 5 ft below the water table. Changes in distance will be recorded in the scientific notebook). Allow probes to stabilize and start datalogging to record the pressure readings from each probe through several measurement cycles (set to collect every 5 min.). Stop datalogging, download the data and clear the memory.
10. Lower the entire pressure probe string exactly 5 ft. or distance as determined by the PI in step 9. Allow probes to stabilize and start datalogging to record the pressure readings from each probe through several measurement cycles. Stop datalogging, download the data logger and clear the memory. (See Section 5.6.2 for procedures to calculate percent error in these measurements.)

11. Install all pressure probes as described in Section 5.2.1.
12. Place another recently calibrated data logger that is dedicated to calibration verifications (called the reference data logger in the following) beside the field data logger in the borehole surface completion vault. The recently calibrated data logger will not be connected to downhole probes, but will monitor ground surface atmospheric pressure at the same frequency as the dedicated data logger. Start 24-hour monitoring in both loggers and replace the borehole cover.
13. Return in approximately 24 hours and inspect the probe data. Acceptable data requires approximately 50 temperature and pressure readings from each sensor being monitored with no null values. If the data are determined to be acceptable, download both data loggers and return the reference data logger to the NWRPO. If the data are not acceptable, determine the cause, correct, and repeat the 24-hour monitoring. See Section 5.6.3 for procedures to compare downhole pressure probe data from the 24-hour period before arriving on site and the 24-hour period after reinstalling probes. Section 5.6.2.2 also describes the comparison of atmospheric pressure measurements made with the field data logger and the reference data logger.

## **5.6.2 Field Calibration Verification Calculations and Corrective Action Steps.**

All error calculations described below (Microsoft<sup>®</sup> Excel files) shall be submitted to the QARC along with the associated metadata.

### **5.6.2.1 Up-Down Pressure Probe Response Calibration Verification**

Assume 5 ft in pressure units is the true pressure difference. For each pressure probe calculate the difference in readings at the 5 ft endpoints. Determine the absolute value of the overall pressure difference ( $\Delta P$ ) by subtracting the true (measured) pressure difference from the calculated difference in probe readings. (See Section 5.5). If  $\Delta P$  is greater than 0.1 % of the full range of the pressure transducer (pressure error tolerance limit), replace the pressure probe with a recently calibrated probe. This will require removing the pressure probe string from the borehole per Section 5.2.2.

### **5.6.2.2 Data Logger Pressure Sensor Calibration Verification**

Assume that the recently calibrated reference data logger produces true atmospheric pressures in the borehole surface completion vault. Determine the absolute value of the average difference in pressure between the reference data logger output and the dedicated data logger output for the 24-hour monitoring period described in steps 11 and 12 in Section 5.6.1. Calculate the pressure error as described in Section 5.5 for bench calibration verifications. Replace the dedicated data logger with a recently factory calibrated data logger if the acceptable error tolerance described in Section 5.5 is exceeded.

### **5.6.3 Field Operation Verification Calculations and Corrective Action Steps**

It is assumed that the average of pressure probe readings collected over 2 consecutive 24 hour periods will differ by only relatively small amounts due to short term atmospheric barometric fluctuations and/or earth tide differences. Moreover, water temperatures will also not fluctuate significantly. Therefore, error in pressure and temperature will be calculated as described in Section 5.5 assuming the second 24-hour average is the true value. If the calculated error exceeds the acceptable limits listed in Section 5.5, it will be assumed that the sensors are not operating as desired and troubleshooting will be undertaken to attempt to identify the source of error. If the problem cannot be corrected with the pressure probe string in the well, remove it from the wells and check it over on the ground surface (Section 5.2.2). Routine monitoring will not be started again until the operational source(s) of error have been identified and corrected.

## **5.7 Downloading and Processing Data**

Procedures for downloading data from dedicated Westbay<sup>®</sup> Mosdax<sup>®</sup> data loggers using the MLog software package are detailed in the MLog software manual. A laptop computer shall be used to download data from each data logger. The frequency of the downloads shall be determined by the PI or Task Manager and may vary, based on the needs of the project.

### **5.7.1 Converting Raw Data with Either WinGT or MOUT Software Packages**

For the WinGT software (MS Windows based), once raw data are downloaded into the portable field computer, the raw data (\*.wd2 format) shall be converted to a comma separated text file (\*.csv) prior to processing into either a Microsoft<sup>®</sup> Excel spreadsheet format or Microsoft<sup>®</sup> Access database (see section 5.7.3 below). Both the raw data and converted files shall be transferred to CDs and archived at the NWRPO QARC immediately after the data have been collected. *Because of its user friendly interface and file output (\*.csv), use of the WinGT software package is the preferred method for converting raw data into a readily useable format.*

For the MOUT (DOS based) software package, once raw data are downloaded into the portable field computer, the raw data (\*.wd2 format) shall be converted to Wide Lotus format (.wk1) with a Lotus format time column included prior to processing into either a Microsoft<sup>®</sup> Excel spreadsheet or Microsoft<sup>®</sup> Access database (see section 5.7.3 below). Both the raw data and converted files shall be transferred to CDs and archived at the NWRPO QARC immediately after the data have been collected.

Submission of processed data to the NWRPO QARC is detailed in Section 5.7.3.

### **5.7.2 File Naming Convention and File Archival**

The name of the download file shall include a six-digit date and a two-character qualifier for each specific borehole. The first character in the qualifier is a lower case letter unique to each borehole containing Westbay<sup>®</sup> Mosdax<sup>®</sup> monitoring equipment. These letters and associated boreholes are listed in Attachment 5. The second character in the qualifier is a digit and designates the sequential number of the download episode for the day of

interest. For example, the filename *062295a3.wd2* represents the third download of borehole NRG-4 data on June 22, 1995. The .wd2 extension on the file is automatically assigned by the Mosdax<sup>®</sup> software.

### **5.7.3 Processing Converted Data with Microsoft<sup>®</sup> Excel or Access**

The raw pressure data in the either comma separated (\*.csv) or Lotus file format shall be copied and processed to water elevation data as described in Section 3.10. This processing may be conducted in Microsoft<sup>®</sup> Excel spreadsheets or in a Microsoft<sup>®</sup> Access database. These water elevation data will be submitted to the NWRPO QARC on CD with appropriate metadata and subsequently be made available on the Nye County website for distribution to the Department of Energy Yucca Mountain Project and other interested scientists.

## **6.0 DATA COLLECTION LIMITATIONS**

Data collected as part of this technical procedure from Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater monitoring equipment are recorded in appropriate scientific notebooks and/or Mosdax<sup>®</sup> data loggers as described in detail in various subsections within Section 5. Methods to download and process data from Mosdax<sup>®</sup> data loggers are described in Section 5.7.

The limitations of raw pressure and temperature data collected from Westbay<sup>®</sup> Mosdax<sup>®</sup> groundwater monitoring equipment are described in terms of acceptable pressure error tolerances in Sections 5.5 and 5.6, which address calibration verification. The limitations (i.e. error) of water elevation data (converted from raw pressure data) are numerous and include the following: error in the specific weight of water resulting from assuming a constant well water temperature of 15°C, error in the GPS survey of the well head and ground surface elevation, error in the depth measurement of the monitoring ports resulting from measuring the individual components of the Westbay<sup>®</sup> MP55 casing system, and error in the elevation of the monitoring ports due to borehole deviation. These and other sources of error in water level elevation data will be discussed in metadata associated with each data set submitted to the NWRPO QARC.

## **7.0 REFERENCES**

TP-9.9, *Measurement of Groundwater Levels Using Electric Well Sounders*

QAP-3.2, *Documentation of Technical Investigations*

QAP-12.1, *Measuring and Test Equipment*

Westbay<sup>®</sup> field manuals for operation of the Mosdax<sup>®</sup> monitoring equipment in boreholes

Westbay<sup>®</sup> completion report for each applicable borehole

## **8.0 RECORDS**

Original downloaded pressure and temperature data files (extension .wd2)

Comma separated text files (extension .csv) or Lotus worksheet data files (extension .wk1)

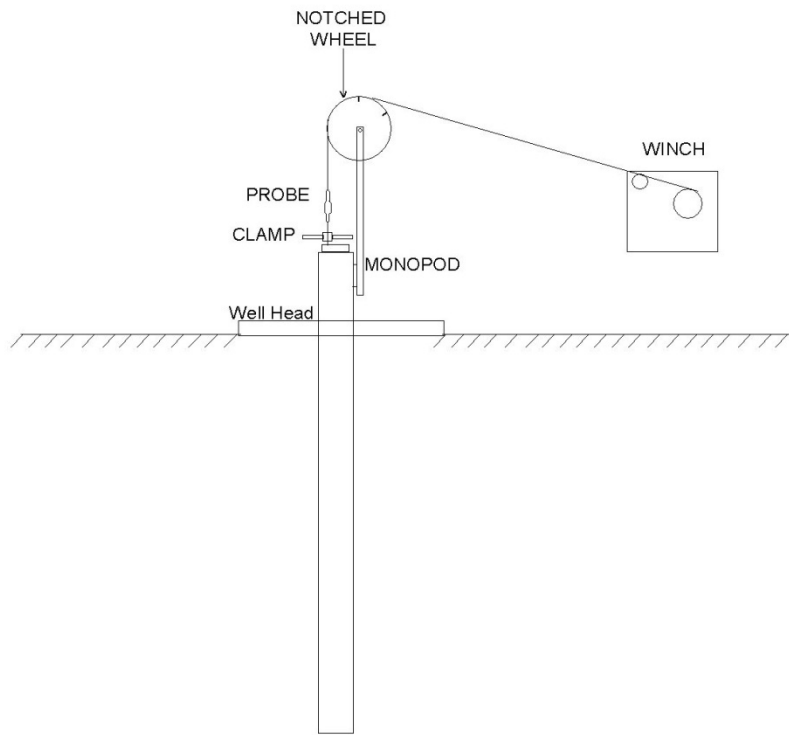
QA processed Excel data files (extension .xls)

Original calibration data files and calibration/operation verification processed Excel data files (extensions .wd2, .csv or .wk1, .xls)

## **9.0 ATTACHMENTS**

1. FIELD EQUIPMENT CHECKLIST – WESTBAY<sup>®</sup> INSTRUMENT INSTALLATION/REMOVAL
2. WESTBAY<sup>®</sup> DATALOGGER SET UP CHECKSHEET
3. EQUIPMENT CHECKLIST – OPENING/CLOSING PORTS
4. EQUIPMENT CHECKLIST – FIELD VERIFICATION
5. QUALIFIERS FOR EWDP WELLS





**Figure 1. Setup of Notched Wheel, Probe, Clamp, Monopod, and Winch at Well Head**

## ATTACHMENT 1

### FIELD EQUIPMENT CHECKLIST – WESTBAY® INSTRUMENT INSTALLATION/REMOVAL

- A copy of this technical procedure
- Monopod with notched wheel
- Spool winch
- Generator and gas
- Extension cords
- Water level sounder
- Metal cable spools
- Plastic cable spools
- Cables
- Cable clamp (appropriate size for well [4-in. vs. 2-in. diameter])
- RSB box
- Pressure Probes
- Metal end cap for bottom probe
- Data logger
- Data cable
- Power cable
- 12-volt battery
- Solar Charger
- Laptop computer with Westbay® software
- RS232 data cable for computer
- Rags
- Fire extinguisher
- Well key
- Duct tape and marker to mark spools
- Tool box
- Gloves
- Satellite phone
- Badge and radio (if entering Nevada Test Site – 510 gate closed Fridays)
- Westbay® bag with spare parts
- Westbay® well schematic
- Active scientific notebook for Westbay® Instrumented Wells
- Voltmeter

**ATTACHMENT 2**

**WESTBAY® DATALOGGER SET UP CHECKSHEET**

Project Information:

Metric Units Y/N

Elevation: \_\_\_\_\_

Company Name \_\_\_\_\_

Project Name \_\_\_\_\_

Well ID \_\_\_\_\_

Well Description \_\_\_\_\_

Latitude \_\_\_\_\_

Longitude \_\_\_\_\_

Schedule Edit:

Stage	Duration	Scan Rate	Collect Rate	Min	Max
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Thresholds:

Probe	Serial	Zone	High Alarm	Low Alarm	Delta-Trig	All
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### ATTACHMENT 3

#### EQUIPMENT CHECKLIST – OPENING/CLOSING PORTS

- A copy of this technical procedure
- Monopod with wheel
- Westbay<sup>®</sup> wireline winch (gray case)
- Generator and gas
- Extension cords
- Westbay<sup>®</sup> bag with spare parts
- Westbay<sup>®</sup> well completion diagrams
- Well key
- 5-gal. water containers with water
- Cable clamp
- Sampler bottle
- Sampler probe with face plates “A” and “B”
- MPCI, handheld controller, coily cable
- Nitrogen regulator and orange hose
- Nitrogen bottle
- Laptop computer with Westbay<sup>®</sup> software
- Rags
- Fire extinguisher
- Voltmeter
- Duct tape
- Tool box
- Gloves
- Satellite phone
- Badge and radio (if entering Nevada Test Site – 510 gate closed Fridays)
- Active scientific notebook for Westbay<sup>®</sup> Instrumented Wells

## ATTACHMENT 4

### EQUIPMENT CHECKLIST – FIELD VERIFICATION

- A copy of this technical procedure
- Monopod with wheel
- Westbay<sup>®</sup> wireline winch (gray case)
- Generator and gas
- Extension cords
- Westbay<sup>®</sup> bag with spare parts
- Westbay<sup>®</sup> well completion diagrams
- Well key
- Cable clamp
- Laptop computer with Westbay<sup>®</sup> software
- Rags
- Fire extinguisher
- Engineers measuring tape
- Duct tape
- Tool box
- Gloves
- Satellite phone
- Badge and radio (if entering Nevada Test Site – 510 gate closed Fridays)
- Active scientific notebook for EWDP Westbay<sup>®</sup> Instrumented Wells
- Reference data logger
- Voltmeter

## ATTACHMENT 5

### QUALIFIERS FOR EWDP WELLS

- “a” NRG-4
- “b” ONC#1
- “c” Campbell scientific ESF Tunnel data
- “d” Solomat data
- “e” Campbell scientific ECRB data
- “f” EWDP-1S
- “g” EWDP-3S
- “h” EWDP-9SX
- “i” EWDP-7SC
- “j” EWDP-4PA/PB
- “k” EWDP-15P
- “l” EWDP-19IM1
- “m” EWDP-19P
- “q” EWDP-10S
- “r” EWDP-22S
- “w” EWDP-Washburn-1X