

# WP 02-EM1002

Revision 3

## Electric Submersible Pump Monitoring System Installation and Operation

Technical Procedure

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APPROVED FOR USE

**TABLE OF CONTENTS**

INTRODUCTION ..... 3

REFERENCES ..... 3

EQUIPMENT ..... 4

PRECAUTIONS AND LIMITATIONS ..... 4

PREREQUISITE ACTIONS ..... 5

PERFORMANCE ..... 5

1.0 SURFACE DISCHARGE AND PRESSURE MONITORING SYSTEM  
INSTALLATION ..... 5

2.0 PRESSURE MONITORING BUBBLER INSTALLATION ..... 6

3.0 PRESSURE MONITORING BUBBLER OPERATION ..... 8

4.0 ELECTRIC THREE-PHASE SUBMERSIBLE PUMP START-UP AND FLOW  
VERIFICATION ..... 11

5.0 ELECTRIC SUBMERSIBLE PUMP SHUTDOWN ..... 13

6.0 REVIEWS ..... 15

Attachment 1 - Hydrology Field Activity Log ..... 16

Attachment 2 - Bubbler System Diagram ..... 17

Attachment 3 - Round-21 Pumping Summary ..... 18

## INTRODUCTION

This procedure provides the instructions necessary to perform the installation and operation of the submersible pump pressure and flowrate monitoring system which is used in support of the Waste Isolation Pilot Plant (WIPP) Groundwater Monitoring Program.

The following record is generated as a result of performing this procedure:

- Attachment 1, Hydrology Field Activity Log

## REFERENCES

### BASELINE DOCUMENTS

- DOE/WIPP 99-2194, *Waste Isolation Pilot Plant Environmental Monitoring Plan*
- DOE/WIPP 03-3230, *Strategic Plan for Groundwater Monitoring at the WIPP*
- Furnas VeeArc Micro 7000 User Manual
- Geokon Geotechnical Instrumentation, Micro-10 Datalogger Instruction Manual
- Geokon Geotechnical Instrumentation, Instruction Manual Model GK-401 Vibrating Wire Readout
- Geokon Geotechnical Instrumentation, Instruction Manual Vibrating Wire Piezometers Model 4500
- WP 02-EM1018, Onan 25DKAF Generator Set Operation
- WP 02-EM1008, Onan 35DGBB Generator Set Operation
- WP 02-EM3001, Administrative Processes for Environmental Monitoring and Hydrology Programs
- WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description
- WP 15-PR, WIPP Records Management Program

### REFERENCED DOCUMENTS

None

**EQUIPMENT**

- Pressure gauge, 0-300 psig, 1/4-inch NPT connection
- Nitrogen cylinder (2 each)
- Pressure regulator for nitrogen cylinder, 0-4000 psig Hi-Side, 0-2000 psig Lo-Side
- Low-rate gas flow meter
- Metering valve
- Nylon air line, 3/16-inch OD (outside diameter)
- Nylon sample line, 3/8-inch OD
- Liquid leak detector
- Vibrating wire pressure transducer, Geokon Model 4500H
- Datalogger, Geokon Micro-10
- SC32A optically isolated RS232 interface
- Vibrating wire readout box, Model GK-401
- Portable field (laptop) computer with PC208 software
- Flow totalizing meter
- Power cable (three conductor)
- Steel main discharge and support pipe
- Surface-mounted flow regulating valves and flow meters
- Rubber hose, 1-inch ID (inside diameter)
- Water level meter

**PRECAUTIONS AND LIMITATIONS**

- Only personnel qualified in accordance with applicable Environmental Monitoring and Hydrology (EM&H) qualification cards or under the direct supervision of a qualified individual may perform this procedure.
- EM&H Manager shall be contacted if this procedure cannot be performed as written.

- EM&H Manager shall be contacted if abnormal conditions are found during the performance of this procedure.
- MSDS sheets for all chemicals used shall be available and shall be reviewed prior to performing this procedure.
- Nitrogen bottles are to be secured in an upright position only.

### **PREREQUISITE ACTIONS**

- 1.0 Ensure that electric submersible pump has been installed in the well.
- 2.0 Ensure that pre-sample water level measurement has been obtained.
- 3.0 Ensure that portable diesel generator is available to supply electrical power per WP 02-EM1018 or WP 02-EM1008.
- 4.0 Verify nitrogen tank gauge reading is greater than 500 psi. Replace cylinder if pressure is equal to or less than 500 psi.

### **PERFORMANCE**

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#### **NOTE**

The installation process may be performed in any sequence if efficiency can be achieved and it is deemed appropriate by the technician performing the procedure.

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- 1.0 SURFACE DISCHARGE AND PRESSURE MONITORING SYSTEM INSTALLATION
  - 1.1 Attach 1-inch flow regulating manifold to 1-inch discharge line located on top of well head.
  - 1.2 Attach 3/8-inch dedicated sample line to discharge line located on top of the well head and mount inside field lab.
  - 1.3 Attach 3/8-inch nylon line between outlet of 3/8-inch flow regulating valve to inlet port of 3-way valve.
  - 1.4 Connect 3/8-inch nylon line between three-way valve outlet port and splitter manifold.
  - 1.5 Connect 3/8-inch nylon lines between splitter manifold and each 1,000-gallon tank.
  - 1.6 Connect outlets from each valve on discharge manifold to each 1,000-gallon tank using 1-inch ID rubber hose.

## 2.0 PRESSURE MONITORING BUBBLER INSTALLATION

### 2.1 Estimate formation pressure as follows:

2.1.1 Verify calibration of water level meter is current and record equipment number and calibration due date on Attachment 1.

2.1.2 Obtain static water level (SWL) measurement of well from water level meter and record measurement on Attachment 1.

2.1.3 Obtain depth of pump installation (D) from summary in previous data package.

2.1.4 Calculate and record column of water above pump intake using the following formula:

$$C = D - SWL$$

where:

C = column of water above pump intake

D = depth of installation

SWL = static water level (from most recent groundwater level measurements)

2.1.5 Convert column of water above the pump intake into pressure from column of water, using the following formula:

$$P = \frac{C}{k}$$

where:

P = pressure from column of water

C = column of water above pump intake calculated in previous step

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### NOTE

There are 2.3066 feet of fresh water for each pound per square inch (psi) of pressure. An estimate is considered because the water in the Culebra is heavier than fresh water and usually has a specific gravity greater than 1.0.

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k = conversion constant 2.3066

2.1.6 Record column (downhole) pressure on Attachment 1.

**WARNING**

Safety glasses shall be worn to prevent eye injury.

**CAUTION**

Do not use oil as a lubricant or cleaning agent. The use of oil will damage equipment.

- 2.2 Crack open and close the nitrogen cylinder valve to clean out foreign matter.
- 2.3 Install pressure regulator on nitrogen cylinder.

**NOTE**

See Attachment 2, Bubbler System Diagram, when performing Steps 2.4 through 2.6.

- 2.4 Connect nitrogen supply line to bubbler three-way valve.
- 2.5 Connect 3/16-inch nylon line between bubbler needle valve outlet and pressure monitoring line on well head.
- 2.6 Connect transducer to side port connection on flow meter.
- 2.7 Connect transducer Amphenol connector to pigtail adapter.
- 2.8 Plug jumper (with colored alligator leads) into GK-401.

**NOTE**

Colored alligator clips on GK-401 adapter are connected to like-colored transducer pigtail leads (Red to Red, Black to Black)

- 2.9 Connect GK-401 jumper alligator clips to transducer leads at pigtail adapter.
- 2.10 Turn GK-401 display switch to "B."
- 2.11 Turn Off-On switch to **ON**.
- 2.12 Verify "zero pressure frequency" reading is displayed in display window. If no reading is displayed on GK-401, battery may require recharging (refer to equipment owners' manual).

- 2.13 Record "zero pressure frequency" on Attachment 1.
- 2.14 Connect transducer Amphenol to number "1" input Amphenol on datalogger.
- 2.15 Obtain gauge factor for transducer being used from the side of the transducer and record on Attachment 1.
- 2.16 Multiply gauge factor of transducer by -1000 to determine multiplier.
- 2.17 Multiply the "zero pressure frequency" by the gauge factor to determine offset. Record on Attachment 1.

3.0 PRESSURE MONITORING BUBBLER OPERATION

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**NOTE**

Refer to Attachment 2 when performing Steps 3.1 through 3.11.

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- 3.1 Position bubbler three-way valve (1) so that flow is in the direction of needle valve (2). The valve will be positioned to the right.
- 3.2 Close bubbler needle valve (2).
- 3.3 Close bubbler metering valve (3).
- 3.4 Close bubbler transducer valve (4).

**CAUTION**

Check positions of all valves before nitrogen is turned on to avoid over pressurization of the system.

- 3.5 Slowly open nitrogen cylinder valve. This valve is on the nitrogen cylinder which is located outside the mobile lab.

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**NOTE**

Actual time required to clear bubbler will depend on well depth. Deeper wells will require more time.

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- 3.6 Purge bubbler by adjusting cylinder pressure regulator to maintain 200 psig and allow bubbler line to clear for three to five minutes.
- 3.7 Record purging start and finish times; the bubbler (pressure) gauge (psi); initial and final readings on Attachment 1.
- 3.8 Position bubbler three-way valve (1) so that flow is toward gas inlet.



- 3.9 Slowly open valve (2) and verify, using the bubbler gauge, that the pressure is increasing to approximate column pressure.
- 3.10 **IF** no indication of pressure is observed,  
**THEN** close valve (2) and troubleshoot, including check for leaks, recheck of valve alignment, and nitrogen cylinder capacity and return system to acceptable operating condition before continuing.
- 3.11 Slowly open metering valve (3) until flowmeter on bubbler system indicates  $3 \pm 1$  mL/min.
- 3.12 Slowly open bubbler transducer valve (4).
- 3.13 Clear datalogger and enter program as follows:
  - 3.13.1 Turn laptop power switch **ON**.
  - 3.13.2 Press Ctrl-Alt-Delete.
  - 3.13.3 Select "OK."
  - 3.13.4 Select "OK."
  - 3.13.5 Select desktop shortcut to PC208W software.
  - 3.13.6 Select the "Connect" button.
  - 3.13.7 Select the "Terminal Emulator" tab.
  - 3.13.8 Select the "Open Port" button.
  - 3.13.9 Press <Enter> twice.
  - 3.13.10 Enter "7H" and press <Enter>.
  - 3.13.11 Press "Shift-8."
  - 3.13.12 Press "A" to enter Mode 10.
  - 3.13.13 Press <Enter> four times to go to line 5.
  - 3.13.14 Enter 1986 and press <Enter>.
  - 3.13.15 Wait 15 seconds for datalogger to clear.
  - 3.13.16 Press <Enter> twice.
  - 3.13.17 Select "Tools" tab.

- 3.13.18 Press "Send" button.
- 3.13.19 Select "OK" in caution window.
- 3.13.20 Enter 4500H for DLD program and select "OK."
- 3.13.21 Select "OK" in download results window.
- 3.13.22 Select "Set datalogger clk" in clock (clk) synchronization window.
- 3.14 Enter multiplier and offset values into datalogger program and set scan rate to 60-second interval as follows:
  - 3.14.1 Select "Terminal Emulator" tab.
  - 3.14.2 Press <Enter> twice.
  - 3.14.3 Enter "7H" and press <Enter>.
  - 3.14.4 Hold down Shift key and press "8."
  - 3.14.5 Press "1" to enter Mode 1.
  - 3.14.6 Press <Enter> 13 times to go to line 9.
  - 3.14.7 Enter multiplier value for transducer obtained from Step 2.16. The multiplier is a negative value. Press "C" to enter a "negative" symbol.
  - 3.14.8 Press <Enter> to go to line 10.
  - 3.14.9 Enter offset value obtained from Step 2.17.
  - 3.14.10 Press "B" (for Back) 13 times to go to Scan Rate.
  - 3.14.11 Enter "60." ("60" refers to 60-second intervals.)
  - 3.14.12 Press <Enter>.
  - 3.14.13 Press "B" to verify scan rate is 60. **IF** not 60, **THEN** return to Step 3.14.11.
  - 3.14.14 Press Shift 8.
  - 3.14.15 Enter "0" (zero) to go to logging mode.

3.14.16 **IF** a leak is present (indicated by decreasing pressure on cylinder regulator lo-side gauge),  
**THEN** perform the following:

[ A ] Apply liquid leak detector to all fittings.

### WARNING

System must be depressurized prior to replacing fittings to prevent injury to personnel.

[ B ] Verify system is depressurized.

[ C ] Repair or replace leaking fittings.

## 4.0 ELECTRIC THREE-PHASE SUBMERSIBLE PUMP START-UP AND FLOW VERIFICATION

### NOTE

Control frequency from Attachment 3, Round-21 Pumping Summary, is for guidance only. Actual frequency used may be different as varying conditions warrant.

- 4.1 Verify Furnas Micro 7000 On-Off switch is **OFF**. This switch is located outside the mobile lab.
- 4.2 Verify Fwd/Rev switch is in Fwd.
- 4.3 Connect power cable between submersible pump and Micro 7000 drive receptacle on GWST.
- 4.4 Switch On-Off switch to **ON**, and the instrument display will light up. **IF** no response, **THEN** turn switch to **OFF** and check power supply.
- 4.5 Verify the following on the keypad:
  - Power LED **ON**
  - Status LED **ON**
  - Display indicates SDP 0.00

4.6 Press Speed button.

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**NOTE**

"Next" or "Prev" keys are used to scroll the menu.

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4.7 Scroll the menu and verify display indicates the following:

- MAX 60.0
- MIN 00.0
- SLIP 0.00

4.8 Scroll until SP1 is displayed.

4.9 Input frequency value for well being sampled using guidance from Attachment 3 (Control Freq.).

4.10 Press <Enter>.

4.11 Press "Exit."

4.12 Verify that GF Signet flow meter/totalizer is reset to "0."

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**NOTE**

One to four minutes will elapse before water will reach the surface after the start button is pressed.

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4.13 Press "Start."

4.14 Verify water flow is to surface by observing indication on flow meter.

4.15 Record flow rate indicated on flow meter after stabilization on Attachment 1.

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**NOTE**

Flow rate is adjusted to assure that a minimum of three well volumes are purged during the sampling event.

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4.16 Adjust pump speed as follows:

4.16.1 Adjust SP1 setting to stabilize flow rate with guidance from Attachment 3.

4.16.2 Change scan rate to 30-minute interval.

4.16.3 Record flow rate on Attachment 1 at least every hour until pressure stabilizes. (Does not vary more than 10 psi.)

4.16.4 Measure water level manually with each flow rate reading and record on Attachment 1.

4.16.5 **WHEN** pressure stabilizes,  
**THEN** record flow rate at start and end of day.

## 5.0 ELECTRIC SUBMERSIBLE PUMP SHUTDOWN

5.1 Change scan rate from 30 minutes- to 60-seconds interval.

5.1.1 Press <Enter> twice.

5.1.2 Enter "7H."

5.1.3 Hold down Shift key and press "8."

5.1.4 Enter "1."

5.1.5 Enter "60."

5.1.6 Hold down Shift key and press "8."

5.1.7 Press "0."

5.1.8 Press "B" to verify scan rate is 60.

5.2 Press Speed (SPD) button on VeeArc key pad.

5.3 Using "Next" button on key pad, scroll until "SP1" is displayed.

5.4 Press "0" (zero).

5.5 Press <Enter>.

5.6 Press "Exit."

5.7 After SPD ramps down to 0.00, press "Stop."

5.8 Turn Micro 7000 On-Off switch to **OFF**. This switch is located outside the mobile lab.

5.9 Record shutdown time on Attachment 1.

5.10 Record flow totalizer reading on Attachment 1.

5.11 Enter "0" (zero) for scan rate to stop logging by using the following steps:

5.11.1 Press <Enter> twice.

- 5.11.2 Enter "7H."
- 5.11.3 Hold down Shift key and press "8."
- 5.11.4 Enter "1."
- 5.11.5 Press "0."
- 5.11.6 Press "B" to verify scan rate is 0 (zero).

5.12 Copy datalogger data to CD as follows:

- 5.12.1 Select "Tools" tab from Datalogger Connection window.
- 5.12.2 Insert CD in drive.
- 5.12.3 Press "Collect All" button under Manual Data Collection.
- 5.12.4 Press "Browse" button.
- 5.12.5 Select "D" drive using the datalogger menu.

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**NOTE**

Actual filename varies from well to well. Number after WQ is well designator (X), number after R is round designator (Y).

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- 5.12.6 Type "D:\WQ(X)R(Y).DAT."
- 5.12.7 Select "OK."
- 5.12.8 Select "OK."
- 5.12.9 Wait for "% Collected" bar to fill.
- 5.12.10 Verify filename entered in Step 5.12.6 is on CD in Drive D:.
- 5.12.11 Close nitrogen cylinder valve.

## 6.0 REVIEWS

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### **NOTE**

WP 02-EM3001 provides guidance for performing reviews.

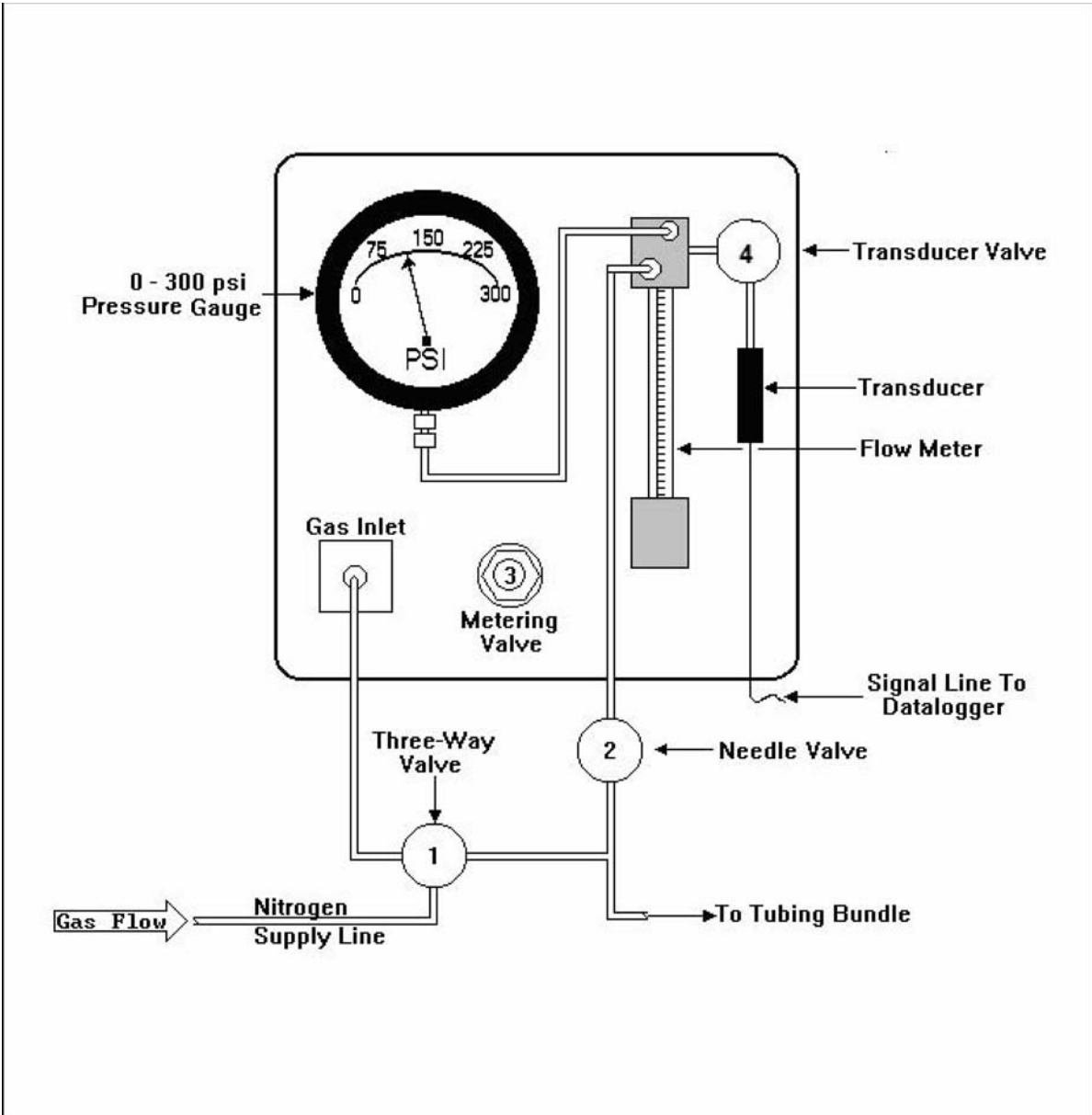
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- 6.1 Team Leader (TL) or designee, review Attachment 1.
- 6.2 TL or designee, store Attachments 1 and 2 in EM one-hour fire rated files in accordance with the department Records Inventory and Disposition Schedule.





Attachment 2 - Bubbler System Diagram



## Attachment 3 - Round-21 Pumping Summary

(This table is for guidance only.)

ROUND-21 PUMPING SUMMARY							
WELL	START SWL (ft)	ENDING WATER LEVEL (ft)	PURGING FLOW RATE (gpm)	DRAW DOWN (ft)	SPECIFIC CAPACITY (gpm/ft)	THREE WELL VOLUME FLOW RATE(+10%) (gpm)	CONTROL FREQ. (HZ.)
WQSP-1	361.43	363.03	0.34	1.60	0.213	0.30	43.0
WQSP-2	400.90	402.31	0.36	1.41	0.255	0.36	45.0
WQSP-3	465.79	616.64	0.33	150.85	0.002	0.34	48.5
WQSP-4	448.14	453.54	0.30	5.40	0.056	0.29	45.0
WQSP-5	384.02	440.49	0.31	56.47	0.005	0.24	49.0
WQSP-6	346.28	460.69	0.24	114.41	0.002	0.21	50.0
WQSP-6A	166.87	166.91	0.38	0.04	9.500	0.03	33.0