NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

TECHNICAL PROCEDURE

TITLE: PUMP-SPINNER TESTS IN UNSCREENED OPEN BOREHOLES AND SCREENED BOREHOLES	Revision: 1 Date: 02-14-02 Page: 1 of 8
PROCEDURE No.: **TP-9.0**	SUPERSEDES: **Rev. 0, 01-14-99**

APPROVAL

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Project Manager **Date**

CONCURRENCE

2-15-02

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14 FEB 2002

Project Quality Assurance Officer **Date**

1.0 PURPOSE

The purpose of this procedure is to provide instructions to NWRPO personnel and contractors for the performance of pump-spinner tests. This test will be the primary test performed to quantify crossflow under static (non-pumping) conditions, estimate hydraulic head levels in individual zones and allocate hydraulic properties obtained from conventional borehole tests. As part of the aquifer testing segment of Nye County's Independent Scientific Investigations Program (ISIP), these tests may be performed on a variety of wells, including existing and future Nye County wells, as well as selected domestic and agricultural water supply wells in Amargosa Valley. This test is appropriate for both open and cased boreholes. The implementation of this procedure ensures that data gathered from the Pump-Spinner logging of the borehole, as part of the Nye County ISIP, meet NWRPO quality assurance (QA) requirements for scientific data.

2.0 SCOPE

2.1 APPLICABILITY

This procedure applies to the NWRPO principal investigator (PI), NWRPO Scientists/Engineers, and contractors or designated personnel performing the scientific investigation tasks listed in the above section. These individuals shall be referred to herein as NWRPO personnel.

2.2 TRAINING

NWRPO personnel shall be trained before conducting work and shall document that they have read and understand this procedure. Personnel performing the tasks described in this technical procedure shall be professional geoscientists or engineers with applicable previous experience. Personnel performing field calibrations as well as data-collection tasks shall be trained in procedures specifically applicable to the equipment used.

3.0 DEFINITIONS

3.1 Aquifer – Rock or sediment which is partially or fully saturated with water and is sufficiently permeable to transmit quantities of water to wells and springs.

3.2 Aquifer Test – A test made by pumping a well for a set period of time while observing the change in hydraulic head in the aquifer. It is used to determine hydraulic characteristics of the aquifer.

3.3 Caliper Log – A log which measures the diameter of the borehole vs. depth.

3.4 Drawdown – The difference in the water level before the well was pumped and the water level at a given time after pumping commences in a pumping well.

3.5 Recovery – The rise in the water level in an aquifer after pumping ceases in a well.

3.6 Spinner Log – A borehole logging technique whereby a logging tool with a rotating impeller is used in a borehole to measure the velocity of the moving fluid with the borehole.

3.7 Transmissivity – A measure of the ability of an aquifer to transmit water through its saturated thickness.

4.0 RESPONSIBILITIES

4.1 The project QA Officer shall be responsible for the coordination of the internal review of this technical procedure.

4.2 The Nye County On-Site Geotechnical Representative will designate a Principal Investigator (PI) to oversee all aquifer-testing activities and an on-site NWRPO Scientist/Engineer to direct aquifer test activities in the field.

4.3 The PI shall be responsible for the preparation and modification of this procedure, preparation of borehole specific testing instructions (test plans) and analysis of the test results. The PI shall be responsible for the preparation and modification of this procedure, as well as oversight of the performance of this procedure.

4.4 The NWRPO Scientist/Engineer will carry out these instructions and supply the PI with the data for analysis and interpretation.

5.0 PROCESS

This procedure concerns the activities performed by NWRPO personnel related to the running of the pump-spinner log surveys at designated boreholes as part of the aquifer testing phase of the ISIP. Any deviation from this procedure shall be documented in the Scientific Notebook.

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, *Procedures for Documentation of Scientific Investigations*."

5.1 BACKGROUND

A spinner log is a tool designed to measure fluid velocity at various depths in a well. Spinners are relatively simple tools, consisting of a centralized logging tool with an impeller mounted on the bottom. The tool counts the number of rotations of the impeller using an optical or magnetic sensor. The counts are expressed as counts per second (CPS). The counts per second are a function of the fluid velocity, the speed of the logging tool in the well, and the size and shape of the impeller. Because the logging tool only counts impeller rotations, a single stationary reading cannot distinguish between upward or downward flow, but only that flow is occurring.

A two-pass technique involving both down and up logging runs at the same speed is used to reduce potential errors due to borehole size changes, tool idiosyncrasies, and other factors. As the upward fluid velocity increases at any point in the wellbore, the counts on the down run will increase while the counts on the up run will decrease, causing the two curves to diverge. To compensate for slight differences in responses, it is also desirable to record measurements in a section of the borehole with known diameter where no flow is occurring. The baseline for the runs is then adjusted slightly until the two runs yield the same count rate across blank pipe with no fluid movement. The net count rate is determined as half the difference in counts per second between the up and down logging runs.

The spinner log survey is designed to provide information about percentage flow contribution by zone at different head levels and quantify the amount of cross flow between various zones intersected by the borehole under initial static conditions. During geophysical logging, a continuous spinner log will be run with initial static head conditions in the borehole. Once the static spinner logging is complete, a submersible pump will be lowered into the borehole and pumping will commence. Once the pumping flow rate has stabilized, the spinner log will again be run both with and against the direction of fluid flow throughout as much of the borehole as can practicably be logged based on the pump size and hole or casing limitations. It may be necessary to run multiple passes at different logging speeds in the up and down mode to negate the effects of cable speed. Additional quality checks are made by taking measurements with a stationary logging tool placed above all screens and between screened intervals. If the well being tested is an open hole, the quality checks should be performed by placing the logging tool at sections of the hole identified on the Caliper Log as being "in gauge". After completion of the pump-spinner log a static spinner log may again be run to verify a return to static conditions. Results of the spinner logs will be analyzed to identify transmissive zones, allocate transmissivity between zones, and determine intervals with differing non-pumping water levels

5.2 CALIBRATION OF EQUIPMENT

Flow meters utilized during the pumping test should be factory calibrated to nationally recognized standards if available. However, if national standards do not exist for a particular flow meter, the best available standard will be used, e.g., the manufacturer's calibration, a field calibration, or other appropriate method. It is understood that the unavailability of a national standard for calibration purposes will not adversely impact the data. A stable flow condition is defined as when the change in flow rate from the outflow tube is less than five percent of the total flow rate. For example, if the borehole is being pumped at 100 gpm, a 5-gpm fluctuation in the pumping rate over a five-minute interval will be acceptable. Otherwise, the spinner log will not be run and pumping will be continued until satisfactory conditions are reached or until the PI decides that the larger fluctuations are acceptable. At this point, the spinner log can then be run.

Detailed procedures for the performance and documentation of both field and laboratory calibrations of pressure and temperature probes are contained in TP-9.2, "*Instrument Calibration and Collection and Processing of Data from Boreholes*". Additional information is contained in QAP-12.1, "*Procedures for Control of Measuring and Testing Equipment*". Care should be taken to document probe serial numbers and calibration status in the Scientific Notebooks. Copies of all calibration files and appropriate metadata will be transmitted to the NWRPO QARC upon completion of the test.

5.3 PROCEDURE FOR PERFORMING A PUMP-SPINNER TEST

1. If the borehole being tested is an uncased borehole, it is important that a caliper log be run and evaluated prior to the running the pump-spinner test. Sections of the wellbore that are "in gauge" and preferable located between the productive intervals should be selected for quality control checks later in the procedure (step 7).

2. The continuous spinner flowmeter (CSF) should be lowered down the open borehole and will be attached by a wireline to a datalogger at the surface. The initial static water level in the hole should be noted. A spinner survey both down and up should be completed through the column of water under initial static head conditions in the borehole, assuring that the CSF is moving at the same constant cable velocity. If the cable logging speed is subject to change, the cable logging speed must be recorded by the datalogger along with the Counts Per Second (CPS) for the impeller.

3. Once the static spinner logging is complete, the submersible pump will be lowered into the borehole. Monitoring of the pump installation should be performed by Nye County field personnel and depth control recorded on the *NWRPO Tubing and Casing Record*. At this time information concerning the specific pump to be used should be recorded in the Scientific Notebook. This information should include type of pump, manufacturer, serial number, pump size and rated pumping capacity, pump setting, and condition of the pump. Depending on hole conditions and pump configuration, it may be necessary to run the spinner cable through a "dead string" of tubing to a depth below the pump intake to prevent the logging tools and cable from getting tangled in the pump intake. The installation of the discharge system should be supervised or conducted by Nye County field personnel. Care should be taken to assure that the discharge water pumped during the test is carried away from the well site to discharge to a natural drainage downslope of the test well. In addition, the discharge system should be constructed to ensure that excessive erosion does not occur at the discharge point.

4. If possible, a pressure transducer should be attached to the pipe above the submersible pump, to measure water-level changes in the borehole. The downhole pressure transducer range should be selected to match the anticipated drawdown and setting depth. If hole conditions preclude the running of a pressure transducer, the water level should be measured using an electric sounding tape at times as designated by the PI.

5. Commence pumping of the test well. The discharge rate should be monitored on a regular basis. Flow metering devices with the capability of totalizing the volume discharged and displaying the current rate will be used at the site. The accuracy of the flow meter should be crosschecked with the timed filling of known volume vessels. All monitoring information should be recorded in the Scientific Notebook. Continue pumping until a relatively stable flow condition is reached, as described in section 5.2.

6. Once a stable flow condition has been reached, run the continuous spinner flowmeter back down the borehole. Readings of CPS for the impeller should be collected both with and against the direction of fluid flow. In order to improve the analysis in intervals where the logging speed is near the average fluid velocity, it may be necessary to make multiple logging runs using different logging speeds. The water level in the hole under stable flowing conditions should be noted.

7. As an additional crosscheck of the data obtained from the above logging run, a series of stationary spinner readings should be taken. This is accomplished by placing the logging tool above the uppermost screen and between each set of screens and recording the CPS for a period of approximately 20 seconds each. In uncased boreholes, the checks should be performed between productive intervals in sections of hole that are “in gauge”.

8. At the conclusion of the test, when the pump is turned off, the recovery should be monitored to allow the head recovery curve to be determined. The duration of the recovery test will be at the discretion of the PI.

9. After completion of the pump-spinner log, an additional static spinner log may be run to verify the return to static conditions. The decision to run this additional log will be at the discretion of the PI.

5.4 DATA ACQUISITION METHODOLOGY AND LIMITATIONS

Data acquired from pump-spinner logs will be quantitative in nature and tied to specific depth intervals or zones within drilled boreholes. These data will be recorded in Scientific Notebooks. The data acquired by means of this Technical Procedure may also be supplemented by data collected under the controls of TP-9.2, “*Instrument Calibration and Collection and Processing of Data from Boreholes”,* and TP-9.9, “*Measurement of Water Levels.”*

Uncertainty attached to the methodology in the acquisition of test data from pump-spinner testing includes the variability of the level of skill of the NWRPO field personnel performing the testing and individual professional judgment.

Pump-spinner log data and associated metadata will be submitted to the NWRPO QA Records Center following the conclusion of the test. Copies of pages from Scientific Notebooks will be submitted on a periodic basis for preservation; the Scientific Notebook will be submitted as well when filled or at the end of the test or project.

6.0 REFERENCES

All manuals related to the calibration and operation of all instruments and equipment in boreholes are maintained at the Nye County Geotechnical Representative or designee's office, including, but not limited to:

- The Westbay® field manual for operation of the Mosdax ® instrument assembly.
- Calibration instructions for pressure and temperature probes
- The wellbore completion diagram
- TP-7.0, *Drill Site Management*
- TP-9.2, *Instrument Calibration and Collection and Processing of Data from Borehole*
- TP-9.9, *Measurement of Groundwater Levels*

7.0 RECORDS

Copies of all electronic data files, calibration files, and associated metadata will be submitted to the NWRPO QARC at the conclusion of the test. NWRPO personnel will be responsible for maintaining the Scientific Notebooks on the individual wells as required by QAP-3.2, Procedures *for Documentation of Scientific Investigations*.

8.0 ATTACHMENTS

N/A

9.0 TEST CONDITIONS

The appropriateness of the test conditions shall be determined by the PI and NWRPO field personnel.

10.0 PERSONNEL REQUIREMENTS

There are no specific personnel requirements other than those described in Section 2.2.

11.0 SPECIAL ENVIRONMENTAL TEST/STORAGE CONDITIONS

There are no special requirements for environmental test or storage conditions.

12.0 INSPECTION HOLD POINTS

There are no applicable inspection hold points

13.0 ACCEPTABLE DETAIL AND ACCURACY LEVELS

Verification of calculations shall be made with a relative error of less than 1 in 1,000.