
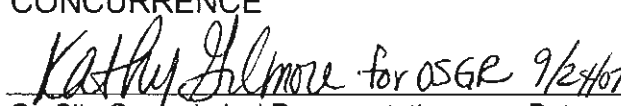

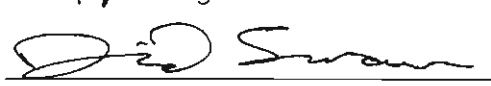




# NYE COUNTY NUCLEAR WASTE REPOSITORY PROJECT OFFICE

## TEST PLAN

<b>TITLE:</b>  <b>Thermal Logging in Early Warning Drilling Program Wells and Laboratory Using Agilent Distributed Temperature Perturbation Sensor Technology</b>		<b>Revision: 0</b>  <b>Date: 9-18-07</b>  <b>Page: 1 of 19</b>
<b>TEST PLAN NUMBER:</b>  <b>TPN-6.2</b>	<b>SUPERSEDES:</b>  <b>None</b>	
<b>APPROVAL</b>  Director	<b>CONCURRENCE</b> <div>  <div>           Kathy Helmore for OSGR           <div>9/24/07</div> </div> </div> <div>           On-Site Geotechnical Representative           <div>Date</div> </div> <div>  <div>9/24/07</div> </div> <div>           Principal Investigator           <div>Date</div> </div> <div>  <div>9-25-07</div> </div> <div>           Quality Assurance Officer           <div>Date</div> </div>	

### 1.0 INTRODUCTION

This test plan (TPN) provides detailed instructions for the collection of temperature data in Nye County Nuclear Waste Repository Project Office (NWRPO) Early Warning Drilling Program (EWDP) wells and the Rock Hydrologic Testing Laboratory (Lab) using Agilent distributed temperature sensor (DTS) technology.

The work described in this TPN will be conducted in EWDP wells (both existing and future) in the lower Fortymile Wash area of the Amargosa Desert, as well as the Lab. NWRPO work plan WP-6.0, *Early Warning Drilling Program Geophysical Logging Work Plan*, provides the background, purpose, and general objectives of geophysical data collection in EWDP boreholes and wells.

## **2.0 BACKGROUND AND PURPOSE**

During cooperative distributed temperature perturbation sensor (DTPS, in which the DTS logging fiber is combined with a heater wire) logging work with Lawrence Berkeley National Laboratory in 2006, extremely high groundwater velocities were estimated in fractured portions of the Crater Flat tuff group in well 24PB (Freifeld, et. al., 2006). Nye County believes that these features and others similar to them could act as potential fast flow pathways for groundwater moving from the proposed high level nuclear waste repository at Yucca Mountain to residents in Amargosa Valley.

NWRPO personnel subsequently conducted DTPS logging in other EWDP wells in the summer of 2006. Analysis of DTPS data in the spring of 2007 showed that several properties appeared to influence the data collected with the DTPS method: groundwater flow, changes in well completion materials, and changes in borehole geology.

The collection of temperature data in existing wells and new boreholes using the DTPS method described in this TPN will aid in developing a better understanding of the geology at EWDP wells, and eventually aid in developing improved estimates of flow and transport properties within the aquifers downgradient from Yucca Mountain. These data may also be used to support and complement those obtained from future pump tests, tracer tests, and other hydrogeologic investigations conducted by the NWRPO.

## **3.0 SCOPE OF WORK**

### **3.1 Responsibilities**

The NWRPO On-Site Geotechnical Representative is ultimately responsible for the proper implementation of this TPN, as well as ensuring that work is conducted in a manner consistent with the guidelines established in the NWRPO Health and Safety Plan for General Field Activities (HASP).

The Principle Investigator (PI) is responsible for supervising the data collection activities described in this TPN. NWRPO personnel, including staff and contract geologists and technicians, are responsible for conducting the activities described in this TPN.

The Field Safety Supervisor (FSS) is responsible for monitoring the health and safety of workers relative to the guidelines established in the HASP.

The Site Supervisor is responsible for ensuring the completion of work in a safe manner according to the guidelines established in this TPN.

Nye County Field Personnel, as assigned by the PI, FSS, or Site Supervisor are responsible for the completion of the activities described in this TPN.

## 3.2 Data Collection Locations

### 3.2.1 EWDP Wells

Figure 1 shows the locations of existing EWDP wells. DTPS logging work may be conducted within existing wells, in new boreholes, and/or in conjunction with aquifer pump tests, tracer tests, and other activities at the discretion of the PI.

### 3.2.2 NWRPO Laboratory

The NWRPO Lab provides a secure, climate-controlled environment in which testing will be conducted. The flow cell used to test the DTPS method in the Lab is described in Section 4.2.

## 3.3 Equipment Requirements

The equipment required for DTPS logging shall be used according to manufacturer's specifications and/or methods detailed in this TPN. The minimum required equipment is listed in Table 1.

Table 1  
DTPS Logging Equipment

Item (In Alphabetical Order)	Amount
Band-It® band clamps; appropriate length for well casing	Varies
Control Panel for heater wire (240 volts AC at $\leq$ 33 amps)	1
Electrical tape, 7-mil	3 rolls
Electrical tape, 10-mil	3 rolls
Electric wireline winch	1
Fiber optic riser cable (OFNR), 2-fiber, 50/125, loose tube buffer, indoor/outdoor with E2000 8 degree Angle Polish Connector (APC)	1350 feet
Field Trailer, air conditioned	1
Generator (25 kilowatt [KW] minimum), 240 Volts	1
Heat tape, waterproof	9 feet
Heater wire (14-AWG 2-conductor direct burial)	1350 feet
Laptop computer	1
Oven, laboratory quality	1
Polyvinyl chloride (PVC) pipe 1/2-inch diameter (if required)	12 inches
3M™ Scotchcast™ electrical insulating resin (if required)	2 pouches
Agilent N4385A/4386A Distributed Temperature System User's Guide	1
Agilent Technologies Distributed temperature System Configurator PC Software User's Guide	1
Agilent N4386A Distributed Temperature Sensor and associated software	1

### 3.4 Safety

NWRPO personnel shall adhere to the safety practices described in the HASP. Hazard Analysis worksheets will be completed by the Field Safety Supervisor (FSS), or designee, prior to commencement of work to determine what hazards are present and the control measures or personal protective equipment (PPE) necessary to mitigate them. All personnel shall wear appropriate PPE at all times and stop work if life-threatening or otherwise unsafe conditions develop or are observed. Work shall resume only when actions have been taken to correct unsafe conditions and all on-site personnel have been briefed.

It should be noted that the DTS is a Class 1M laser product, and care should be taken to avoid looking directly into or magnifying the laser while it is energized. Users should refer to the manufacturer's documentation for further safety warnings and precautions.

## 4.0 INSTRUMENTATION AND DATA COLLECTION

The DTS comprises a temperature-logging hardware interface with onboard memory and communications ports. This system is capable of collecting and stacking distributed temperature data along the length of a fiber optic cable at user-defined intervals. Data are recorded to the onboard memory or downloaded directly to a laptop computer.

### 4.1 Data Collection in EWDP Wells

At a minimum, DTPS logging shall be conducted in well NC-EWDP-24PB, in order to verify the results of previous DTPS logging conducted under TPN-6.1, Rev. 0 *Thermal Logging in Early Warning Drilling Program Wells Using SensorNet Equipment*. DTPS logging may be conducted in other EWDP wells, at the discretion of the PI.

#### 4.1.1 Cable Preparation

If suitable heater wire is not already installed as part of the well completion, the downhole end of the heater wire should be prepared as follows:

1. Split the two conductor wires apart approximately 2-inches (in.) at the end of the wire.
2. Strip 1-in. insulation from the end of each wire.
3. Twist the two wires together and solder the connection.
4. Place the wires inside a 3-in. long section of 1/2-in. PVC pipe.
5. Verify connection and measure the resistance value of the wire. Record this value in the scientific notebook.
6. Tape over bottom end of PVC pipe to ensure the Scotchcast™ electrical insulation resin does not leak out.
7. Mix the Scotchcast™ according to package instructions and pour into the pipe, around the wires and allow at least one hour to set.

Once the resin has set, the heater wire is ready to be installed.

The downhole end of the fiber optic cable should be prepared in a similar manner:

1. Two options are available for terminating the end of the cable.
  - a. Specify that the end of the cable have a 14° minimum angle finish (from the manufacturer); or
  - b. Fold the end of the cable back on itself and pinch the crease with a pair of pliers.
2. Secure the end of the fiber optic cable with several wraps of 7-mil electrical tape.

The fiber optic cable is now ready to be installed.

#### 4.1.2 Cable Installation and Removal

##### 4.1.2.1 Cable Installation

Heater wire and fiber optic temperature sensing cables may be installed at the time a well is completed or in an existing well. If installation takes place at the time a well is completed, cables should be secured to the outside of the well casing using 10-mil electrical tape and/or Band-It® clamps at regular intervals (e.g., every 10 to 20 feet [ft]). Care should be taken to ensure that the fiber optic cable is not crushed or kinked during installation. Centralizers should be used on the well casing to help protect the cables.

When installing cables in an existing well, an electric winch cable shall be used as a support member due to the weight of the heater wire and fiber optic cables (approximately 0.07 pounds [lbs]/ft together). The procedure for installing cables using a winch is as follows:

1. Set up a tripod and sheave block over the well to be instrumented, and position spools on spool stands so each cable will feed into the well without interference.
2. Drive rebar stakes into the ground through the holes in the tripod legs to prevent instability.
3. Install a coupler and end cap or a Westbay probe with end cap on the cable head, if using the Westbay/Mount Sopris (or similar) “sampler” winch.
4. Run the winch cable over the sheave block and position the cable head at the top of the well casing;
5. Tape the resin-sealed cable end immediately above the cable head.
6. Tape the fiber optic cable termination just above the cable head.
7. Begin lowering the winch cable, heater wire and fiber optic cable into the well, stopping to “zero” the depth counter on the winch (if applicable) when the fiber optic cable termination is at ground level.

8. Continue lowering the cables into the well, taping the heater wire and fiber optic cables to the winch cable every 10 ft; and ensuring the cables feed into the well without snagging, pinching or kinking.
9. When the bottoms of the cables reach the desired depth, clamp the winch cable at the top of the well, and power down the winch. For data collection procedures, see section 4.3.
10. Run the remaining lengths of heater wire and fiber optic cable inside PVC pipe to the control panel in the office trailer (if used) or climate controlled field trailer. Ensure that all lengths of cable at ground surface are protected from local fauna.
11. Plug the heater wire into its control panel.
12. Ensure the generator is powered off.
13. Wire the control panel into the generator. Plug the E2000 connector on the end of the fiber optic cable into the Agilent DTS.
14. Allow the cables to equilibrate to in situ temperatures. Cable equilibration will be determined by field personnel observing subsequent temperature profiles using the DTS and the laptop.

#### *4.1.2.2 Cable Removal*

After data collection is complete, ensure that the system is de-energized. Before disconnecting any plug or wires from the generator, ensure the generator is powered down. Disconnect power cables from the heater wire and its control panel. Disconnect the fiber optic cable from the Agilent DTS. Remove the heater wire and fiber optic cable from the well according to the following instructions:

1. Power up the winch and use it to pull the support cable up until the clamp is off the top of the well. Remove the clamp.
2. Continue winching in the support cable until the first piece of tape passes the top of the well. Remove the tape, being careful not to crush or pinch the fiber optic cable, and reel the heater wire and fiber optic cable onto their respective spools.
3. Repeat step 2 until the ends of the wires have reached the top of the well casing. Remove them from the winch cable and secure the reels for transport, if necessary.

#### *4.1.3 Data Collection*

Data collection shall comprise three separate phases: background, heating and cooling data. A description of the Agilent DTS configuration and each phase can be found in the sections below.

#### 4.1.3.1 DTS System Setup and Startup

Once cables are installed in the well, they should be allowed to equilibrate to in situ temperatures before any data are collected. Set the Agilent DTS up in the field trailer (e.g., attach the laptop and power cords). Other requirements are listed on page 18 of the Agilent N4385A/4386A Distributed Temperature System User's Guide. Temperatures in the field trailer should be kept below 90 °Fahrenheit (F), if the laptop is to be left in the trailer.

The procedure for powering up the Agilent DTS and collecting data is as follows:

1. Plug the Agilent DTS into a ground fault circuit interrupter (GFCI). Also turn the laptop computer on.
2. After the DTS and the laptop have booted, start the Agilent software by clicking on the "Agilent DTS Configurator.exe" icon on the desktop.
3. Load configuration file created from cable calibration in section 4.4, and retitle it in the following format: Well/Lab designator YYYYMMDD, (e.g. 24PB20070530). Ensure the following parameters are set in the configuration file. Double click on the configuration file. The Edit Configuration window appears. Change the repetition time to 900 seconds (sec.) under the "repetitions" tab. Ensure that the "continuous" checkbox is selected. The repetition time may be changed at the discretion of the PI.
4. Under the "installation details" tab, fill in the installation and notes fields with the name of the well and zone to be instrumented and other pertinent notes, respectively.
5. Set the default directory to save data files to C:\Agilent DTS\Well/Lab designator and Date, in the same format as in step 3.
6. Under the "range" tab, set the range field to the total length of the deployed fiber optic cable (e.g., the length in the well plus the length at the surface). All other values may be left at their defaults (for more detail, refer to the Agilent *Distributed Temperature System User's Guide* and the *Distributed Temperature Sensor Configurator PC Software User's Guide*).
7. The PI retains the authority to alter these or any other values at his or her discretion. Deviations from the specifications in this procedure shall be annotated in the scientific notebook.
8. Click on the "Save" button at the bottom of the window. Note the name and path of the configuration file in the scientific notebook for future reference. Click the "OK" button to return to the main menu.
9. On the main menu, select the "Start Measurement" button to begin collecting data. After the laser stabilizes, data collection will begin.
10. Ensure that traces are downloaded to the NWRPO field laptop before the Agilent buffer fills (at approximately 150 traces). Follow the procedures outlined in *Agilent Technologies Distributed Temperature Sensor Configurator PC Software User's Guide*, (First Edition, September 2006), page 34 "Downloading Traces."

11. After data have been collected for the length of time determined by the PI, press the “Stop” button. Note the filename and path where the software writes the data.
12. Download the remainder of traces collected by the DTS as outlined in step 11.

#### **4.1.3.2 Background Data**

Background data are used to help identify temperature conditions in the well or borehole prior to disturbance by heating and cooling.

After the fiber optic cable has equilibrated to in situ temperatures, collect a minimum of one cycle (15 minutes or 900 sec.) of background data following the instructions in section 4.1.3, annotating what trace number(s) are background data.

#### **4.1.3.3 Heating and Cooling Data**

Heating and cooling data help identify zones in the well or borehole where groundwater may be moving. These zones appear as anomalous highs or lows in the temperature data. Heating data should be collected as follows:

1. Start data collection as detailed in section 4.1.3. After one cycle (15 minutes or 900 sec.) or longer as directed by the PI, turn the heater wire control switch to the “On” position. Note that the power output of the control panel is about 8,000 watts.
2. Heating data should be collected for a minimum of 24 hours, at the discretion of the PI.
3. After 24 hours of data have been collected, turn the heater wire control switch to the “Off” position. Record total kilowatt-hours (kWh) displayed on the control panel in the scientific notebook. Collect cooling data for the same length of time as heating data were collected.
4. After collection of heating and cooling data is complete, stop logging according to section 4.1.3.1.

## **4.2 Laboratory Data Collection**

Data will be collected in the Lab using a specially designed flow cell to simulate horizontal and flow across a well. The cell can also be configured to simulate horizontal and vertical cross flow.

### **4.2.1 Experimental Setup**

The flow cell (Figure 2) consists of an approximately 6 ft tall hollow steel cylinder (with a bottom and removable top). This cylinder has six inflow and six outflow points diametrically opposed. Each inflow and outflow point can be independently isolated, to allow or prevent flow through it. The cell also has a drain near its base, to facilitate the removal of water.



A 2-in. schedule 80 PVC casing approximately 1 ft longer than the cell will be used to simulate a piezometer well casing. The fiber optic cable shall be attached to the pipe as follows:

1. Place 10-mil tape around flow cell lid opening to protect fiber optic cable.
2. Place bottom centralizing disk at the bottom of the flow cell.
3. Run the fiber optic cable through the flow cell lid, top centralizing disk, in the top of the pipe, out through the bottom, and through the centralizer ring.
4. Run heat tape down the top of the pipe, leaving the plug end at the top of the pipe.
5. Thread the fiber optic cable through the hole in the side of the modified end cap, taking care not to bend, crush, or pinch the cable. The length of cable pulled through the hole should be three times the length of the flow-through cell.
6. Secure heat tape to centralizer ring and fiber optic cable.
7. Place the centralizer ring in the other end of the modified end cap, then glue the end cap onto the PVC pipe.
8. Run the fiber optic cable up the side of the PVC pipe and secure it with 7-mil electrical tape in several places, ensuring at least a 10-millimeter (mm) bend radius.
9. Run the cable around the pipe 120°, then down to the bottom of the pipe, securing the cable with tape in several places.
10. Run the cable around the pipe 120°, then up to the top of the pipe, securing the cable with tape in several places.
11. After configuring the cable on the pipe, connect the cable to the DTS and verify that the data recorded with the cable/pipe apparatus contain no aberrant data points due to sharp bends, etc.
12. Ensure that the cable used for the Lab experiments has been calibrated according to Section 4.4.
13. Lower pipe into the flow cell, seating the hexagonal end cap into the bottom centralizing disk so that the zone #1 fiber optic cable section is aligned with the flow cell input points.
14. Place top centralizing disk over the pipe on top of the flow cell and secure with drum top clamp ring.

The source of water for the experiment will be a garden hose attached to a sink. This hose will have a pressure regulator and totalizer in-line to quantify the pressure on the cell, and the amount of water “flowed” through the cell, respectively, during the test.

#### 4.2.2 Data Collection

Data will be collected in two types of media: water, and 8/12 mesh silica sand saturated with water. The data collection scenarios below will run in each media type, starting with water only, as follows:

1. Place the PVC pipe with the fiber optic cable inside the cell, approximately in the center.
2. Fill the PVC pipe with water.
3. Record the initial totalizer reading in the scientific notebook.
4. Fill the cell with water, from the bottom up, using the manifold on the outside of the cell.
5. Record the final totalizer reading in the scientific notebook.
6. Collect background data at the specified frequency.
7. Initiate either heating or cross flowing, or both, as specified below.
8. After data collection has been completed, drain the water using the hose bib near the bottom of the cell and a garden hose. The drained water should be discharged onto the playa behind the laboratory, away from roads and vehicles.
9. Remove the PVC pipe, then place the wooden centralizer disk in the bottom of the cell.
10. Place the PVC pipe in the socket in the center of the centralizer disk.
11. Fill the cell with sand, taking care not to damage the fiber optic cable.
12. Repeat steps 4 through 6.
13. After the cell has been drained, empty the sand from the cell using manual methods.

##### 4.2.2.1 Background (Baseline)

Baseline data will be averaged over a 15 minute interval, or at an interval specified by the PI, to reduce the noise in the data as much as possible.

##### 4.2.2.2 Horizontal and Vertical Cross Flowing without Heating

In order to determine the utility of the DTSPS method for detecting horizontal and vertical cross flow without heat, data will be collected in the following manner:

1. Horizontal flow with one input point flowing and the equivalent outflow point open (e.g., if inflow point 2 is open, outflow point 2 will also be open). Collect at least one data set for each zone (1 through 6). Note that the water supplied from the hose should be supplied at a constant temperature before the experiment starts.

2. Horizontal and vertical flow with one input point flowing and a nonequivalent outflow open. The input and outflow pairs for which at least one data set will be collected are summarized in Table 2.

**Table 2**  
**Pairs of Input and Outflow Pairs for Cross Flowing Tests**

1-6	2-5	3-4	4-3	5-1	6-1
		3-6		5-2	6-4

#### **4.2.2.3 Nonflowing Radiant Heating**

This test will be conducted without water flow. With the fiber optic cable and pipe apparatus installed in the flow-through cell, plug the heat tape into a GFCI. Ensure that data collection with the DTS starts at the same time heating begins. Collect data and continue heating for several hours, at the discretion of the PI, and depending upon the amount of heat introduced into the cell.

#### **4.2.2.4 Cross Flowing while Heating**

This test will be conducted with water flow. Ensure that the lid on the flow cell is tightly sealed. After the cell has heated for several hours, continue heating and introduce flow into the system by following the steps outlined in Section 4.2.2.2.

### **4.3 Data Processing**

Data are recorded by the Agilent DTS in \*.tra format. The location of these files on the hard drive will be specified by the user at the time of data collection, as noted in Section 4.1.3. File naming convention will be in the “Well/Lab designator YYYYMMDD.\*” format (e.g. “LabCalibration20070520.\*”). This convention can be changed as specified by the PI at the time of data collection and documented in the appropriate scientific notebook.

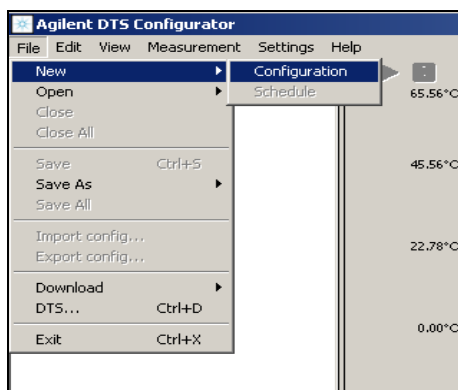
After a complete set of heating and cooling data has been collected (e.g., for a 48-hour period), the temperature data should be combined into spreadsheets, one for heating data and one for cooling data, along with length information. If time permits, data will be graphed and analyzed during the experiments. If not, data will be graphed and analyzed at later time.

### **4.4 Calibration**

Prior to installation in a well or the Lab cell, each fiber optic cable used shall be calibrated using the calibration software included with Agilent DTS and have its configuration file updated to correct the data collected for gain, offset, and attenuation ratio. Calibration procedures are outlined in the *Agilent Technologies Distributed Temperature Sensor Configurator PC Software User’s Guide*, (First Edition, September 2006), and procedures specific to NWRPO applications are outlined below.

Cable calibration shall be conducted according to the Agilent DTS Configurator software guidelines, following the steps outlined below:

1. Connect the new fiber optic cable to the Agilent DTS using only an E2000 8° angle polish connector (APC). Route the cable through the bushing in the Agilent enclosure. For field installations, ensure the bushing seals the enclosure from the environment.
2. Connect the Agilent DTS Universal Serial Bus (USB) cable to the NWRPO Field Laptop USB port. Connect the Agilent DTS power cord to an Underwriter's Laboratory (UL) listed surge protector and connect the surge protector to a standard outlet.
3. Place approximately 100 ft of the fiber optic cable (measured from the non-connectorized end) in a temperature-controlled oven. Ensure that the cable is distributed evenly around the rack in the oven it sits upon.
4. Place probe of a National Institute of Standards and Technology calibrated reference temperature sensor (RTS) in contact with the bulk of cable in the oven. This same RTS will later be used to measure room temperature in the Lab.
5. Route the fiber out of the door of the oven, taking care to avoid crushing or sharply bending the fiber.
6. Energize the oven and heat to a fixed value as determined by the PI. Energize the Agilent DTS. Energize the NWRPO Field Laptop and log in.
7. Once the temperature in the oven has stabilized, as determined by the RTS, start the Agilent DTS Configurator software on the NWRPO Field Laptop.
8. In the Agilent DTS Configurator software window, go to the **File** menu, select **New** and **Configuration**. See picture below:



9. In the top left hand pane, "New Configuration\_0" will appear. Select it with the mouse, and right click. Select **Edit Configuration...** Alternately, you may double click the "New Configuration\_0."

10. A Configuration window appears with four tabs. The tabs marked “Alarm Settings” and “Alarm Zones” will not be used. The Measurement tab is already selected.
11. Change the values for the fields listed below to match NWRPO standard values listed below. These values may be determined at the discretion of the PI, and will be annotated in the appropriate scientific notebook and on metadata submitted to the NWRPO Quality Assurance Records Center (QARC).

Range: Start: 0.00 m Span: 400.0 m (or appropriate to cable being used)

Mode: Measurement Time: 15 min 0 s Update Time: 30 s

Sampling Interval: .5 m Spatial Resolution: 1.00 m

Data Saved: Temperature Repeat: Forever

Fiber End Detection: “Enable” box checked Threshold: 40 dB

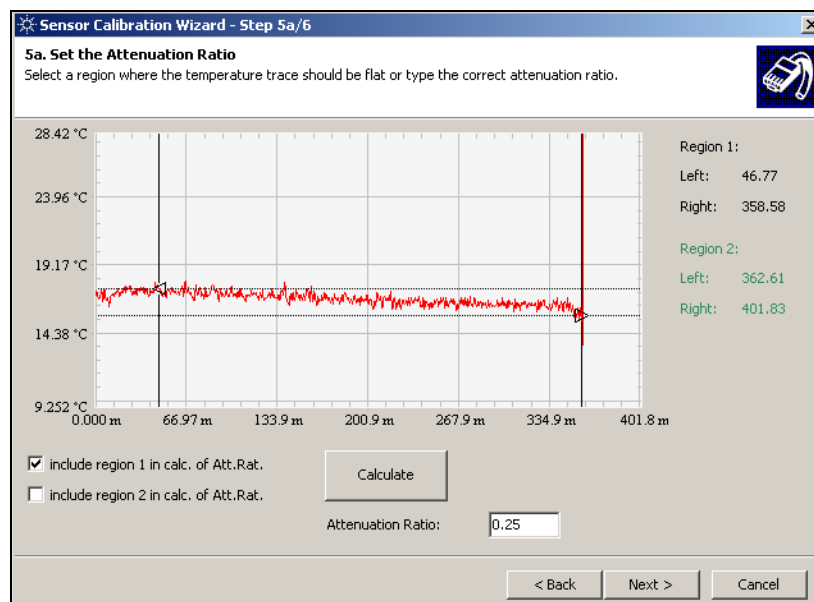
Channel Number: 1

Alias and Comment: as directed by the PI but must include cable identification, Test Procedure number, and other information as directed.

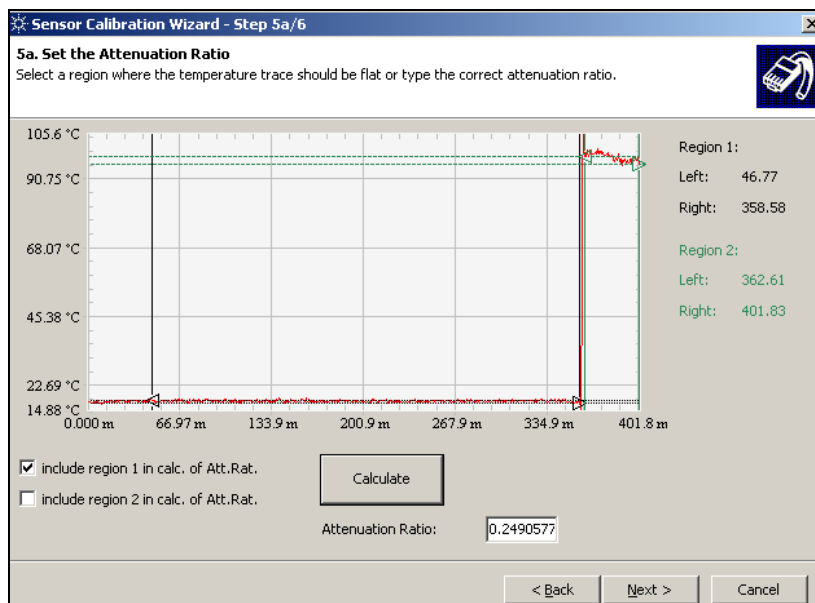
The screenshot shows a 'Configuration' dialog box with the 'Measurement' tab selected. The 'Range' section has 'Start' at 0.00 m and 'Span' at 400 m. The 'Mode' section includes 'Measurement Time' (15 min 0 s), 'Update Time' (30 s), 'Sampling Interval' (.5 m), 'Spatial Resolution' (1.00 m), and 'Data Saved' (Temperature). The 'Fiber End Detection' section has 'Enable' checked and 'Threshold' at 40 dB. The 'Channel Number' is set to 1. The 'Alias' field contains '20070518 Calibration 01 cablestrand 01 NWRPO Lab' and the 'Comment' field contains 'Conducted in conjunction with Agilent via Telecon'. At the bottom are 'Defaults', 'OK', and 'Cancel' buttons.

12. Select the Sensor tab. Select the **Sensor Calibration Wizard** button.
13. A welcome screen appears, outlining the calibration steps. Press **Next** at the bottom.
14. **Sensor Calibration Wizard – Step 1/6** is displayed along the top. In the Select Data Source box, select **run a measurement**.
15. A new window appears with a progress bar indicating that the instrument is taking a measurement. Wait until the measurement is complete.

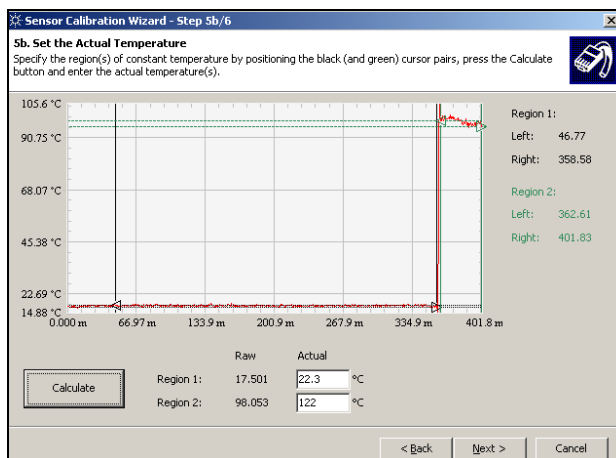
16. **Sensor Calibration Wizard – Step 2/6** is displayed along the top. A graphic of the temperature trace is shown. In the “Please select before continuing” box, ensure that **Gain and Offset Calibration** is selected. Press the **Next** button.
17. **Sensor Calibration Wizard – Step 3/6** is displayed along the top. The temperature trace is graphically displayed along with a blue triangle in cross hairs. Place the blue triangle at the end of the temperature trace, or at the discretion of the PI. Click the **Set Temp** button.
18. **Sensor Calibration Wizard – Step 5a/6** is displayed along the top. The temperature trace is graphically displayed along with several markers. Place the left pointing black triangle marker at the leftmost extent of the most level part of the temperature trace and the right pointing black triangle marker at the end of the flat lower extent of the trace. Place the left pointing green triangle marker at the leftmost extent of the higher temperature portion of the trace, and the right pointing green triangle marker near the end of the trace where the temperature should be flat. See the illustration below. You can zoom in and out of the trace area with the mouse.



19. Select the checkbox for **include region 1 in calc. of Att. Rat.** Do not check the **include region 2 in calc. of Att. Rat.** checkbox. Press the **Calculate** button. Annotate the left and right values for region 1 in the notebook. Press **Next** at the bottom of the window. The screen should look similar to the below illustration:



20. **Sensor Calibration Wizard – Step 5b/6** is displayed along the top. Enter the observed value for temperature from RST #1 into the Region 2 Actual box. Enter the observed value for temperature from RST #2 into the Region 1 Actual box. Press the **Calculate** button. Do not change the triangle pointers established in step 18. Observe a display similar to the one below. Press the **Next** button.



21. **Sensor Calibration Wizard – Step 6/6** is displayed along the top. PI shall verify that the gain, offset, and attenuation ratio values are reasonable. Press **Next** at the bottom.
22. **Sensor Calibration Wizard – Step 3/6** is again displayed at the top. If your cable has no splices, press the **Finish** button at the bottom. If the cable under test has a splice or a connector, each segment needs to be calibrated similarly. A new cable

section can be defined on the “step 3/6” screen by pressing the **New** button. To calibrate this new section, repeat steps 17-22.

23. You are back to the configuration window. Press **OK** at the bottom. The cable is now calibrated.
24. Select the **New Configuration\_0** icon in the file pane. Go to the **File** menu, select **Save As...**, and rename the file in the “Project/Well designator YYYYMMDD.\*” format, or according to PI discretion. Record the filename in the notebook as the configuration file for this particular fiber strand.
25. Select the configuration file, right click, and choose **Edit Configuration...**
26. Under the Measurement tab, in the Mode box, change the Data Saved pull down box from **Temperature** to **Loss**. Change the Repeat from **Forever** to **Value** and enter “1” in the white text entry box. Do not change any other values.

The screenshot shows the 'Configuration' dialog box with the 'Measurement' tab selected. The 'Range' section includes 'Start' (0.00 m) and 'Span' (400.00 m). The 'Mode' section contains 'Measurement Time' (15 min), 'Update Time' (30 s), 'Sampling Interval' (0.50 m), 'Spatial Resolution' (1.00 m), and 'Data Saved' (Temperature). The 'Repeat' section has 'Value' selected with a value of 1. The 'Fiber End Detection' section has 'Enable' checked and 'Threshold' (40 dB). The 'Channel Number' is 1, 'Alias' is '20070518Calibration01 cableid 01', and 'Comment' is 'Calibration methodology determination'. At the bottom are 'Defaults', 'OK', and 'Cancel' buttons.

27. Press **OK** at the bottom of the Configuration window.
28. On the Menu bar, press the green **Start Measurement** arrow. This will record a trace of the loss in dB vs. cable distance.
29. Save the loss trace in the same directory as the Configuration, in the following format: “Project/Well designator LOSSTRACE YYYYMMDD.tra”, or as directed by the PI.

## 5.0 RECORDS

Data collected as part of this TPN are recorded electronically by the Agilent DTS and documented manually in the appropriate scientific notebook, in accordance with QAP-3.2, Rev. 2, *Documentation of Technical Investigations*. Data will be submitted, along with metadata



describing their collection and limitations, to the NWRPO QARC for archival. Records in the QARC are available upon request.

## 6.0 REFERENCES

*Agilent N4385A/4386A Distributed Temperature System User's Guide*, Agilent Technologies Manufacturing GmbH, August 2006.

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HSP-1.0, *Independent Scientific Investigations Program Health and Safety Plan for General Field Activities*. Health and Safety Plan: Nye County Nuclear Waste Repository Project Office. Pahrump, Nevada.

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\_QAP-5.2, *Preparation of Work Plans and Technical Procedures*.

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Figure 1  
EWDP Well Locations





Figure 2  
Laboratory Flow Cell