Enclosure 1

Summer 2010 Compliance Survey for Watts Bar Nuclear Plant Outfall Passive Mixing Zone

TENNESSEE VALLEY AUTHORITY
River Operations

SUMMER 2010 COMPLIANCE SURVEY FOR WATTS BAR NUCLEAR PLANT OUTFALL 113 PASSIVE MIXING ZONE

Prepared by

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and
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EXECUTIVE SUMMARY

The National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for Watts Bar Nuclear Plant (WBN) identifies the discharge of water to the Tennessee River from the Supplemental Condenser Cooling Water (SCCW) System as Outfall 113. Furthermore, the permit identifies that when there is no flow released from Watts Bar Dam (WBH), the effluent from Outfall 113 shall be regulated based on a passive mixing zone extending in the river from bank-to-bank and 1,000 feet downstream from the outfall. Compliance with the requirements for the passive mixing zone is to be made by two annual instream temperature surveys—one for winter conditions and one for summer conditions. Summarized in this report are the measurements, analyses, and results for the passive mixing zone survey conducted for 2010 summer conditions. The survey was conducted on August 25, 2010 between 07:00 CDT and 15:00 CDT (eight hours) and included the collection of temperature data at twelve temporary monitoring stations deployed across the downstream edge of the passive mixing zone during a period of no flow in the river. The data were analyzed to compute three compliance parameters: the 1-hour average temperature at the downstream edge of mixing zone, T_d; the 1-hour average temperature rise from upstream to the downstream edge of the mixing zone, ΔT; and the 1-hour average temperature rate-of-change at the downstream edge of the mixing zone, TROC. The measured parameters were compared to predicted values from the thermal plume model used by TVA to help determine the safe operation of Outfall 113. The results of the comparisons, in terms of maximum values observed during the no flow event, are as follows:

Parameter	Model	Measured	NPDES Limit
Maximum T_d	80.1°F	80.0°F	86.9°F
Maximum ΔT	2.3 F°	1.5 F°	5.4°F
Maximum |TROC|	1.5 F°/hour	0.6 F°/hour	3.6 F°/hr

As shown, values predicted by the model were equal or larger to those measured in the survey. Thus, for the conditions of the survey, the plume model was found to be good for enforcing the operation of Outfall 113 at levels of T_d, ΔT, and TROC without exceeding the NPDES limits. For T_d and ΔT, these results are consistent with those of all the previous surveys for the passive mixing zone. For TROC, however, previous surveys have revealed that the model is capable of underpredicting measured values for TROC by as much as 0.3 F°/hour (e.g., see McCall and Hopping, 2006). Under these conditions, a factor of safety of 0.3 F°/hour is currently used in the plume model for predicting the maximum value of TROC. In this manner, the safe operation of Outfall 113 for the passive mixing zone is evaluated based on a maximum value of TROC of ±3.3 F°/hour rather than ±3.6 F°/hour. This practice will continue until further notice.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SUMMER 2010 COMPLIANCE SURVEY FOR WATTS BAR NUCLEAR PLANT OUTFALL 113 PASSIVE MIXING ZONE

INTRODUCTION

Outfall 113 for the Watts Bar Nuclear Plant (WBN) includes the discharge of water to the Tennessee River from the Supplemental Condenser Cooling Water (SCCW) system. Due to the dynamic behavior of the thermal effluent in the river, the National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for the plant specifies two mixing zones for Outfall 113—one for active operation of the river and one for passive operation of the river (TDEC, 2010). The passive mixing zone corresponds to periods when the operation of Watts Bar Dam (WBH) produces no flow in the river (i.e., hydropower and/or spillway releases). The dimensions of the passive mixing zone extend from bank-to-bank and downstream 1,000 feet from the outfall. The active mixing zone applies to all other river flow conditions. The dimensions of the active mixing zone include the right-half of the river (facing downstream) and extend downstream 2,000 feet from the outfall. The passive and the active mixing zones are illustrated in Figure 1.

Table 1 summarizes the NPDES temperature limits for Outfall 113. The limits apply to both the active and passive mixing zones. Compliance for the active mixing zone is monitored by permanent instream water temperature stations situated in the right-half of the river. Due to navigation issues associated with placing permanent stations in the left-half of the river, a thermal plume model is used to determine the safe operation of Outfall 113 for the passive mixing zone. To verify the thermal plume model, the NPDES permit specifies that two instream temperature surveys shall be conducted each year—one for winter conditions and one for summer conditions. The purpose of this report is to present the results for the passive mixing zone temperature survey conducted for summer 2010 conditions. The survey was conducted on August 25, 2010 between 07:00 CDT and 15:00 CDT (eight hours) and included the deployment of temporary temperature stations at twelve locations across the downstream edge of the passive mixing zone. Data from these and other monitoring stations were analyzed to obtain measured values for the compliance parameters listed in Table 1 and to compare these with the corresponding values estimated from the SCCW thermal plume model. Summarized herein are descriptions of the survey method, results, and conclusions.

Table 1. Temperature Criteria for SCCW Mixing Zones

Maximum Temperature, Downstream Edge of Mixing Zone, T_d	Running 1-hr	86.9°F
Maximum Temperature Rise, Upstream to Downstream, ΔT	Running 1-hr	5.4 F°
Maximum Temperature Rate-of-Change, TROC	Running 1-hr	±3.6 F°/hr

INSTREAM SURVEY

The method of conducting the instream survey is the same as that used for the first such survey, performed for winter conditions on May 6, 2005 (McCall and Hopping, 2005). Table 2 provides a summary of the sources of data for the survey. The WBN Environmental Data Station (EDS) provided measurements from existing permanent monitoring stations, including the upstream (ambient) river temperature, river water surface elevation, SCCW effluent temperature, SCCW effluent flow, and air temperature. WaterView, a hydroplant monitoring system, was used to provide measurements for the discharge from WBH.

The effluent plume for Outfall 113 was monitored by deploying twelve temporary monitoring stations at roughly equal intervals across the downstream edge of the passive mixing zone. The temporary water temperature monitoring stations recorded temperature profiles using HOBO water temperature sensors positioned at depths of 0.5, 3, 5, and 7 feet below the water surface. Shown in Figure 2 is a schematic of the temporary monitoring stations, which included an assembly containing a tire float, a string of HOBO water temperature sensors, and anchor weights. The water temperature sensors have an accuracy of about ±0.4 F° and resolution of about 0.04 F°, which is consistent with other temperature measurements used for TVA hydrothermal compliance. The HOBO devices include an internal data acquisition unit and were programmed to collect measurements once per minute. All the temperature probes used in the survey, including both the HOBOs and the thermistors at the permanent EDS monitoring stations, were calibrated by a quality program with equipment traceable to the National Institute of Standards and Technology (NIST). The calibration procedure is summarized in Appendix A. The temporary monitoring stations were deployed on August 24, several hours before the beginning of the survey, and were retrieved at the end of the survey. A Global Positioning System (GPS) device was used to position the stations along the downstream edge of the passive mixing zone, as shown in Figure 3.

Table 2. Sources of Data for Passive Mixing Zone Survey

Data	Source	Frequency
River discharge from Watts Bar Dam	WaterView	15 min
River water surface elevation	WBN EDS Station 30 (Tailwater at WBH)	15 min
River ambient water temperature	WBN EDS Station 30 (Tailwater at WBH)	15 min
SCCW effluent discharge	WBN EDS Station 32 (Outfall 113)	15 min
SCCW effluent temperature	WBN EDS Station 32 (Outfall 113)	15 min
Air temperature	WBN EDS Met Tower	15 min
Passive mixing zone temperatures	Temporary HOBO Monitors	1 min

RESULTS

River Conditions

Figure 4 shows the measured ambient conditions of the river during the survey; including the discharge, water surface elevation, and temperature of the river exiting Watts Bar Dam upstream of the plant. To provide a period of no flow in the river, releases from Watts Bar Dam were suspended between about 07:00 CDT and 15:00 CDT on August 25, a total of eight hours (daytime). When the releases were suspended, the river water surface elevation below WBH slightly dropped, but then slowly increased to 682.5 feet at 11:30 CDT, due to filling from the river downstream. Over the next hour, the elevation slowly decreased, but then between 12:45 CDT and 15:00 CDT, the water surface elevation rapidly decreased and increased for the last two hours of the survey. This was likely due to sloshing in Chickamauga Reservoir from routine hydro peaking at Watts Bar Dam and Chickamauga Dam. The water surface elevation at the end of the survey was 680.8 feet. The ambient river temperature was about 76.5°F at the beginning of the survey and increased to 78.9°F by 13:15 CDT, due primarily to solar heating. The above-mentioned sloshing, which moves water in and out of the tailrace area, was probably responsible for the small fluctuations in water temperature observed beginning at about 12:45 CDT. At the end of the survey, the river temperature had decreased to 78.1°F.

SCCW Conditions

During the survey, the SCCW system at WBN was thermally loaded and operating in "summer" mode. That is, the system was operating in a manner producing the largest possible heat load to the river. Shown in Figure 5 are the measured conditions of the SCCW system during the survey; including the discharge and temperature of the SCCW effluent. The SCCW discharge fluctuated between approximately 265 cfs and 296 cfs. The average discharge during the survey was about 285 cfs. The SCCW effluent temperature increased throughout the survey from about 80.5°F at the beginning of the survey to about 85.0°F by the end of the survey. This trend coincides with the air temperature, also shown in Figure 5 (i.e., the performance of the Unit 1 cooling tower is directly related to the air temperature). Relative to the upstream ambient river temperature, the temperature rise of the effluent exiting the SCCW system hovered around 4.0°F for the first two hours of the survey, and then slowly increased, reaching 6.9°F at the end of the survey.

Effluent Behavior

Individual Temperature Stations

Shown in Figure 6 are the readings from the HOBO temperature stations at the downstream end of the passive mixing zone. The stations are labeled consecutively from WB1 to WB12, with

WB1 situated near the left shoreline of the river and WB12 situated near the right shoreline of the river (i.e., facing downstream—see Figure 3). The following behaviors are noted:

- Throughout the survey, there was a steady increase in temperature at all stations and depths. Even in the absence of the thermal effluent from Outfall 113, this is typical of daytime solar heating of the river (e.g., recall that the ambient river temperature increased by about 2.5°F during the survey). It took about three and a half hours for the warmest part of the effluent plume to spread across to the left-hand-side of the river and to the downstream edge of the passive mixing zone. During the first three hours of the survey, there was a slight increase in temperature of about 0.5°F at most stations at depths of 0.5 feet and 3 feet. However, the 5-foot and 7-foot depths remained fairly constant for the first three hours. In the following five hours, the temperature at all stations increased by as much as 3°F at the 0.5-foot depth, and as much as 2°F at the 7-foot depth. A temperature increase of only about 2°F at the 7-foot depth, which is consistent with the daytime solar heating, suggests that for the prevailing conditions of the river and WBN, most of the thermal effluent from Outfall 113 resides in the surface layer of the water column (i.e., the mid and bottom layers of the river are protected).

- During the period of no flow, the temperature for WB12 at the 0.5-foot depth was higher than those for most of the stations. This is because prior to and at the beginning of the period of no flow, the effluent plume from Outfall 113 resided in the extreme right-hand-side of the river where WB12 was located. Between 13:00 CDT and 14:00 CDT there was a decrease in temperature at WB9 through WB12 as the effluent plume shifted towards and filled the left-hand-side of the river. Reservoir sloshing also may be a contributing factor to this behavior. But at the end of the survey, the temperature at these stations increased as the thermal front created by plume filling in the left-hand-side of the river finally began to build back into the right-hand-side of the river.

- At the end of the survey, the temperatures at the 0.5-foot depth for WB1 through WB7 were approximately 1°F higher than the temperatures for WB8 through WB12. This is because most of the effluent from Outfall 113 resided in the left-hand-side of the river in the surface layer of the water column at temperatures between 81°F and 82°F. At a depth of 7 feet and below, the maximum temperature is in the neighborhood of 80°F, only about 1.5°F above the ambient river temperature.

Distribution Across The Mixing Zone

At each HOBO station, the instantaneous compliance temperature was determined by averaging the measurements for the sensors at the 3-foot, 5-foot, and 7-foot depths. Plotted in Figure 7 are the resulting temperatures across the downstream end of the passive mixing zone, measured at

the top of each hour from 07:00 CDT to 15:00 CDT on August 25. The following behaviors are noted:

- For the first three hours of the survey, between 07:00 CDT and 10:00 CDT, the temperature at all locations remained fairly constant with only small fluctuations between 0.1°F to 0.2°F.

- By 11:00 CDT, the effluent appears to have reached the downstream end of the passive mixing zone, increasing the temperature (along with solar heating) by about 0.6°F at most locations.

- Over the remainder of the survey, temperatures continued to increase. Between 12:00 CDT and 13:00 CDT, there were small temperature changes of about 0.1°F at WB5 through WB12. However, at WB1 through WB4, there were larger increases of almost 0.5°F. At this time, the majority of the thermal effluent resided in the left-hand-side of the river.

- From 13:00 CDT to 14:00 CDT, the river temperature increased an additional 0.5°F at all locations. The effluent still remained on the left-hand-side of the river showing warmer temperatures at WB1 through WB5.

- By the end of the survey, at 15:00 CDT, the thermal effluent began to shift back toward the right-hand-side of the river with an increase in temperature of about 0.5°F at WB6 through WB9.

Compliance Parameters

Since heat from the outfall is distributed across the full width of the river, data from all of the HOBO stations were used to compute the NPDES compliance parameters, which is consistent with the dimensions of the passive mixing zone (e.g., as shown in Figure 1). The compliance parameters examined include those given in Table 1—the temperature at the downstream edge of mixing zone, T_d; the temperature rise from upstream to the downstream edge of the mixing zone, ΔT; and the temperature rate-of-change at the downstream edge of the mixing zone, TROC. The fundamental equations used to compute the compliance parameters are provided in Appendix B, based on the criteria specified in the NPDES permit. The temperature at the downstream end of the mixing zone was determined from the HOBO measurements (i.e., average of sensors at depths 3, 5, and 7 feet for all twelve HOBO stations). The temperature rise was computed as the difference between the temperature at the downstream end of the mixing zone and the upstream temperature measured at Station 30. The temperature rate-of-change was determined by the change in the temperature at the downstream end of the mixing zone from one hour to the next. The data were averaged over a period of one hour using 15-minute readings, as specified in the NPDES permit, and compared with the WBN thermal plume model. The results are presented in

Figure 8, along with the results obtained by the thermal plume model. The following comments are provided.

- Temperature at the downstream edge of the passive mixing zone, T_d: The maximum 1-hour average T_d estimated by the thermal plume model was 80.1°F, whereas the maximum measured value was about 80.0°F. Thus, the model overpredicted the maximum measured T_d by 0.1°F. Compared to the measurements, the increase in river temperature due to the no flow event was predicted to occur much more rapidly by the model. This is because the model assumes impacts due to changes in the river and/or Outfall 113 are fully realized within one hour (i.e., the model time-step); whereas in reality, the actual time for the development of such impacts is much longer, at least for events with little or no river flow. Both the predictions from the model and measurements from the survey were well below the NPDES limit of 86.9°F.

- Temperature rise, ΔT: The maximum 1-hour average ΔT predicted by the plume model was 2.3 F°, whereas the maximum measured value was about 1.5 F°. Thus, the model overpredicted the maximum measured temperature rise by 0.8 F°. For the reason cited above (i.e., computational time-step of one hour), the model predicted the temperature rise to occur sooner than that found by the measurements. Both the predictions from the model and measurements from the survey were well below the NPDES limit of 5.4 F°.

- Temperature rate-of-change, TROC: The maximum 1-hour average TROC predicted by the plume model was 1.5 F°/hour, whereas the maximum measured value was about 0.6 F°/hour (absolute values). Thus, the model overpredicted the actual value of the temperature rate-of-change. Both the predictions from the model and measurements from the survey were well below the NPDES limit of ±3.6 F°/hour.

CONCLUSIONS

The survey for 2010 summer conditions was successful in measuring the NPDES water temperature parameters for the Outfall 113 passive mixing zone. The measurements were compared with values predicted by the thermal plume model that currently is used to judge the safe operation of the SCCW system. Overall, for the conditions of the 2010 summer survey, the model was found to be good in estimating the impact of Outfall 113 on the temperature, T_d, temperature rise, ΔT, and temperature rate-of-change, TROC, at the downstream end of the passive mixing zone. This is because the model overpredicted the maximum value measured for T_d, ΔT, and TROC. Therefore, Outfall 113 can operate at levels of T_d, ΔT, and TROC without exceeding the NPDES limits. For T_d and ΔT, these results are consistent with those for all of the previous surveys for the passive mixing zone. The same is not true, however, for TROC. Previous surveys have revealed that the model is capable of underpredicting measured values for TROC by as much as 0.3 F°/hour (e.g., see McCall and Hopping, 2006). Under these conditions, and despite the results summarized herein, a factor of safety of 0.3 F°/hour is used in the plume model for predicting the maximum value of TROC. That is, the safe operation of Outfall 113 for the passive mixing zone will continue to be evaluated based on a maximum value of TROC of ±3.3 F°/hour rather than ±3.6 F°/hour. In general, this action will have only a very slight impact on the SCCW, since the operation of the SCCW tends to be controlled primarily by the NPDES limit for ΔT, not the limit for TROC.

REFERENCES

McCall, Michael J., and P.N. Hopping, "Summer 2005 Compliance Survey for Watts Bar Nuclear Plant Outfall 113 Passive Mixing Zone," TVA River Operations, Report No. WR2006-2-85-152, February 2006.

McCall, Michael J., and P.N. Hopping, "Winter 2005 Compliance Survey for Watts Bar Nuclear Plant Outfall 113 Passive Mixing Zone," TVA River Operations, Report No. WR2005-2-85-151, October 2005.

TDEC, *State of Tennessee NPDES Permit No. TN0020168*, Tennessee Department of Environment and Conservation, Issued June 2010.

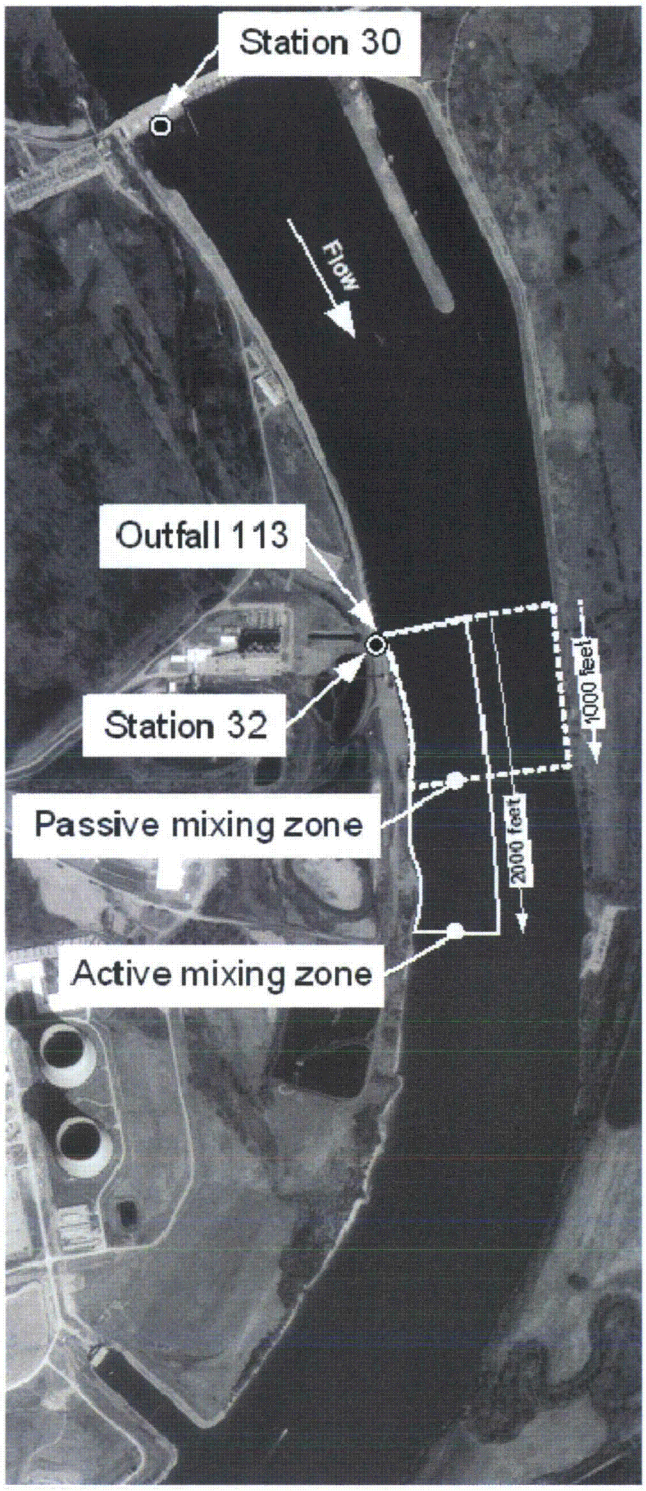

Figure 1. Watts Bar Nuclear Plant Outfall 113 (SCCW) Mixing Zones

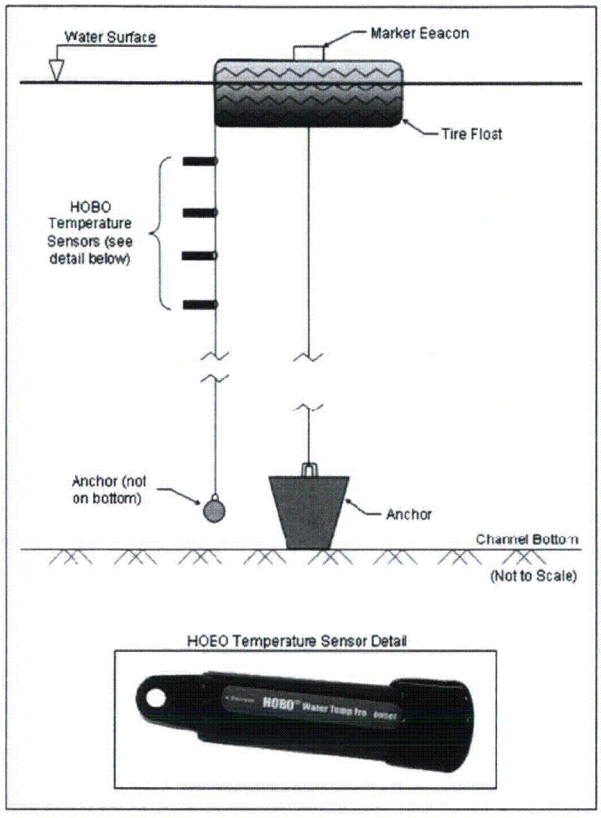

Figure 2. Schematic of HOBO Water Temperature Monitoring Stations

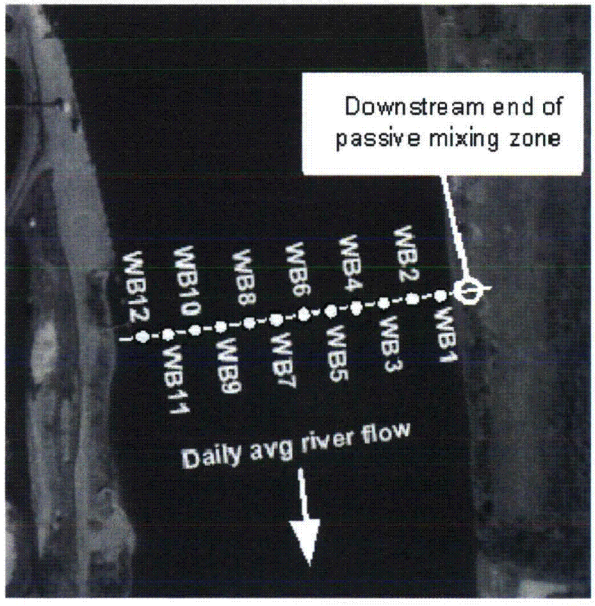

Figure 3. Location of HOBO Monitoring Stations

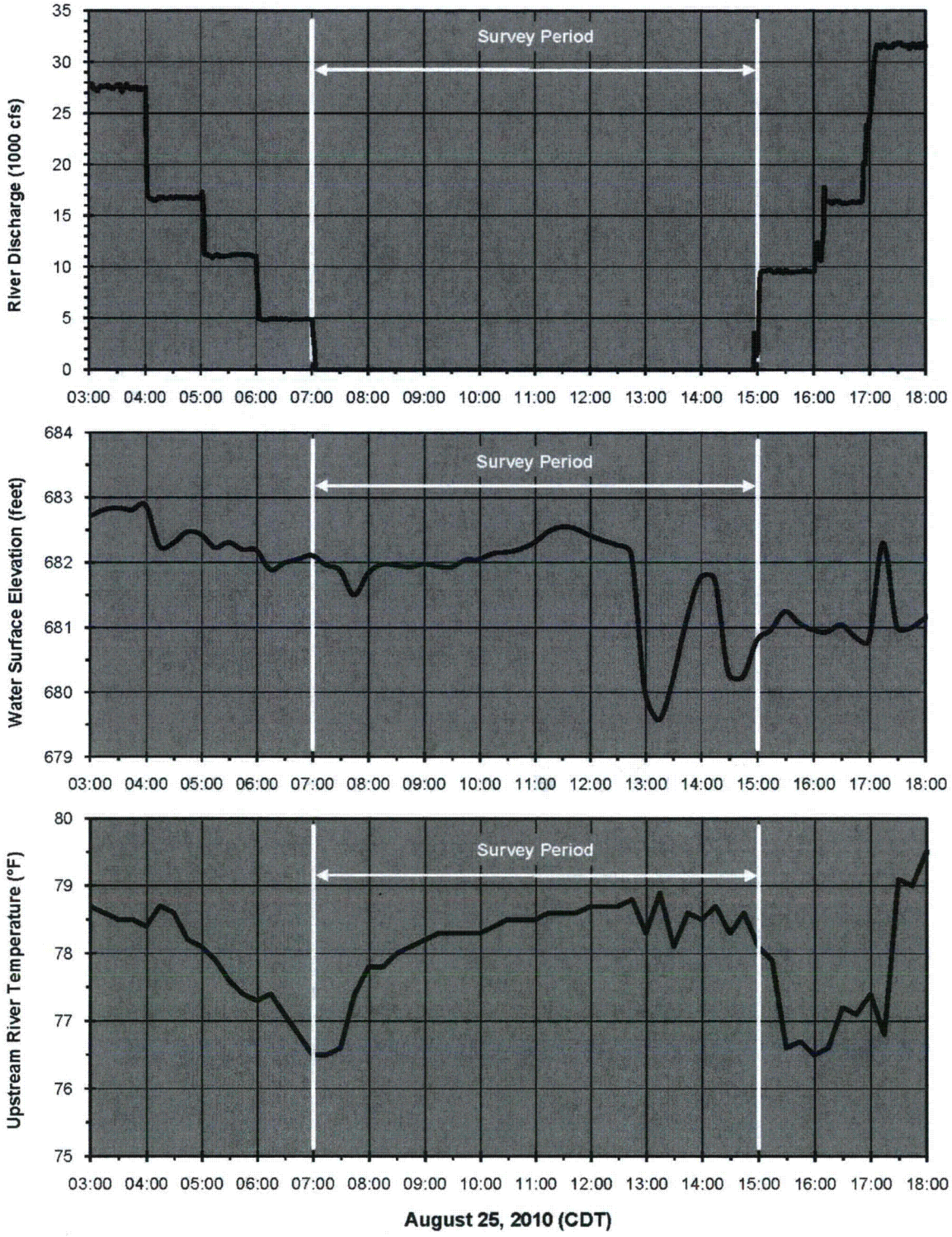

Figure 4. River Conditions

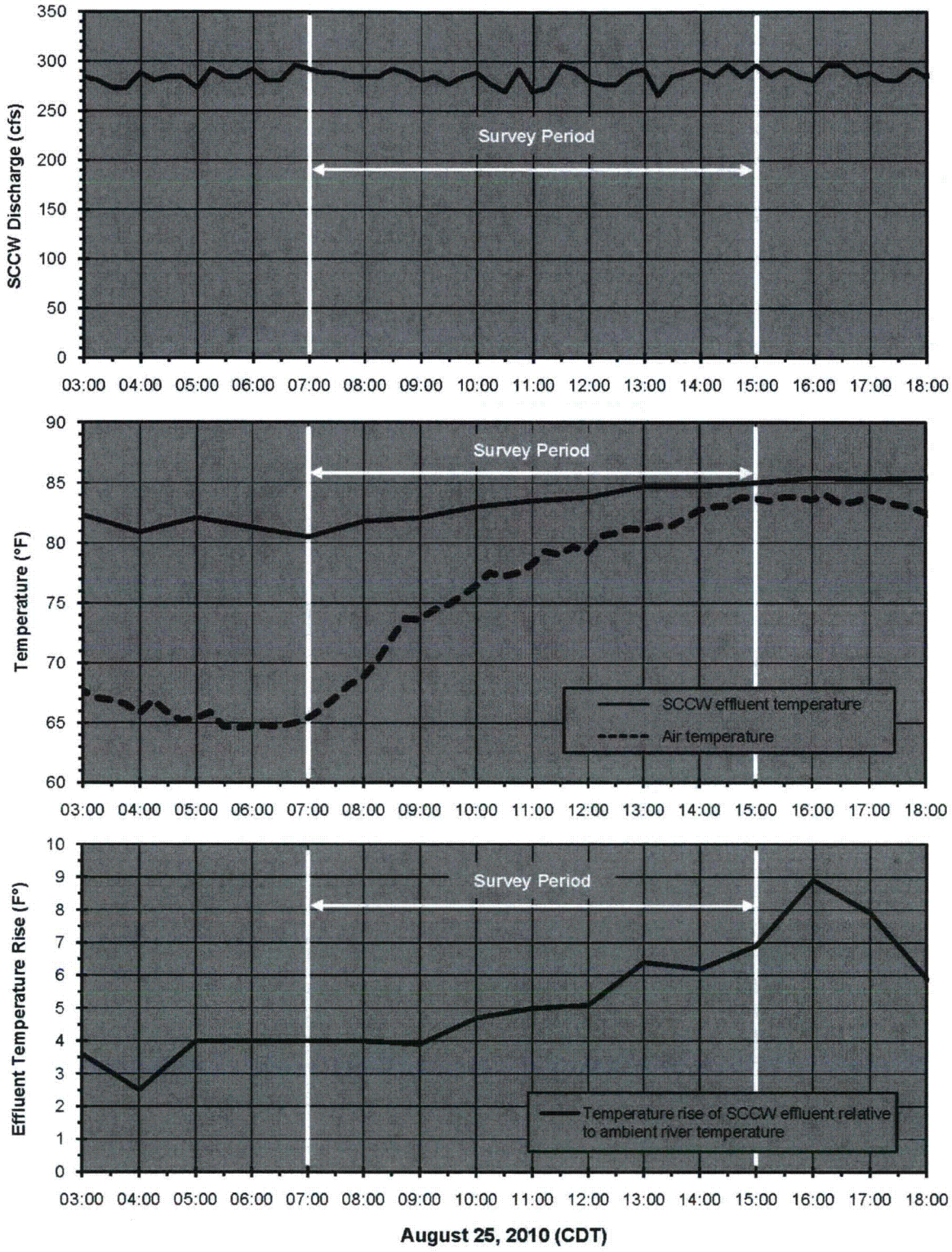

Figure 5. SCCW Conditions

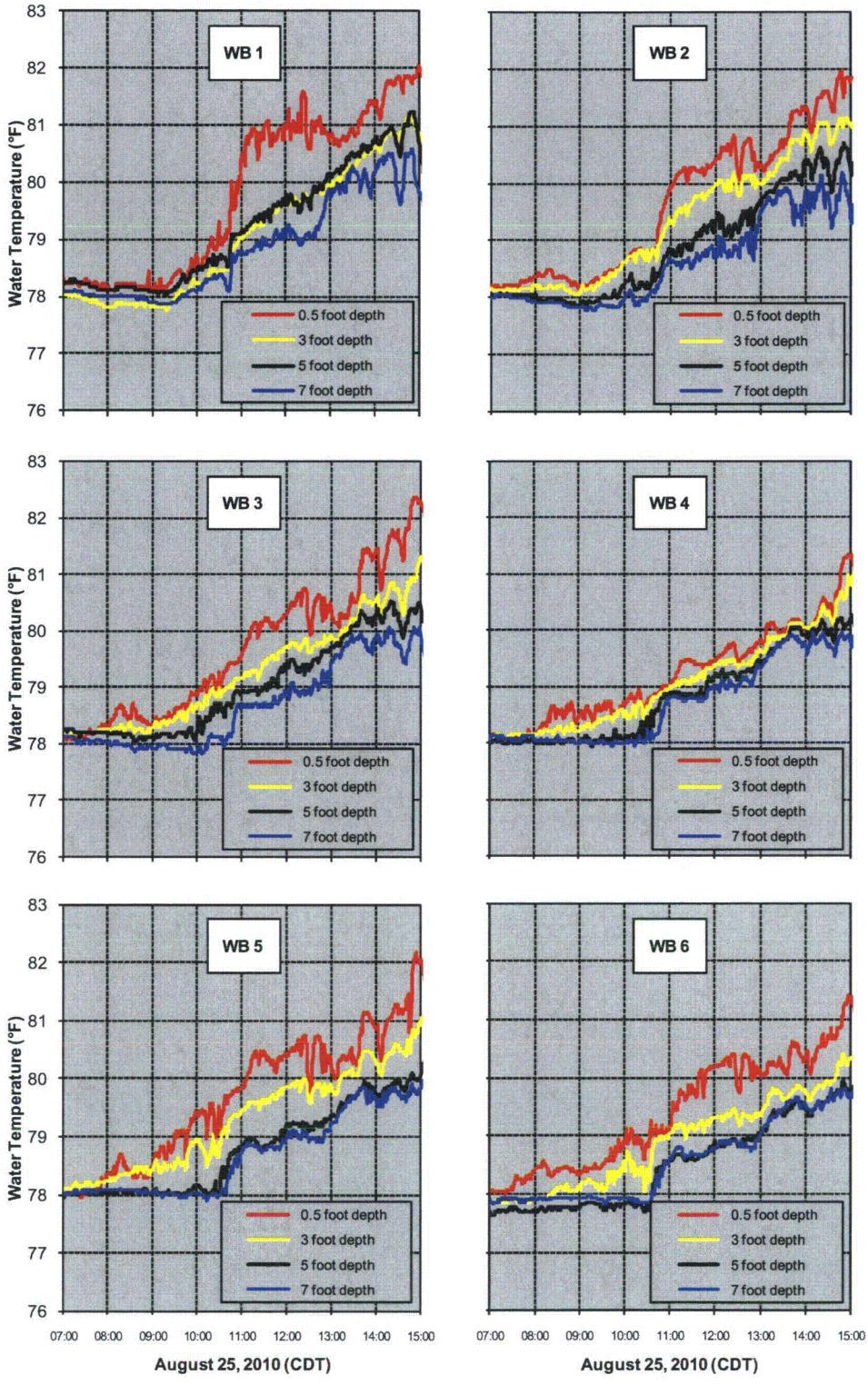

Figure 6. HOBO Water Temperature Measurements During Survey

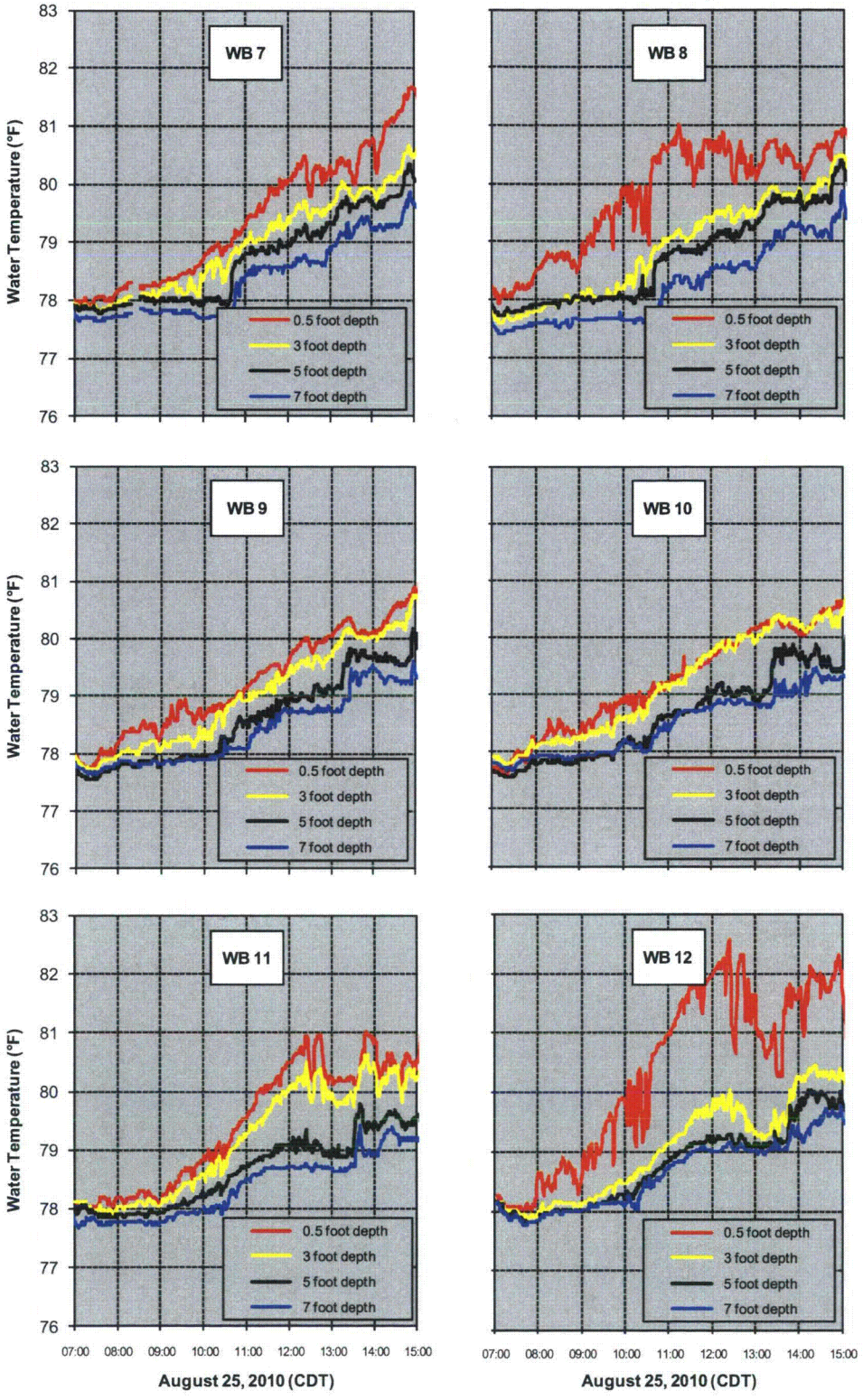

Figure 6 (Continued). HOBO Water Temperature Measurements During Survey

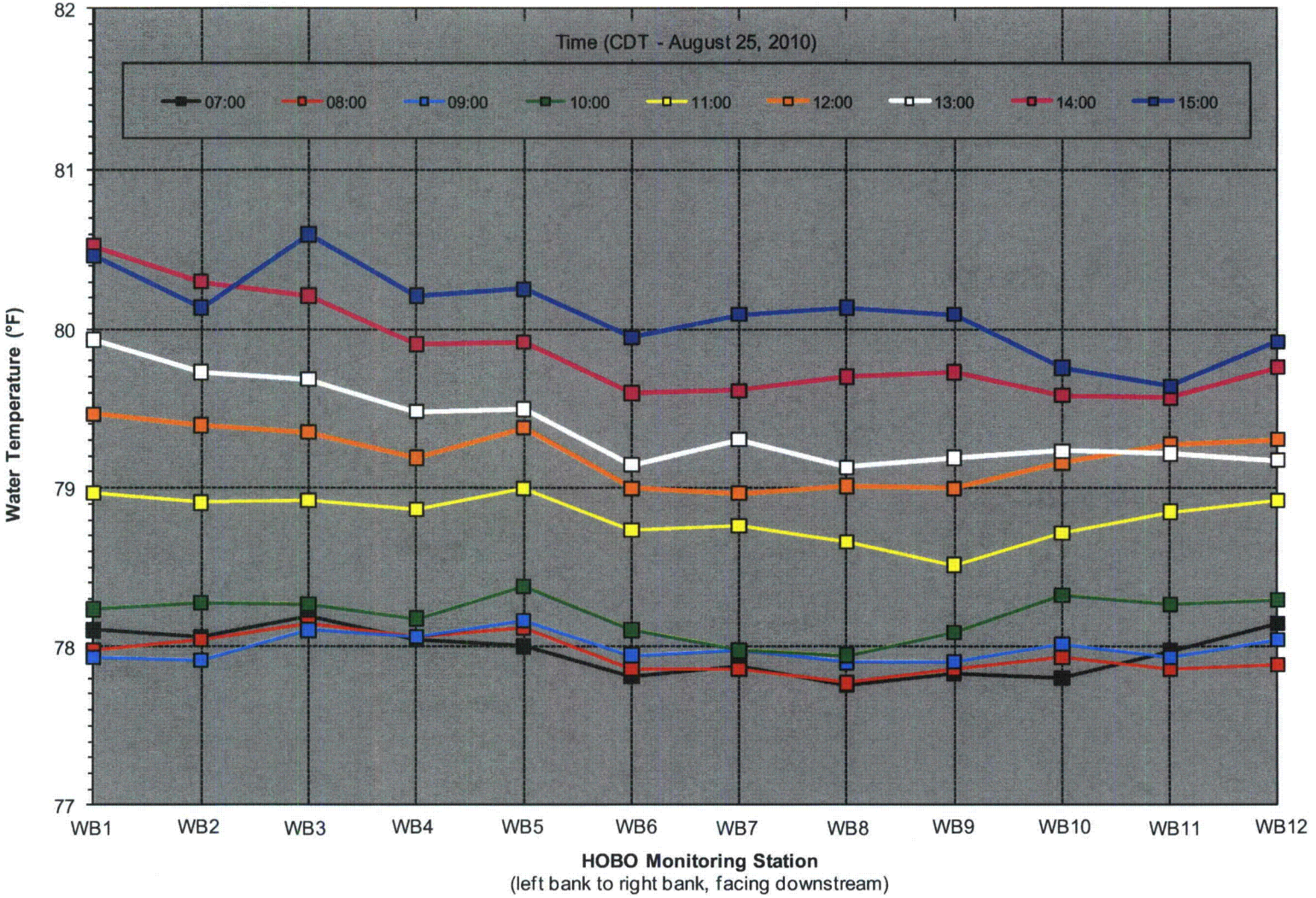

Figure 7. Profiles of Instantaneous Compliance Temperature across Downstream End of Passive Mixing Zone (Average of Readings at 3-Foot, 5-Foot, and 7-Foot Depths)

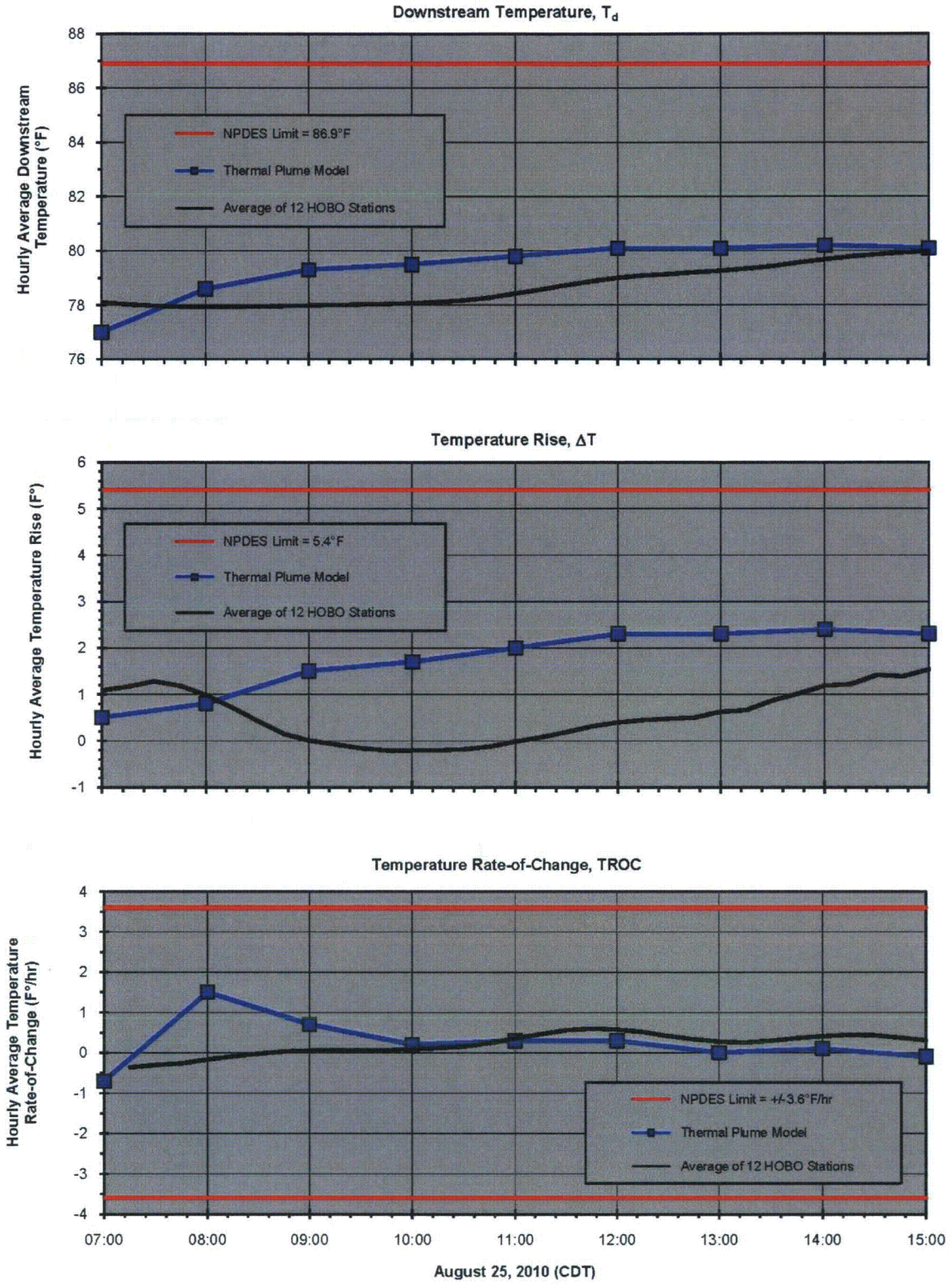

Figure 8. Measured and Computed Compliance Parameters for Passive Mixing Zone

APPENDIX A

(The following information is provided per request of Mike Kelly of TDEC on August 26, 2008)

All sensors used by TVA for monitoring compliance of NPDES water temperature requirements are certified and maintained to meet the following industry and regulatory standards:

- ISO/IEC 17025—Quality assurance requirements for the competence to carry out sampling, testing, and calibrations using standard, non-standard, and laboratory-developed methods (ISO=International Organization for Standardization, IEC=International Electrotechnical Commission).

- 10CFR50 Appendix B—Quality assurance criteria for design, fabrication, construction, and testing of the structures, systems, and components of nuclear power plants (CFR=Code of Federal Regulations).

- 40CFR136—Guidelines establishing test procedures for the analysis of pollutants under the Clean Water Act.

- ANSI N45.2. 1971—Quality assurance requirements for Nuclear Power Plants (ANSI= American National Standards Institute).

- ANSI/NCSL Z540-1-1994—General requirements for calibration laboratories and equipment used for measurements and testing (NCSL=National Conference of Standards Laboratories).

The standard used to certify the thermistors for the permanent EDS stations and the temporary HOBO stations is traceable to the National Institute of Standards and Technology (NIST). The standard includes two pieces of equipment—a platinum resistance temperature detector (RTD) manufactured by Burns Engineering, Inc. and an ohmmeter manufactured by Azonix Inc. The latter is used to measure the resistance of the RTD (i.e., the resistance of platinum varies with temperature). The NTIS traceable calibration certificates for the Burns RTDs and the Azonix ohmmeter that were used to calibrate the HOBO probes are provided below. The end result of the RTD calibration is a set of International Temperature Scale 1990 (ITS 90) coefficients that are used to compute water temperature from the measured RTD resistance. Based on the calibration certificates, the accuracy of the system for the temperature standard is about ±0.05°F. The tolerance of the thermistors used for the WBN field survey is about ±0.4°F, thus providing a calibration test accuracy ratio (TAR) of about 1:8. That is, the accuracy of temperature standard used for the sensor calibrations is 8 times greater than the minimum acceptable field accuracy of temperature sensors. This is twice the recommended maximum TAR of 1:4 for sensor calibrations.

The TVA procedure to calibrate the HOBO water temperature probes, Instruction No. 450.01-020, is provided below. Briefly, the HOBO probes are immersed in a stirred temperature-controlled water bath along with the standard (i.e., along with the Burns RTD probe). After the bath stabilizes, temperature readings from the HOBO probes are compared to the temperature readings from the standard. Experience has shown that in nearly all cases, the readings from both the HOBO probes and the standard and are essentially constant, so that the 95 percent confidence interval of the readings is diminutive. Under these conditions, the accuracy of each HOBO probe is recorded simply as the difference between the HOBO reading and that of the standard (negative difference = HOBO reading low/below standard, positive difference = HOBO reading high/above standard). The HOBO probes are tested at three temperatures between 30°F and 100°F, covering the range of expected water temperature for natural river conditions. Specifically, the three temperatures are at about the 10 percent, 50 percent, and 90 percent intervals, or 37°F, 65°F and 93°F, respectively. Any HOBO probe with measured accuracy (i.e., difference) in excess of the maximum allowable tolerance of ±0.4°F for any one temperature fails the calibration test and is removed from the field survey inventory. In general, based on TVA experience, most HOBO probes that pass the calibration test usually have measured accuracies better than about ±0.25°F for all three temperatures examined in the bath tests. The calibration certificates for HOBO probes used in field survey summarized herein are provided below. Included are certificates for both the pre- and post-survey calibration tests. A close examination of the certificates shows that all the HOBO probes passed the calibration test both before and after the field survey.

Calibration Certificates for Burns Platinum Resistance Thermometer (RTD)

RTD ID No. 906535 was used for both pre-survey and post-survey calibrations.

REPORT of CALIBRATION

Asset ID:	906535
Certificate No:	17538
Page 1 of 6	

Tennessee Valley Authority
Central Laboratories Services
Mailing Address: 1101 Market Street, PSC-1B-C, Chattanooga, TN 37402
Shipping Address: 4601 North Access Road, Bldg. A, Chattanooga, TN 37415
Phone: (423) 876-4318 Fax: (423) 876-4137

QA RECORD

Customer:
CLS KNOXVILLE
400 W. SUMMIT HILL DR.
KNOXVILLE, TN 37902

Instrument Information:

Description:	RTD
Manufacturer:	BURNS
Model:	3925
Serial Number:	

Calibration Information:

Cal Date:	12/10/2009
Due Date:	12/10/2010
Interval:	12 Months
Cal Instruction:	307.04-004
As Found:	Out of Tolerance
As Left:	In Tolerance - Adjusted

AS FOUND OUT OF TOLERANCE

Ambient Temperature: 72°F +/- 9°F **Ambient Humidity:** <=80% RH

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10CFR50 Appendix B, ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced, except in full, without the written approval of CLS.

Technical Remarks:

Standards Utilized

TVA I.D.	Mfg.	Model No.	Description	Cal. Date	Due Date
891602	ASL	F17	TEMPERATURE MEASURING SYSTEM	08/28/2009	08/28/2010
891603	TINSLEY	5685-A	STANDARD RESISTOR,25 Ohms	12/09/2009	06/09/2010
905463	GUILDLINE	9330	STANDARD RESISTOR	12/07/2009	12/07/2010
906643	ISOTECH	MERCURY CELL	FIXED POINT CELL	12/08/2009	12/08/2014
906644	HART SCIENTIFIC	WATER TRIPLE CELL	TRIPLE POINT BATH & CELL	12/08/2009	12/08/2014
906645	ISOTECH	GALLIUM CELL	FIXED POINT CELL	12/08/2009	12/08/2014
906646	ISOTECH	TIN CELL	FIXED POINT CELL	12/08/2009	12/08/2014
906647	ISOTECH	ZINC CELL	FIXED POINT CELL	12/08/2009	12/08/2014

Calibrated by:	David R. Bird	Approved By:	Sam Bertram	12/15/2009
	Sr Metrology Tech		Calibration Supv.	Date

This report was electronically approved using Edison Mudcats Metrology Suite Ver. 2.2.1.

Tennessee Valley Authority

CENTRAL LABORATORIES SERVICES CHATTANOOGA, TENNESSEE	Cust. I.D. No.:	906535
	Page No.:	2 of 6
CALIBRATION REPORT	Date of Report:	12/10/09

Remarks: Accuracy +/- 0.02 Degrees C.
Recalculated coefficients prior to As Left test to bring within tolerance.
For As Left data and coefficients refer to page 3 of 6.

AS FOUND TEST

UUT °C	STD °C	ERROR °C	
-38.8536	-38.8344	0.0192	
0.01000	0.0100	0.0000	
29.7362	29.7646	0.0284	*Failed
231.9149	231.9280	0.0131	
419.4449	419.5270	0.0821	*Failed

As Found ITS 90 Coefficients

Rtpw	100.032105
a5	-4.15854650E-04
b5	-1.55621388E-04
a8	-2.72593907E-04
b8	-2.28004426E-04

Test current 1mA

Report for ITS-90 Coefficients

Model: 3925
Serial: TVA 906535
Date: December 03,2009

TPW:

Reference (°C)	UUT (Ohms)	Residual (°C)
0.0100	100.0317	N/A

Low Range:

Reference (°C)	UUT (Ohms)	Residual (°C)
-38.8344	84.4397	0.0026
29.7646	111.8350	-0.0008

High Range:

Reference (°C)	UUT (Ohms)	Residual (°C)
231.9280	189.2937	0.0001
419.5270	256.8467	0.0000

Coefficients:

RTPW = 100.031701

Low Range:

a5 = -6.56647710 E-04
b5 = -4.73559772 E-03

High Range:

a8 = -1.32503333 E-04
b8 = -4.29922201 E-04

Model: 3925 Serial: TVA 906535 ITS-90 Temperature vs. Resistance Table

°C	Resistance	dr/dT	°C	Resistance	dr/dT	°C	Resistance	dr/dT
-39.00	84.371755	0.4041701	20.00	107.98165	0.3964075	79.00	131.16111	0.3892309
-38.00	84.775925	0.4040197	21.00	108.37805	0.3962850	80.00	131.55034	0.3891100
-37.00	85.179945	0.4038700	22.00	108.77434	0.3961626	81.00	131.93945	0.3889891
-36.00	85.583815	0.4037209	23.00	109.17050	0.3960401	82.00	132.32844	0.3888683
-35.00	85.987536	0.4035724	24.00	109.56654	0.3959178	83.00	132.71731	0.3887474
-34.00	86.391108	0.4034245	25.00	109.96246	0.3957954	84.00	133.10605	0.3886266
-33.00	86.794533	0.4032772	26.00	110.35826	0.3956731	85.00	133.49468	0.3885058
-32.00	87.197810	0.4031305	27.00	110.75393	0.3955508	86.00	133.88319	0.3883851
-31.00	87.600940	0.4029843	28.00	111.14948	0.3954285	87.00	134.27157	0.3882643
-30.00	88.003925	0.4028387	29.00	111.54491	0.3953063	88.00	134.65984	0.3881436
-29.00	88.406764	0.4026937	30.00	111.94021	0.3951841	89.00	135.04798	0.3880229
-28.00	88.809457	0.4025492	31.00	112.33540	0.3950620	90.00	135.43600	0.3879022
-27.00	89.212006	0.4024052	32.00	112.73046	0.3949399	91.00	135.82391	0.3877816
-26.00	89.614412	0.4022617	33.00	113.12540	0.3948178	92.00	136.21169	0.3876609
-25.00	90.016673	0.4021187	34.00	113.52022	0.3946957	93.00	136.59935	0.3875403
-24.00	90.418792	0.4019762	35.00	113.91491	0.3945737	94.00	136.98689	0.3874197
-23.00	90.820768	0.4018341	36.00	114.30949	0.3944517	95.00	137.37431	0.3872992
-22.00	91.222602	0.4016925	37.00	114.70394	0.3943297	96.00	137.76161	0.3871786
-21.00	91.624295	0.4015513	38.00	115.09827	0.3942078	97.00	138.14879	0.3870581
-20.00	92.025846	0.4014105	39.00	115.49248	0.3940859	98.00	138.53584	0.3869376
-19.00	92.427257	0.4012701	40.00	115.88656	0.3939640	99.00	138.92278	0.3868171
-18.00	92.828527	0.4011301	41.00	116.28053	0.3938422	100.00	139.30960	0.3866966
-17.00	93.229657	0.4009904	42.00	116.67437	0.3937204	101.00	139.69630	0.3865762
-16.00	93.630647	0.4008511	43.00	117.06809	0.3935986	102.00	140.08287	0.3864558
-15.00	94.031498	0.4007121	44.00	117.46169	0.3934768	103.00	140.46933	0.3863354
-14.00	94.432210	0.4005734	45.00	117.85516	0.3933551	104.00	140.85566	0.3862150
-13.00	94.832784	0.4004350	46.00	118.24852	0.3932334	105.00	141.24188	0.3860946
-12.00	95.233219	0.4002969	47.00	118.64175	0.3931117	106.00	141.62797	0.3859743
-11.00	95.633516	0.4001589	48.00	119.03486	0.3929900	107.00	142.01395	0.3858540
-10.00	96.033675	0.4000212	49.00	119.42785	0.3928684	108.00	142.39980	0.3857337
-9.00	96.433696	0.3998837	50.00	119.82072	0.3927468	109.00	142.78553	0.3856134
-8.00	96.833579	0.3997464	51.00	120.21347	0.3926252	110.00	143.17115	0.3854931
-7.00	97.233326	0.3996091	52.00	120.60609	0.3925037	111.00	143.55664	0.3853729
-6.00	97.632935	0.3994720	53.00	120.99860	0.3923821	112.00	143.94201	0.3852527
-5.00	98.032407	0.3993350	54.00	121.39098	0.3922606	113.00	144.32727	0.3851325
-4.00	98.431742	0.3991981	55.00	121.78324	0.3921392	114.00	144.71240	0.3850124
-3.00	98.830940	0.3990612	56.00	122.17538	0.3920177	115.00	145.09741	0.3848922
-2.00	99.230001	0.3989242	57.00	122.56740	0.3918963	116.00	145.48230	0.3847721
-1.00	99.628926	0.3987873	58.00	122.95929	0.3917749	117.00	145.86708	0.3846520
0.00	100.02771	0.3988660	59.00	123.35107	0.3916535	118.00	146.25173	0.3845319
1.00	100.42658	0.3987426	60.00	123.74272	0.3915322	119.00	146.63626	0.3844118
2.00	100.82532	0.3986193	61.00	124.13425	0.3914108	120.00	147.02067	0.3842918
3.00	101.22394	0.3984961	62.00	124.52567	0.3912895	121.00	147.40496	0.3841718
4.00	101.62244	0.3983729	63.00	124.91696	0.3911682	122.00	147.78913	0.3840518
5.00	102.02081	0.3982497	64.00	125.30812	0.3910470	123.00	148.17319	0.3839318
6.00	102.41906	0.3981266	65.00	125.69917	0.3909258	124.00	148.55712	0.3838119
7.00	102.81718	0.3980035	66.00	126.09010	0.3908045	125.00	148.94093	0.3836919
8.00	103.21519	0.3978805	67.00	126.48090	0.3906834	126.00	149.32462	0.3835720
9.00	103.61307	0.3977575	68.00	126.87158	0.3905622	127.00	149.70819	0.3834522
10.00	104.01083	0.3976346	69.00	127.26215	0.3904410	128.00	150.09165	0.3833323
11.00	104.40846	0.3975117	70.00	127.65259	0.3903199	129.00	150.47498	0.3832125
12.00	104.80597	0.3973889	71.00	128.04291	0.3901988	130.00	150.85819	0.3830926
13.00	105.20336	0.3972660	72.00	128.43311	0.3900778	131.00	151.24128	0.3829728
14.00	105.60063	0.3971433	73.00	128.82318	0.3899567	132.00	151.62426	0.3828531
15.00	105.99777	0.3970206	74.00	129.21314	0.3898357	133.00	152.00711	0.3827333
16.00	106.39479	0.3968979	75.00	129.60298	0.3897147	134.00	152.38984	0.3826136
17.00	106.79169	0.3967752	76.00	129.99269	0.3895937	135.00	152.77246	0.3824939
18.00	107.18846	0.3966526	77.00	130.38228	0.3894727	136.00	153.15495	0.3823742
19.00	107.58512	0.3965300	78.00	130.77176	0.3893518	137.00	153.53732	0.3822545

Model: 3925 Serial: TVA 906535 ITS-90 Temperature vs. Resistance Table

°C	Resistance	dr/dT	°C	Resistance	dr/dT	°C	Resistance	dr/dT
138.00	153.91958	0.3821349	197.00	176.26160	0.3751159	256.00	198.19174	0.3681726
139.00	154.30171	0.3820152	198.00	176.63671	0.3749976	257.00	198.55991	0.3680555
140.00	154.68373	0.3818957	199.00	177.01171	0.3748793	258.00	198.92797	0.3679384
141.00	155.06562	0.3817761	200.00	177.38659	0.3747611	259.00	199.29590	0.3678213
142.00	155.44740	0.3816565	201.00	177.76135	0.3746429	260.00	199.66373	0.3677042
143.00	155.82906	0.3815370	202.00	178.13599	0.3745247	261.00	200.03143	0.3675871
144.00	156.21059	0.3814175	203.00	178.51052	0.3744065	262.00	200.39902	0.3674701
145.00	156.59201	0.3812980	204.00	178.88493	0.3742884	263.00	200.76649	0.3673531
146.00	156.97331	0.3811785	205.00	179.25921	0.3741702	264.00	201.13384	0.3672361
147.00	157.35449	0.3810591	206.00	179.63338	0.3740521	265.00	201.50108	0.3671191
148.00	157.73555	0.3809397	207.00	180.00744	0.3739340	266.00	201.86820	0.3670021
149.00	158.11649	0.3808203	208.00	180.38137	0.3738160	267.00	202.23520	0.3668851
150.00	158.49731	0.3807009	209.00	180.75519	0.3736979	268.00	202.60208	0.3667681
151.00	158.87801	0.3805815	210.00	181.12888	0.3735799	269.00	202.96885	0.3666512
152.00	159.25859	0.3804622	211.00	181.50246	0.3734619	270.00	203.33550	0.3665343
153.00	159.63905	0.3803429	212.00	181.87593	0.3733439	271.00	203.70204	0.3664174
154.00	160.01939	0.3802236	213.00	182.24927	0.3732259	272.00	204.06845	0.3663005
155.00	160.39962	0.3801044	214.00	182.62250	0.3731080	273.00	204.43475	0.3661836
156.00	160.77972	0.3799851	215.00	182.99560	0.3729901	274.00	204.80094	0.3660667
157.00	161.15971	0.3798659	216.00	183.36859	0.3728722	275.00	205.16700	0.3659498
158.00	161.53957	0.3797467	217.00	183.74147	0.3727543	276.00	205.53295	0.3658330
159.00	161.91932	0.3796275	218.00	184.11422	0.3726365	277.00	205.89879	0.3657161
160.00	162.29895	0.3795084	219.00	184.48686	0.3725186	278.00	206.26450	0.3655993
161.00	162.67846	0.3793893	220.00	184.85938	0.3724008	279.00	206.63010	0.3654825
162.00	163.05785	0.3792702	221.00	185.23178	0.3722830	280.00	206.99559	0.3653657
163.00	163.43712	0.3791511	222.00	185.60406	0.3721653	281.00	207.36095	0.3652489
164.00	163.81627	0.3790320	223.00	185.97622	0.3720475	282.00	207.72620	0.3651321
165.00	164.19530	0.3789130	224.00	186.34827	0.3719298	283.00	208.09133	0.3650154
166.00	164.57421	0.3787940	225.00	186.72020	0.3718121	284.00	208.45635	0.3648986
167.00	164.95301	0.3786750	226.00	187.09201	0.3716944	285.00	208.82125	0.3647819
168.00	165.33168	0.3785560	227.00	187.46371	0.3715767	286.00	209.18603	0.3646651
169.00	165.71024	0.3784371	228.00	187.83529	0.3714591	287.00	209.55069	0.3645484
170.00	166.08867	0.3783182	229.00	188.20674	0.3713415	288.00	209.91524	0.3644317
171.00	166.46699	0.3781993	230.00	188.57809	0.3712238	289.00	210.27967	0.3643150
172.00	166.84519	0.3780804	231.00	188.94931	0.3711063	290.00	210.64399	0.3641983
173.00	167.22327	0.3779615	232.00	189.32042	0.3709887	291.00	211.00819	0.3640816
174.00	167.60123	0.3778427	233.00	189.69140	0.3708711	292.00	211.37227	0.3639649
175.00	167.97908	0.3777239	234.00	190.06228	0.3707536	293.00	211.73623	0.3638483
176.00	168.35680	0.3776051	235.00	190.43303	0.3706361	294.00	212.10008	0.3637316
177.00	168.73440	0.3774863	236.00	190.80367	0.3705186	295.00	212.46381	0.3636150
178.00	169.11189	0.3773676	237.00	191.17418	0.3704011	296.00	212.82743	0.3634983
179.00	169.48926	0.3772489	238.00	191.54459	0.3702837	297.00	213.19093	0.3633817
180.00	169.86651	0.3771302	239.00	191.91487	0.3701662	298.00	213.55431	0.3632651
181.00	170.24364	0.3770115	240.00	192.28503	0.3700488	299.00	213.91757	0.3631484
182.00	170.62065	0.3768929	241.00	192.65508	0.3699314	300.00	214.28072	0.3630318
183.00	170.99754	0.3767743	242.00	193.02502	0.3698141	301.00	214.64375	0.3629152
184.00	171.37432	0.3766557	243.00	193.39483	0.3696967	302.00	215.00667	0.3627986
185.00	171.75097	0.3765371	244.00	193.76453	0.3695793	303.00	215.36947	0.3626820
186.00	172.12751	0.3764185	245.00	194.13411	0.3694620	304.00	215.73215	0.3625655
187.00	172.50393	0.3763000	246.00	194.50357	0.3693447	305.00	216.09471	0.3624489
188.00	172.88023	0.3761815	247.00	194.87291	0.3692274	306.00	216.45716	0.3623323
189.00	173.25641	0.3760630	248.00	195.24214	0.3691102	307.00	216.81950	0.3622157
190.00	173.63247	0.3759445	249.00	195.61125	0.3689929	308.00	217.18171	0.3620992
191.00	174.00842	0.3758261	250.00	195.98024	0.3688757	309.00	217.54381	0.3619826
192.00	174.38424	0.3757077	251.00	196.34912	0.3687584	310.00	217.90579	0.3618661
193.00	174.75995	0.3755893	252.00	196.71788	0.3686412	311.00	218.26766	0.3617495
194.00	175.13554	0.3754709	253.00	197.08652	0.3685241	312.00	218.62941	0.3616330
195.00	175.51101	0.3753525	254.00	197.45504	0.3684069	313.00	218.99104	0.3615164
196.00	175.88636	0.3752342	255.00	197.82345	0.3682897	314.00	219.35256	0.3613999

Calibration Certificate for Azonix Ohmmeter

Instrument used to read resistance of Burns RTD thermometers.

Azonix Ohmmeter ID No. 906527 was used for both pre-survey and post-survey calibrations.

REPORT of CALIBRATION

Asset ID:	906527
Certificate No:	18904
Page 1 of 2	

Tennessee Valley Authority
Central Laboratories Services
Mailing Address: 1101 Market Street, PSC-1B-C, Chattanooga, TN 37402
Shipping Address: 4601 North Access Road, Bldg. A, Chattanooga, TN 37415
Phone: (423) 876-4318 Fax: (423) 876-4137

QA RECORD

Customer:
CLS KNOXVILLE
400 W. SUMMIT HILL DR.
KNOXVILLE, TN 37902

Instrument Information:

Description:	DIGITAL THERMOMETER
Manufacturer:	AZONIX
Model:	A1011-RS-A0-RT41
Serial Number:	

Calibration Information:

Cal Date:	01/11/2010
Due Date:	01/11/2011
Interval:	12 Months
Cal Instruction:	308.02-003
As Found:	In Tolerance
As Left:	In Tolerance

Ambient Temperature: 72°F +/- 2°F **Ambient Humidity:** <=50% RH

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025. 10CFR50 Appendix B, ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced, except in full, without the written approval of CLS.

Technical Remarks:

Standards Utilized

TVA I.D.	Mfg.	Model No.	Description	Cal. Date	Due Date
259304	HONEYWELL	1190	RESISTANCE STANDARD,1 OHM	05/25/2005	05/25/2010
906374	ERTCO	ASTM 17F	GLASS THERMOMETER	12/08/2009	12/08/2010
E29099	GUILDLINE	6675A	DC RESISTANCE BRIDGE	11/10/2009	11/10/2010

Calibrated by:	Matthew R. Snyder	Approved By:	Sam Bertram	01/12/2010
	Sr Metrology Tech		Calibration Supv	Date

This report was electronically approved using Edison Mudcats Metrology Suite Ver. 2.2.1.

Tennessee Valley Authority

CENTRAL LABORATORIES SERVICES CHATTANOOGA, TENNESSEE	Cust. I. D. No.:	906527
	Page No.:	2 of 2
CALIBRATION REPORT	Date of Report:	1/11/10

Remarks: Accuracy = 0 004 Ohms

Certification is limited to channels 1 and 2; channels 3 and 4 are not certified.
Limited certification label is attached.

Left as found.

*Denotes out of tolerance.

AS FOUND

Probe	Standard Resistance (Ohms)	UUT Reading (Ohms)	Error (Ohms)
1	89.9999	90.001	0.001
	100.0000	100.001	0.001
	119.9999	120.002	0.002
2	89.9999	90.001	0.001
	100.0000	100.001	0.001
	119.9999	120.000	0.000

TVA Procedure for Calibration of HOBO Water Temperature Probes

CENTRAL LABORATORIES SERVICES QUALITY PROGRAM INSTRUCTION	TITLE Certification of HOBO Water Temp Pro Data Acquisition Systems $H_2$0-001	Instruction No. 450.01-020 Rev. No. 0 Page No. 1 of 7 Effective Date 5/19/03

LEVEL OF USE ☐ Continuous ☒ Reference ☐ Information

QA RECORD

Dennis T. Darby — Preparer — 5/19/03 — Date

Paul B. Loiseau, Jr. — Technical Reviewer — 5/19/03 — Date

Administrative Review — 6/5/03 — Date

APPROVAL

Jerry D. Hubble — Department Manager — 5/19/03 — Date

REVISION LOG

Revision Number	Effective Date	Pages Affected	Description of Revision
0	5/19/03	All	Initial Issue.

1.0 PURPOSE

To provide uniform and effective certifications of Hobo Water Temp Pro data acquisition systems meeting the accuracy and performance requirements of TVA's water temperature-monitoring programs. This technical instruction uses the method of comparison with a laboratory standard thermometer.

2.0 SCOPE

This instruction applies to the certification of Hobo Water Temp Pro data loggers manufactured by Onset Computer Corporation of Bourne, Massachusetts. The Hobo Water Temp Pro is a data acquisition system containing a temperature sensor, data logger and battery sealed in a single submersible case. The Hobo Water Temp Pro is programmed and data retrieved by use of an infrared interface located in one end of the case. Hobo Water Temp Pros are certified upon receipt from the manufacturer at no greater than 12 month intervals during use or when requested.

3.0 SUMMARY

In this three-point certification systems are tested as actually used over the historical water temperature range of 30° to 100°F and submerged in water. The three test points are 37°, 65° and 93°F. The systems are required to perform within Onset Computer Corporation tolerances. System conformity at each temperature point is determined by comparing system temperature, logged by the Hobo Water Temp Pro and a laboratory standard thermometer.

Systems are programmed and submerged with a standard thermometer in a stirred, temperature-controlled temperature bath. The systems are read after the test by an infrared interface adapter connected to a computer running Onset Computer Corporation's Boxcar Pro software. Traceability of the certification is through the thermometer.

"As-found" certifications are performed on new systems as an acceptance test and on sensors returned from field service. "As-left" certifications are performed before delivery for field service if more than 12 months has elapsed since the last certification. "As-found" and "as-left" certifications may be combined on the same record if there is clear indication which type each system is undergoing.

Multiple HOBOs may be certified at the same time in the temperature bath.

- Accuracy of ±0.2°C at 25°C (0.33°Flat 70°F)
- Waterproof case, submersible to 100 feet
- Capacity to store up to 21,580 temperature measurements
- Selectable sampling interval from 1 second to 9 hours
- Programmable start time/date
- Two data recording modes: Stop when full or wrap around when full.
- Two data offload modes: Halt then offload or offload while logging.
- Nonvolatile EEPROM memory that retains data even if batteries fail
- Light-emitting diode (LED) operation, indicator, which can be disabled during logging by selecting "Stealth"1 mode
- High-speed IR communications for offloading data; can readout full logger in less than 30 seconds while logging continues
- Battery life of 6 years with typical usage

4.0 PRACTICES/EXCEPTIONS

N/A

5.0 SAFETY

5.1 Standard electrical equipment safety.

6.0 STANDARDS USED

6.1 Laboratory reference thermometer, range 30° to 100°F or greater, 0.01°F resolution, 0.1°F accuracy or better, with current calibration sticker.

7.0 EQUIPMENT/APPARATUS

7.1 Temperature bath, stirred, temperature-controlled.
7.2 Computer with Onset Boxcar Pro software installed (version 4.3 or later)
7.3 IR Base station, Onset Part # BST -IR

8.0 PREREQUISITE ACTIONS

8.1 Turn on temperature bath and set for 37°F.
8.2 Check the IR interface to verify that it is plugged into the correct serial port on the PC. Set the correct time on the PC.
8.3 Align the IR port on the Base station with the HOBO Water Temp Pro communications window. Place the logger no further than 4 to 5 inches away from the Base station (see Figure 2) and make sure the IR windows in both devices point at each other. There is a 30° acceptance angle for the IR beam, so some misalignment is acceptable.

8.4 Start the Onset Box Car Software and select **Logger** then **Hobo Water Temp Pro** and **Launch.**

8.5 The computer will respond with a list of loggers found. The serial number in this list should match the serial number printed on the side of the logger. If these numbers do not match, click the **Refresh** button. Record this serial number on the certification form. Either wait or click the **Stop Searching** button. Using the mouse select the logger and click the **Launch** button.

8.6 After a few seconds the screen will display the status of the HOBO Water Temp Pro. Record the battery percentage on the certification form.

8.7 Verify that the Hobo is set to Fahrenheit and program it to a recording interval of 0:1:0 for a reading once a minute. Verify that the start logging immediately box is checked and that the set data logger clock with host launch is also checked.

8.8 Using the mouse click the **Launch Immediately** button.

8.9 If last HOBO is programmed click the **DONE** button, else select the **Launch Another** and repeat steps 8.5 through 8.9.

9.0 TEST PROCEDURE/METHOD

9.1 On the certification form record the serial number of the laboratory reference thermometer.

9.2 Place the HOBO Water Temp Pro in the temperature bath, making sure the end opposite the IR windows is submerged, and allow the bath to stabilize at 37°F ±0.5°F on the thermometer. Adjust the bath set point if needed. After the bath reaches the desired temperature allow 20 minutes 'soak time' for the HOBO to reach its final temperature.

9.3 Record the thermometer reading on the certification form and the time. (The time will be needed to get the correct reading from the HOBO.)

9.4 Repeat steps 9.2 and 9.3 for bath settings of 65.0°F ± 0.5°F and 93°F ± 0.5°F.

9.5 Remove the HOBO from the temperature bath and align the IR port on the Base station with the HOBO Water Temp Pro communications window.

9.6 Restart Onset BoxCar Pro if it is not running and select **Logger** then **Hobo Water Temp Pro and Readout.**

9.7 The computer will respond with a list of loggers found. Using the mouse select the logger and click the **Readout** button. The computer will ask to download data and continue logging or the stop logging and offload data. Select the **Stop Logging and Offload data.** After a few seconds the computer will respond with a suggested file name. Select **Save** and allow the HOBO to transfer the data.

9.8 After a successful download click the **OK** button. The computer will then ask if the data should be displayed in Centigrade or Fahrenheit. Deselect °C and select °F and click **OK.** The computer should display a graph of the collected data. Click the view details button (this is the button just left of the question mark button.)

9.9 Scroll down the displayed list until the time recorded for the 37°F point is found. Record the corresponding temperature on the certification form. Repeat this step for 65° and 93°.

9.10 Close the view details windows and repeat steps 9.6 through 9.9 for additional HOBOs.

9.11 Fill out the rest of the certification form.

10.0 ACCEPTANCE CRITERIA

10.1 Based upon the manufacturer specifications the HOBO Water Temp Pro should be within ±0.4°F over the range of 32°F to 100°F. Any HOBO with an error of greater than ±0.5°F at any of the three measured points shall fail certification.

11.0 POST PROCEDURE ACTIVITY

11.1 Close the BoxCar Software.

12.0 RECORDS

12.1 Completed HOBO Water Temperature Pro Certification form and associated Report of Certification cover sheet is a QA record.

13.0 REFERENCE

13.1 HOBO Water Temp Pro User's Manual, version 1.0 or later

13.2 Onset BoxCar Pro4 Manual Version 1.0 or later

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	SN Page Date

WATER TEMPERATURE HOBO WATER TEMP PRO CALIBRATION RECORD

Date of Certification: April 25, 2001

Type of Certification: As-found_____ As-Left X

SENSOR INFO For As-Found List Plant S/N & PLNT	37 deg F BATH TEMP Limits 0.40 -0.40	degF	OBSVD ERROR	65 degF BATH TEMP Limits 0.40 -0.40	degF	OBSVD ERROR	93 degF BATH TEMP Limits 0.40 -0.40	degF	OBSVD ERROR	PASS	FAIL	Battery LIFE
1			0.00			0.00			0.00	✓		
2			0.00			0.00			0.00	✓		
3			0.00			0.00			0.00	✓		
4			0.00			0.00			0.00	✓		
5			0.00			0.00			0.00	✓		
6			0.00			0.00			0.00	✓		
7			0.00			0.00			0.00	✓		
8			0.00			0.00			0.00	✓		
9			0.00			0.00			0.00	✓		
10			0.00			0.00			0.00	✓		

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks: _____

Calibration Certificates for HOBO Water Temperature Probes

Table of HOBO Probes Used for the WBN Survey Summarized Herein

Station (Figure 3)	Depth (feet)	HOBO Logger (Serial Number)
WB1	0.5	1305180
	3	9776682
	5	1305184
	7	1304890
WB2	0.5	9674342
	3	9674349
	5	9674341
	7	9776681
WB3	0.5	9790917
	3	9790914
	5	9790921
	7	9790915
WB4	0.5	9790938
	3	9790940
	5	9790943
	7	9790941
WB5	0.5	9790931
	3	9790926
	5	9790930
	7	9790925
WB6	0.5	9790909
	3	9790912
	5	9790932
	7	9790924

Station (Figure 3)	Depth (feet)	HOBO Logger (Serial Number)
WB7	0.5	9790911
	3	9790905
	5	9790907
	7	9790908
WB8	0.5	9791154
	3	9791149
	5	9791151
	7	9791145
WB9	0.5	9791097
	3	9791100
	5	9791102
	7	9791103
WB10	0.5	9791170
	3	9791171
	5	9791172
	7	9791174
WB11	0.5	9791196
	3	9791168
	5	9791175
	7	9791176
WB12	0.5	9791192
	3	9791191
	5	9791190
	7	9791130

Pre-Survey Calibrations

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43165 Page 1 of 2 Date 06/28/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 06/28/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E43165

Manufacturer: Onset Computer Corporation

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howard

Approved By: Randy Cooper

Date Approved: 8/3/2010

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43165 Page 2 of 2 Date 06/28/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

	37 deg F			65 degF			93 degF					Battery
	BATH TEMP			BATH TEMP			BATH TEMP			P	F	L
	36.955			64.993			92.952			A	A	I
Sensor	Limits			Limits			Limits			S	I	F
Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	E
Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB1 - 7 ft	1304890	36.94	-0.02	65.10	0.11	93.09	0.14	✓				3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log. WBN Unit 2 Specimen Test

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44406 Page 1 of 2 Date 06/30/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 06/30/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44406

Manufacturer: *Onset Computer Corporation*

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Melvin Howard

Approved By: Randy Cooper

Date Approved: 8/3/2010

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44406 Page 2 of 2 Date 06/30/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery L
		36.948			64.997			92.953			A	A	I
	Sensor	Limits			Limits			Limits			S	I	F
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	E
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB1 - ½ ft	1305180	37.04		0.09	65.10		0.11	93.05		0.09	✓		3.57
WB2 - 5 ft	9674341	36.84		-0.11	64.97		-0.02	92.90		-0.05	✓		3.57

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log. WBN Unit 2 Special Test

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44407 Page 1 of 2 Date 06/30/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 06/30/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44407

Manufacturer: Onset Computer Corporation

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: [signature]

Approved By: [signature]

Date Approved: 8/3/2010

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44407 Page 2 of 2 Date 06/30/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery L
		36.935			64.995			92.953			A	A	I
	Sensor	Limits			Limits			Limits			S	I	F
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	E
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB2 - ½ ft	9674342	37.08		0.15	65.10		0.11	93.05		0.09	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log. WBN Unit 2 Special Test

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY CENTRAL LABORATORIES SERVICES 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44410 Page 1 of 2 Date 07/26/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 07/26/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44410

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hansen

Approved By: Randy Cooper

Date Approved: 9/2/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44410 Page 2 of 2 Date 07/26/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.956			64.998			92.957			A	A	L
	Sensor	Limits			Limits			Limits			S	I	I
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB1 - 5 ft	1305184	37.08		0.13	65.23		0.23	93.19		0.23	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

BFN Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4998	ID E44414 Page 1 of 2 Date 07/29/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 07/29/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44414

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hansen

Approved By: Randy Cooper

Date Approved: 9/2/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44414 Page 2 of 2 Date 07/29/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

	37 deg F			65 degF			93 degF					
	BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
	36.954			64.998			92.953			A	A	L
Sensor	Limits			Limits			Limits			S	I	I
Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E

WB2 - 7 ft	9776681	36.84	-0.11	64.93	-0.07	92.90	-0.05	✓		3.54
WB1 - 3 ft	9776682	36.84	-0.11	64.93	-0.07	92.90	-0.05	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial pre calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44416 Page 1 of 2 Date 07/28/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 07/28/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44416

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011.
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Melissa Houser

Approved By: Randy Cooper

Date Approved: 9/2/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44416 Page 2 of 2 Date 07/28/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

	37 deg F			65 degF			93 degF					
	BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
	36.961			64.998			92.954			A	A	L
Sensor	Limits			Limits			Limits			S	I	I
Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB2 - 3 ft	9674349	36.94	-0.02	65.02	0.02	93.00	0.04	✓				3.70

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

BFN Pre Calibration

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44417 Page 1 of 2 Date 08/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 08/06/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44417

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howell
Approved By: Randy Cooper
Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44417 Page 2 of 2 Date 08/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.959			65.000			92.955			A	A	L
	Sensor	Limits			Limits			Limits			S	I	F
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	E
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB7 - 3 ft	9790905	36.81		-0.15	65.02		0.02	93.00		0.04	✓		3.54
WB7 - 5 ft	9790907	37.04		0.08	65.06		0.06	93.00		0.04	✓		3.54
WB7 - 7 ft	9790908	36.84		-0.12	64.93		-0.07	92.86		-0.10	✓		3.54
WB6 - ½ ft	9790909	36.99		0.03	65.06		0.06	93.00		0.04	✓		3.57
WB7 - ½ ft	9790911	36.94		-0.02	65.02		0.02	93.00		0.04	✓		3.54
WB6 - 3 ft	9790912	36.80		-0.16	64.89		-0.11	92.86		-0.10	✓		3.51

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY CENTRAL LABORATORIES SERVICES 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44418 Page 1 of 2 Date 08/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 08/06/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44418

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Weldon Howard
Approved By: Randy Cooper
Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44418 Page 2 of 2 Date 08/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.959			BATH TEMP 65.000			BATH TEMP 92.955			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB3 - 3 ft	9790914	36.94		-0.02	65.06		0.06	93.05		0.09	✓		3.54
WB3 - 7 ft	9790915	36.94		-0.02	65.02		0.02	92.95		0.00	✓		3.54
WB3 - ½ ft	9790917	36.89		-0.07	65.02		0.02	93.00		0.04	✓		3.54
WB3 - 5 ft	9790921	37.04		0.08	65.10		0.10	93.09		0.14	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 *Phone: (865) 632-2304 Fax: (865) 632-4996*	ID E44419 Page 1 of 2 Date 08/09/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 08/09/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44419

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howell

Approved By: Randy Cooper

Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44419 Page 2 of 2 Date 08/09/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.958			BATH TEMP 64.995			BATH TEMP 92.953			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB6 - 7 ft	9790924	37.04		0.08	65.10		0.11	93.05		0.09	✓		3.54
WB5 - 7 ft	9790925	36.99		0.03	65.10		0.11	93.05		0.09	✓		3.54
WB5 - 3 ft	9790926	36.99		0.03	65.10		0.11	93.05		0.09	✓		3.54
WB5 - 5 ft	9790930	36.94		-0.02	65.02		0.02	93.00		0.04	✓		3.57
WB5 - ½ ft	9790931	36.99		0.03	64.97		-0.02	92.90		-0.05	✓		3.54
WB6 - 5 ft	9790932	36.84		-0.12	64.85		-0.15	92.71		-0.24	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44420 Page 1 of 2 Date 08/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 08/06/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44420

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howard
Approved By: Randy Cooper
Date Approved: 9/2/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44420 Page 2 of 2 Date 08/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

	37 deg F			65 degF			93 degF					
	BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
	36.958			64.995			92.953			A	A	L
Sensor	Limits			Limits			Limits			S	I	I
Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB4 - ½ ft	9790938	36.84	-0.12	65.02	0.02	92.95	0.00	✓				3.54
WB4 - 3 ft	9790940	36.99	0.03	65.06	0.06	93.00	0.04	✓				3.57
WB4 - 7 ft	9790941	37.04	0.08	65.10	0.11	93.05	0.09	✓				3.54
WB4 - 5 ft	9790943	36.94	-0.02	64.97	-0.02	92.90	-0.05	✓				3.54

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44421 Page 1 of 2 Date 08/11/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 08/11/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44421

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hansen

Approved By: Randy Cooper

Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44421 Page 2 of 2 Date 08/11/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

	37 deg F			65 degF			93 degF					
	BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
	36.955			64.999			92.955			A	A	L
Sensor	Limits			Limits			Limits			S	I	I
Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB9 - ½ ft	9791097	36.99	0.03	65.10	0.10	93.00	0.04	✓		3.54
WB9 - 3 ft	9791100	36.94	-0.02	65.10	0.10	93.09	0.14	✓		3.54
WB9 - 5 ft	9791102	36.89	-0.06	64.97	-0.02	92.86	-0.10	✓		3.54
WB9 - 7 ft	9791103	36.99	0.03	65.06	0.06	93.00	0.04	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44895 Page 1 of 2 Date 08/11/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 08/11/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44895

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010
			E

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hansen
Approved By: Randy Cooper
Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44895 Page 2 of 2 Date 08/11/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

	37 deg F			65 degF			93 degF					
	BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
	36.954			64.994			92.953			A	A	L
Sensor	Limits			Limits			Limits			S	I	I
Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB12 - 7 ft	9791130	36.99	0.03	65.10	0.11	93.05	0.09	✓				3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44897 Page 1 of 2 Date 08/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 08/12/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44897

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hansen

Approved By: Randy Cooper

Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44897 Page 2 of 2 Date 08/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.954			BATH TEMP 64.997			BATH TEMP 92.954			PASS	FAIL	Battery LIFE
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB8 - 7 ft	9791145	36.84		-0.11	64.85		-0.15	92.71		-0.24	✓		3.54
WB8 - 3 ft	9791149	36.84		-0.11	64.93		-0.07	92.90		-0.05	✓		3.54
WB8 - 5 ft	9791151	37.04		0.08	65.10		0.11	93.05		0.09	✓		3.54
WB8 - ½ ft	9791154	37.08		0.13	65.15		0.15	93.09		0.14	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44899 Page 1 of 2 Date 08/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 08/12/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44899

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hamm

Approved By: Randy Conyers

Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44899 Page 2 of 2 Date 08/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			PASS	FAIL	Battery LIFE
		BATH TEMP 36.956			BATH TEMP 64.998			BATH TEMP 92.954					
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB11 - 3 ft	9791168	36.84		-0.11	64.93		-0.07	92.90		-0.05	✓		3.54
WB10 - ½ ft	9791170	36.84		-0.11	64.97		-0.02	92.90		-0.05	✓		3.54
WB10 - 3 ft	9791171	37.04		0.08	65.15		0.15	93.14		0.19	✓		3.57
WB10 - 5 ft	9791172	36.89		-0.07	64.97		-0.02	92.90		-0.05	✓		3.54
WB10 - 7 ft	9791174	37.04		0.08	65.10		0.10	93.05		0.09	✓		3.57
WB11 - 5 ft	9791175	36.89		-0.07	65.02		0.02	92.95		0.00	✓		3.57
WB11 - 7 ft	9791176	36.84		-0.11	64.93		-0.07	92.86		-0.10	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44901 Page 1 of 2 Date 08/13/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 08/13/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44901

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hansen

Approved By: Randy Cooper

Date Approved: 8/24/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44901 Page 2 of 2 Date 08/13/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.957			64.999			92.954			A	A	L
Sensor		Limits			Limits			Limits			S	I	I
Serial		0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
Number		-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB12 - 5 ft	9791190	36.99		0.03	65.06		0.06	93.00		0.04	✓		3.54
WB12 - 3 ft	9791191	37.04		0.08	65.06		0.06	93.00		0.04	✓		3.54
WB12 - ½ ft	9791192	36.94		-0.02	64.97		-0.02	92.86		-0.10	✓		3.57
WB11 - ½ ft	9791196	36.84		-0.12	64.93		-0.07	92.86		-0.10	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

Initial Pre Calibration.

Post-Survey Calibrations

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43165 Page 1 of 2 Date 10/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/06/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E43165

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Melvin Hauser

Approved By: Randy Cooper

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43165 Page 2 of 2 Date 10/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.957			BATH TEMP 64.998			BATH TEMP 92.955			P	F	Battery
	Sensor	Limits			Limits			Limits			A	A	L
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	I	I
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR	S	L	F E
WB1 - 7 ft	1304890	37.04		0.08	65.10		0.10	93.09		0.14	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID – E44406 Page 1 of 2 Date 10/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/06/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44406

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hooper

Approved By: Randy Cooper

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44406 Page 2 of 2 Date 10/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			PASS	FAIL	Battery FAILE
		BATH TEMP 36.957			BATH TEMP 64.998			BATH TEMP 92.955					
	Sensor Serial Number	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR			
WB1 - ½ ft	1305180	37.04		0.08	65.10		0.10	93.05		0.09	✓		3.57
WB2 - 5 ft	9674341	36.89		-0.07	64.97		-0.02	92.90		-0.05	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44407 Page 1 of 2 Date 10/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 10/06/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44407

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hansen
Approved By: Randy Cooper
Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44407 Page 2 of 2 Date 10/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F		65 degF		93 degF		PASS	FAIL	Battery LIFE
		BATH TEMP 36.957		BATH TEMP 64.998		BATH TEMP 92.955				
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR			
WB2 - ½ ft	9674342	37.04	0.08	65.10	0.10	93.05	0.09	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44410 Page 1 of 2 Date 10/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/06/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44410

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the *requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is* designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: [signature]

Approved By: [signature]

Date Approved: 10/11/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44410 Page 2 of 2 Date 10/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			P A S S	F A I L	Battery L I F E
		BATH TEMP 36.957			BATH TEMP 64.998			BATH TEMP 92.955					
	Sensor Serial Number	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR			
WB1 - 5 ft	1305184	37.13		0.17	65.23		0.23	93.19		0.23	✓		

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44414 Page 1 of 2 Date 10/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/06/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44414

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Bobbie Howell

Approved By: Randy Cooper

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44414 Page 2 of 2 Date 10/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.957			64.998			92.955			A	A	L
	Sensor	Limits			Limits			Limits			S	I	I
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB2 - 7 ft	9776681	36.84		-0.12	64.93		-0.07	92.90		-0.05	✓		3.54
WB1 - 3 ft	9776682	36.84		-0.12	64.93		-0.07	92.86		-0.10	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44416 Page 1 of 2 Date 10/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance — Date of Report: 10/06/2010

Item Description: HOBO WATER PRO — TVA I.D. No.: E44416

Manufacturer: Onset Computer Corporation

Model: U22-001 — CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab — As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hamm — Approved By: Rudy Lopez

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44416 Page 2 of 2 Date 10/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.957			64.998			92.955			A	A	L
	Sensor	Limits			Limits			Limits			S	I	I
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB2 - 3 ft	9674349	36.94		-0.02	65.02		0.02	93.00		0.04	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44417_A Page 1 of 2 Date 10/06/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance — Date of Report: 10/06/2010

Item Description: HOBO WATER PRO — TVA I.D. No.: E44417_A

Manufacturer: Onset Computer Corporation

Model: U22-001 — CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab — As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: [signature] — Approved By: [signature]

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44417_A Page 2 of 2 Date 10/06/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			PASS	FAIL	Battery LIFE
		BATH TEMP 36.957			BATH TEMP 64.998			BATH TEMP 92.955					
	Sensor Serial Number	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR			
WB7 - 3 ft	9790905	36.89		-0.07	65.02		0.02	93.00		0.04	✓		3.54
WB7 - 5 ft	9790907	36.99		0.03	65.06		0.06	93.00		0.04	✓		3.54
WB7 - 7 ft	9790908	36.84		-0.12	64.93		-0.07	92.86		-0.10	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44417_B Page 1 of 2 Date 10/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 10/12/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44417_B

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: [signature]
Approved By: [signature]
Date Approved: 11/11/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44417_B Page 2 of 2 Date 10/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.952			BATH TEMP 64.993			BATH TEMP 92.952			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR			
WB6 - ½ ft	9790909	36.94		-0.01	65.06		0.07	93.00		0.05	✓		3.57
WB7 - ½ ft	9790911	36.94		-0.01	65.02		0.02	92.95		0.00	✓		3.57
WB6 - 3 ft	9790912	36.84		-0.11	64.89		-0.10	92.86		-0.10	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY CENTRAL LABORATORIES SERVICES 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44418 Page 1 of 2 Date 10/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/12/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44418

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howse

Approved By: [signature]

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44418 Page 2 of 2 Date 10/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F		65 degF		93 degF				
		BATH TEMP 36.952		BATH TEMP 64.993		BATH TEMP 92.952		PASS	FAIL	Battery LIFE
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR			
WB3 - 3 ft	9790914	36.94	-0.01	65.06	0.07	93.05	0.09	✓		3.57
WB3 - 7 ft	9790915	36.94	-0.01	65.02	0.02	93.00	0.05	✓		3.54
WB3 - ½ ft	9790917	36.84	-0.11	65.02	0.02	93.00	0.05	✓		3.57
WB3 - 5 ft	9790921	37.04	0.08	65.10	0.11	93.08	0.13	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB 8A-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44419_A Page 1 of 2 Date 10/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/12/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44419_A

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hamm

Approved By: Randy Lyon

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44419_A Page 2 of 2 Date 10/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F		65 degF		93 degF				Battery
		BATH TEMP 36.952		BATH TEMP 64.993		BATH TEMP 92.952		P A S S	F A I L	L I F E
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR			
WB6 - 7 ft	9790924	37.04	0.08	65.10	0.11	93.04	0.08	✓		3.54
WB5 - 7 ft	9790925	36.94	-0.01	65.10	0.11	93.05	0.09	✓		3.57
WB5 - 3 ft	9790926	37.04	0.08	65.10	0.11	93.00	0.05	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44419_B Page 1 of 2 Date 10/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/12/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44419_B

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howard

Approved By: Randy Cope

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44419_B Page 2 of 2 Date 10/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.961			BATH TEMP 64.996			BATH TEMP 92.954			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR			
WB5 - 5 ft	9790930	36.94		-0.02	65.02		0.02	92.95		0.00	✓		3.57
WB5 - ½ ft	9790931	36.89		-0.07	64.97		-0.02	92.86		-0.10	✓		3.54
WB6 - 5 ft	9790932	36.75		-0.21	64.80		-0.19	92.71		-0.24	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY CENTRAL LABORATORIES SERVICES 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44420 Page 1 of 2 Date 10/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/12/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44420

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hauser

Approved By: Randy Rogers

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44420 Page 2 of 2 Date 10/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.961			64.996			92.954			A	A	L
Sensor		Limits			Limits			Limits			S	I	F
Serial		0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	E
Number		-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB4 - ½ ft	9790938	36.84		-0.12	64.97		-0.02	92.95		0.00	✓		3.57
WB4 - 3 ft	9790940	36.94		-0.02	65.06		0.06	92.95		0.00	✓		3.57
WB4 - 7 ft	9790941	36.99		0.02	65.10		0.11	93.05		0.09	✓		3.54
WB4 - 5 ft	9790943	36.89		-0.07	64.97		-0.02	92.90		-0.05	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB 8A-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44421_A Page 1 of 2 Date 10/12/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/12/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44421_A

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: [signature]

Approved By: [signature]

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44421_A Page 2 of 2 Date 10/12/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.961			64.996			92.954			A	A	L
Sensor		Limits			Limits			Limits			S	I	F
Serial		0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	E
Number		-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB9 - ½ ft	9791097	36.99		0.02	65.06		0.06	93.00		0.04	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB 8A-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44421_B Page 1 of 2 Date 10/15/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 10/15/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44421_B

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hooper
Approved By: Randy Cooper
Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44421_B Page 2 of 2 Date 10/15/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			PASS	FAIL	Battery LIFE
		BATH TEMP 36.958			BATH TEMP 64.998			BATH TEMP 92.957					
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB9 - 3 ft	9791100	36.94		-0.02	65.10		0.10	93.05		0.09	✓		3.57
WB9 - 5 ft	9791102	36.89		-0.07	64.97		-0.02	92.86		-0.10	✓		3.57
WB9 - 7 ft	9791103	36.99		0.03	65.06		0.06	93.00		0.04	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44895 Page 1 of 2 Date 10/18/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 10/18/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44895

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hamm
Approved By: Randy Rogers
Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44895 Page 2 of 2 Date 10/18/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

	37 deg F			65 degF			93 degF					Battery
	BATH TEMP			BATH TEMP			BATH TEMP			P	F	L
	36.955			64.997			92.954			A	A	I
Sensor	Limits			Limits			Limits			S	I	F
Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	E
Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			

WB12 - 7 ft	9791130	37.04	0.08	65.10	0.11	93.05	0.09	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44897 Page 1 of 2 Date 10/19/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/19/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44897

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howard

Approved By: Randy Cooper

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44897 Page 2 of 2 Date 10/19/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F		65 degF		93 degF				Battery
		BATH TEMP 36.956		BATH TEMP 64.996		BATH TEMP 92.956		P A S S	F A I L	L I F E
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	Limits 0.40 deg F -0.40 deg F	OBSVD ERROR	9791145 0.40 deg F -0.40 deg F	OBSVD ERROR			
WB8 - 7 ft	9791145	36.75	-0.21	64.85	-0.15	92.71	-0.24	✓		3.54
WB8 - 3 ft	9791149	36.80	-0.16	64.93	-0.06	92.90	-0.05	✓		3.57
WB8 - 5 ft	9791151	37.04	0.08	65.10	0.11	93.05	0.09	✓		3.54
WB8 - ½ ft	9791154	37.13	0.17	65.15	0.15	93.05	0.09	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44899 Page 1 of 2 Date 10/20/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 10/20/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44899

Manufacturer: Onset Computer Corporation

Model: U22-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Robbie Hamm
Approved By: Randy Cooper

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44899 Page 2 of 2 Date 10/20/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			P	F	Battery
		BATH TEMP			BATH TEMP			BATH TEMP			A	A	L
		36.956			64.994			92.953			S	I	I
	Sensor	Limits			Limits			Limits			S	L	F
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD			E
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB11 - 3 ft	9791168	36.84		-0.11	64.93		-0.06	92.86		-0.10	✓		3.54
WB10 - ½ ft	9791170	36.84		-0.11	64.97		-0.02	92.90		-0.05	✓		3.57
WB10 - 3 ft	9791171	37.04		0.08	65.10		0.11	93.14		0.19	✓		3.57
WB10 - 5 ft	9791172	36.89		-0.07	64.97		-0.02	92.86		-0.10	✓		3.57
WB10 - 7 ft	9791174	37.04		0.08	65.10		0.11	93.05		0.09	✓		3.57
WB11 - 5 ft	9791175	36.89		-0.07	64.97		-0.02	92.90		-0.05	✓		3.57
WB11 - 7 ft	9791176	36.84		-0.11	64.89		-0.11	92.81		-0.14	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44901 Page 1 of 2 Date 10/21/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 10/21/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44901

Manufacturer: Onset Computer Corporation

Model: U22-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Hou[signature]

Approved By: [signature]

Date Approved: 11/1/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44901 Page 2 of 2 Date 10/21/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			P	F	Battery
		BATH TEMP			BATH TEMP			BATH TEMP			A	A	L
		36.954			64.996			92.993			S	I	I
	Sensor	Limits			Limits			Limits			S	L	F
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD			E
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			
WB12 - 5 ft	9791190	36.99		0.03	65.06		0.06	93.00		0.00	✓		3.57
WB12 - 3 ft	9791191	36.94		-0.02	65.06		0.06	93.00		0.00	✓		3.54
WB12 - ½ ft	9791192	36.89		-0.06	64.93		-0.06	92.86		-0.14	✓		3.57
WB11 - ½ ft	9791196	36.80		-0.16	64.93		-0.06	92.86		-0.14	✓		3.54

SENSOR TYPE: HOBO Water Temp Pro U22-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Summer 2010.

APPENDIX B

WBN Outfall 113 NPDES Compliance Parameters

- Current Instantaneous Upstream Temperature:

  Tu_i (measured at EDS Station 30 by the first sensor below a depth of 5 feet)

- Current 1-Hour Average Upstream Temperature:

$$Tu1_i = \frac{Tu_i + Tu_{i-1} + Tu_{i-2} + Tu_{i-3} + Tu_{i-4}}{5},$$

  where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of Tu

- Current Instantaneous Downstream Temperature:

$$Td_i = \frac{Td3_i + Td5_i + Td7_i}{3},$$

  where $Td3_i$, $Td5_i$, and $Td7_i$ denote the current measurements of river temperature at the downstream end of the mixing zone at water depths 3 feet, 5 feet, and 7 feet, respectively

- Current 1-Hour Average Downstream Temperature:

$$Td1_i = \frac{Td_i + Td_{i-1} + Td_{i-2} + Td_{i-3} + Td_{i-4}}{5},$$

  where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of Td

- Current Instantaneous Temperature Rise:

$$\Delta T_i = Td_i - Tu_i$$

- Current 1-Hour Average Temperature Rise:

$$\Delta T1_i = \frac{\Delta T_i + \Delta T_{i-1} + \Delta T_{i-2} + \Delta T_{i-3} + \Delta T_{i-4}}{5},$$

where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of ΔT

- Current Temperature Rate-of-Change:

$$TROC_i = \frac{Td_i - Td_{i-4}}{1\,\text{hour}},$$

- Current 1-Hour Average Temperature Rate-of-Change:

$$TROC1_i = \frac{TROC_i + TROC_{i-1} + TROC_{i-2} + TROC_{i-3} + TROC_{i-4}}{5}$$

where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of TROC

Enclosure 2

Winter 2010 Compliance Survey for Watts Bar Nuclear Plant Outfall Passive Mixing Zone

TENNESSEE VALLEY AUTHORITY
River Operations

WINTER 2010 COMPLIANCE SURVEY FOR WATTS BAR NUCLEAR PLANT OUTFALL 113 PASSIVE MIXING ZONE

Prepared by

Brandi L. Ruth
and
Paul N. Hopping

Knoxville, Tennessee
August 2010

EXECUTIVE SUMMARY

The National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for Watts Bar Nuclear Plant (WBN) identifies the discharge of water to the Tennessee River from the Supplemental Condenser Cooling Water (SCCW) System as Outfall 113. Furthermore, the permit identifies that when there is no flow released from Watts Bar Dam (WBH), the effluent from Outfall 113 shall be regulated based on a passive mixing zone extending in the river from bank-to-bank and 1,000 feet downstream from the outfall. Compliance with the requirements for the passive mixing zone is to be made by two annual instream temperature surveys—one for winter conditions and one for summer conditions. Summarized in this report are the measurements, analyses, and results for the passive mixing zone survey conducted for 2010 winter conditions. The survey was conducted between 23:00 CST on March 3 and 05:00 CST on March 4 (six hours) and included the collection of temperature data at twelve temporary monitoring stations deployed across the downstream edge of the passive mixing zone during a period of no flow in the river. The data were analyzed to compute three compliance parameters: the 1-hour average temperature at the downstream edge of mixing zone, T_d; the 1-hour average temperature rise from upstream to the downstream edge of the mixing zone, ΔT; and the 1-hour average temperature rate-of-change at the downstream edge of the mixing zone, TROC. The measured parameters were compared to predicted values from the thermal plume model used by TVA to help determine the safe operation of Outfall 113. The results of the comparisons, in terms of maximum values observed during the no flow event, are as follows:

Parameter	Model	Measured	NPDES Limit
Maximum T_d	46.1°F	43.6°F	86.9°F
Maximum ΔT	4.4 F°	2.1 F°	5.4 F°
Maximum |TROC|	1.0 F°/hour	1.0 F°/hour	3.6 F°/hr

As shown, values predicted by the model were equal or larger to those measured in the survey. Thus, for the conditions of the survey, the plume model was found to be good for enforcing the operation of Outfall 113 at levels of T_d, ΔT, and TROC without exceeding the NPDES limits. For T_d and ΔT, these results are consistent with those of all the previous surveys for the passive mixing zone. For TROC, however, previous surveys have revealed that the model is capable of underpredicting measured values for TROC by as much as 0.3 F°/hour (e.g., see McCall and Hopping, 2006). Under these conditions, a factor of safety of 0.3 F°/hour is currently used in the plume model for predicting the maximum value of TROC. In this manner, the safe operation of Outfall 113 for the passive mixing zone is evaluated based on a maximum value of TROC of ±3.3 F°/hour rather than ±3.6 F°/hour. This practice will continue until further notice.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

WINTER 2010 COMPLIANCE SURVEY FOR WATTS BAR NUCLEAR PLANT OUTFALL 113 PASSIVE MIXING ZONE

INTRODUCTION

Outfall 113 for the Watts Bar Nuclear Plant (WBN) includes the discharge of water to the Tennessee River from the Supplemental Condenser Cooling Water (SCCW) system. Due to the dynamic behavior of the thermal effluent in the river, the National Pollutant Discharge Elimination System (NPDES) Permit No. TN0020168 for the plant specifies two mixing zones for Outfall 113—one for active operation of the river and one for passive operation of the river (TDEC, 2004). The passive mixing zone corresponds to periods when the operation of Watts Bar Dam (WBH) produces no flow in the river (i.e., hydropower and/or spillway releases). The dimensions of the passive mixing zone extend from bank-to-bank and downstream 1,000 feet from the outfall. The active mixing zone applies to all other river flow conditions. The dimensions of the active mixing zone include the right-half of the river (facing downstream) and extend downstream 2,000 feet from the outfall. The passive and the active mixing zones are illustrated in Figure 1.

Table 1 summarizes the NPDES temperature limits for Outfall 113. The limits apply to both the active and passive mixing zones. Compliance for the active mixing zone is monitored by permanent instream water temperature stations situated in the right-half of the river. Due to navigation issues associated with placing permanent stations in the left-half of the river, a thermal plume model is used to determine the safe operation of Outfall 113 for the passive mixing zone. To verify the thermal plume model, the NPDES permit specifies that two instream temperature surveys shall be conducted each year—one for winter conditions and one for summer conditions. The purpose of this report is to present the results for the passive mixing zone temperature survey conducted for winter 2010 conditions. The survey was conducted between 23:00 CST on March 3 and 05:00 CST on March 4 (six hours) and included the deployment of temporary temperature stations at twelve locations across the downstream edge of the passive mixing zone. Data from these and other monitoring stations were analyzed to obtain measured values for the compliance parameters listed in Table 1 and to compare these with the corresponding values estimated from the SCCW thermal plume model. Summarized herein are descriptions of the survey method, results, and conclusions.

Table 1. Temperature Criteria for SCCW Mixing Zones

Maximum Temperature, Downstream Edge of Mixing Zone, T_d	Running 1-hr	86.9°F
Maximum Temperature Rise, Upstream to Downstream, ΔT	Running 1-hr	5.4 F°
Maximum Temperature Rate-of-Change, TROC	Running 1-hr	±3.7 F°/hr

INSTREAM SURVEY

The method of conducting the instream survey is the same as that used for the first such survey, performed for winter conditions on May 6, 2005 (McCall and Hopping, 2005). Table 2 provides a summary of the sources of data for the survey. The WBN Environmental Data Station (EDS) provided measurements from existing permanent monitoring stations, including the upstream (ambient) river temperature, river water surface elevation, SCCW effluent temperature, SCCW effluent flow, and air temperature. WaterView, a hydroplant monitoring system, was used to provide measurements for the discharge from WBH.

The effluent plume for Outfall 113 was monitored by deploying twelve temporary monitoring stations at roughly equal intervals across the downstream edge of the passive mixing zone. The temporary water temperature monitoring stations recorded temperature profiles using HOBO water temperature sensors positioned at depths of 0.5, 3, 5, and 7 feet below the water surface. Shown in Figure 2 is a schematic of the temporary monitoring stations, which included an assembly containing a tire float, a string of HOBO water temperature sensors, and anchor weights. The water temperature sensors have an accuracy of about ±0.4 F° and resolution of about 0.04 F°, which is consistent with other temperature measurements used for TVA hydrothermal compliance. The HOBO devices include an internal data acquisition unit and were programmed to collect measurements once per minute. All the temperature probes used in the survey, including both the HOBOs and the thermistors at the permanent EDS monitoring stations, were calibrated by a quality program with equipment traceable to the National Institute of Standards and Technology (NIST). The calibration procedure is summarized in Appendix A. The temporary monitoring stations were deployed on March 3, several hours before the beginning of the survey, and were retrieved at the end of the survey. A Global Positioning System (GPS) device was used to position the stations along the downstream edge of the passive mixing zone, as shown in Figure 3.

Table 2. Sources of Data for Passive Mixing Zone Survey

Data	Source	Frequency
River discharge from Watts Bar Dam	WaterView	15 min
River water surface elevation	WBN EDS Station 30 (Tailwater at WBH)	15 min
River ambient water temperature	WBN EDS Station 30 (Tailwater at WBH)	15 min
SCCW effluent discharge	WBN EDS Station 32 (Outfall 113)	15 min
SCCW effluent temperature	WBN EDS Station 32 (Outfall 113)	15 min
Air temperature	WBN EDS Met Tower	15 min
Passive mixing zone temperatures	Temporary HOBO Monitors	1 min

RESULTS

River Conditions

Figure 4 shows the measured ambient conditions of the river during the survey; including the discharge, water surface elevation, and temperature of the river exiting Watts Bar Dam upstream of the plant. To provide a period of no flow in the river, releases from Watts Bar Dam were suspended between about 23:00 CST on March 3 and 05:00 CST on March 4, a total of six hours (nighttime). When the releases were suspended, the river water surface elevation below WBH first dropped, but then slowly increased, due to filling from the river downstream. The ambient river temperature was about 41.6°F at the beginning of the survey, and in effect, remained steady throughout the survey.

SCCW Conditions

During the survey, the SCCW system at WBN was thermally loaded and operating in "summer" mode That is, the system was operating in a manner producing the largest possible thermal load to the river. Shown in Figure 5 are the measured conditions of the SCCW system during the survey; including the discharge and temperature of the SCCW effluent. The SCCW discharge fluctuated between approximately 184 cfs and 207 cfs. The average discharge during the survey was about 195 cfs. At the beginning of the survey, the SCCW effluent temperature decreased from about 63.0°F at the beginning of the survey to about 61.8°F at the 01:00 CST. The temperature then increased throughout most of the remaining part of the survey, reaching about 64.1°F at the end of the survey. This trend coincides with the air temperature, also shown in Figure 5 (i.e., the performance of the Unit 1 cooling tower is directly related to the air temperature). Relative to the upstream river temperature, the temperature rise of the effluent exiting the SCCW system decreased from about 21.4°F at the beginning of the survey to about 20.2°F at 01:00 CST, then increased to about 22.6°F at the end of the survey.

Effluent Behavior

Individual Temperature Stations

Shown in Figure 6 are the readings from the HOBO temperature stations at the downstream end of the passive mixing zone. The stations are labeled consecutively from WB1 to WB12, with WB1 situated near the left shoreline of the river and WB12 situated near the right shoreline of the river (i.e., facing downstream—see Figure 3). The following behaviors are noted:

- The temperatures for WB1 through WB7, located in the left-hand part of the river, were fairly steady for about the first 3 hours of the survey, at all the compliance depths of 0.5, 3, 5, and 7 feet. In the following 3 hours, the temperatures for these stations increased by about 4.5°F at the 0.5-foot depth and about 2°F at the 7-foot depth. This likely corresponds to the

leading edge of the effluent plume from Outfall 113 as it migrated across the river during the period of no flow. That is, for this event, it took about 3 hours for the warmest part of the effluent plume to spread across to the left-hand-side of the river and to the downstream edge of the passive mixing zone. A temperature increase of only about 2°F at the 7-foot depth demonstrates that for the prevailing conditions of the river and WBN, most of the thermal effluent from Outfall 113 resides in the surface layer of the water column (i.e., the mid and bottom layers of the river are protected).

- At the beginning of the period of no flow, the temperatures for WB11 and WB12 were higher than those for WB1 through WB7. This is because prior to and at the beginning of the period of no flow, the effluent plume from Outfall 113 resided in the extreme right-hand-side of the river where these stations were located. Afterwards, the temperatures for WB11 and WB12 cooled as the effluent plume shifted towards and filled the left-hand-side of the river. But at the end of the survey, the temperature at these stations increased as the thermal front created by plume filling in the left-hand-side of the river finally began to build to the right-hand-side of the river.

- The temperatures for WB8 through WB10 exhibited an increase in temperature within the first 2 hours of the period of no flow, followed by a decrease in temperature, particularly at the 0.5 and 3 feet depths. This is due to the transport of effluent plume across the mixing zone from the right-hand-side to the left-hand-side of the river. Later, in the sixth and final hour of the period of no flow, the temperatures for these stations again increased as the thermal effluent began to build back across the river from the left-hand-side to the right-hand-side.

- At the end of the survey, the effluent from Outfall 113 was well distributed across the river, with most of the effluent residing in the surface layer of the water column at temperatures between 44°F and 46°F. At a depth of 7 feet and below, the maximum temperature is in the neighborhood of 43°F, only about 1.5°F above the ambient river temperature.

Distribution Across The Mixing Zone

At each HOBO station, the instantaneous compliance temperature was determined by averaging the measurements for the sensors at the 3-foot, 5-foot, and 7-foot depths. Plotted in Figure 7 are the resulting temperatures across the downstream end of the passive mixing zone, measured at the top of each hour from 23:00 CST on March 3 to 05:00 CST on March 4. The following behaviors are noted:

- At the beginning of the survey (23:00 CST of March 3), most of the effluent plume from Outfall 113 resided in the right-hand-side of the river, between WB11 and WB12. This is

noted by the higher water temperatures in this area. As the survey progressed, the water temperature for these stations slowly decreased as the thermal effluent shifted towards the left-hand-side of the river.

- In contrast, for the first 3 hours of the survey (until about 02:00 CST of March 3), there was very little change in water temperature in the left-hand-side of the river, between WB1 and WB7. After 02:00 CST, the water temperatures in this area increased as the effluent plume spread into the left-hand-side of the river at the downstream edge of the passive mixing zone. Between 02:00 CST and 05:00 CST, water temperatures in this area increased as much as 3 F°. By 05:00 CST, the effluent plume had spread back across to the right-hand-side of the river, reaching WB12.

Compliance Parameters

Since heat from the outfall is distributed across the full width of the river, data from all of the HOBO stations were used to compute the NPDES compliance parameters, which is consistent with the dimensions of the passive mixing zone (e.g., as shown in Figure 1). The compliance parameters examined include those given in Table 1—the temperature at the downstream edge of mixing zone, T_d; the temperature rise from upstream to the downstream edge of the mixing zone, ΔT; and the temperature rate-of-change at the downstream edge of the mixing zone, TROC. The fundamental equations used to compute the compliance parameters are provided in Appendix B, based on the criteria specified in the NPDES permit. The temperature at the downstream end of the mixing zone was determined from the HOBO measurements (i.e., average of sensors at depths 3, 5, and 7 feet for all twelve HOBO stations). The temperature rise was computed as the difference between the temperature at the downstream end of the mixing zone and the upstream temperature measured at Station 30. The temperature rate-of-change was determined by the change in the temperature at the downstream end of the mixing zone from one hour to the next. The data were averaged over a period of one hour using 15-minute readings, as specified in the NPDES permit, and compared with the WBN thermal plume model. The results are presented in Figure 8, along with the results obtained by the thermal plume model. The following comments are provided.

- Temperature at the downstream edge of the passive mixing zone, T_d: The maximum 1-hour average T_d estimated by the thermal plume model was 46.1°F, whereas the maximum measured value was about 43.6°F. Thus, the model overpredicted the maximum measured T_d by 2.5°F. Compared to the measurements, the increase in river temperature due to the no flow event was predicted to occur much more rapidly by the model. This is because the model assumes that impacts due to changes in the river and/or Outfall 113 are fully realized within one hour (i.e., the model time-step); whereas in reality, the actual time for the development of such impacts is much longer, at least for events with little or no river flow. Both the predictions from the model and measurements from the survey were well below the NPDES limit of 86.9°F.

- Temperature rise, ΔT: The maximum 1-hour average ΔT predicted by the plume model was 4.4 F°, whereas the maximum measured value was about 2.1 F°. Thus, the model overpredicted the maximum measured temperature rise by 2.3 F°. For the reason cited above (i.e., computational time-step of one hour), the model predicted the temperature rise to occur sooner than that found by the measurements. Both the predictions from the model and measurements from the survey were well below the NPDES limit of 5.4 F°.

- Temperature rate-of-change, TROC: The maximum 1-hour average TROC predicted by the plume model was 1.0 F°/hour, whereas the maximum measured value was about 1.0 F°/hour (absolute values). Thus, the model predicted the actual value of the temperature rate-of-change. Both the predictions from the model and measurements from the survey were well below the NPDES limit of ±3.6°F.

CONCLUSIONS

The survey for 2010 winter conditions was successful in measuring the NPDES water temperature parameters for the Outfall 113 passive mixing zone. The measurements were compared with values predicted by the thermal plume model that currently is used to determine the safe operation of the SCCW system. Overall, for the conditions of the 2010 winter survey, the model was found to be good in estimating the impact of Outfall 113 on the temperature, T_d, temperature rise, ΔT, and temperature rate-of-change, TROC, at the downstream end of the passive mixing zone. This is because the model overpredicted the maximum value measured for T_d and ΔT and predicted the maximum value measured for TROC. Therefore, Outfall 113 can operate at levels of T_d, ΔT, and TROC without exceeding the NPDES limits. For T_d and ΔT, these results are consistent with those for all of the previous surveys for the passive mixing zone. The same is not true, however, for TROC. Previous surveys have revealed that the model is capable of underpredicting measured values for TROC by as much as 0.3 F°/hour (e.g., see McCall and Hopping, 2006). Under these conditions, and despite the results summarized herein, a factor of safety of 0.3 F°/hour is used in the plume model for predicting the maximum value of TROC. That is, the safe operation of Outfall 113 for the passive mixing zone will continue to be evaluated based on a maximum value of TROC of ±3.3 F°/hour rather than ±3.6 F°/hour. In general, this action will have only a very slight impact on the SCCW, since the operation of the SCCW tends to be controlled primarily by the NPDES limit for ΔT, not the limit for TROC.

REFERENCES

McCall, Michael J., and P.N. Hopping, "Summer 2005 Compliance Survey for Watts Bar Nuclear Plant Outfall 113 Passive Mixing Zone," TVA River Operations, Report No. WR2006-2-85-152, February 2006.

McCall, Michael J., and P.N. Hopping, "Winter 2005 Compliance Survey for Watts Bar Nuclear Plant Outfall 113 Passive Mixing Zone," TVA River Operations, Report No. WR2005-2-85-151, October 2005.

TDEC, *State of Tennessee NPDES Permit No. TN0020168*, Tennessee Department of Environment and Conservation, November 2004.

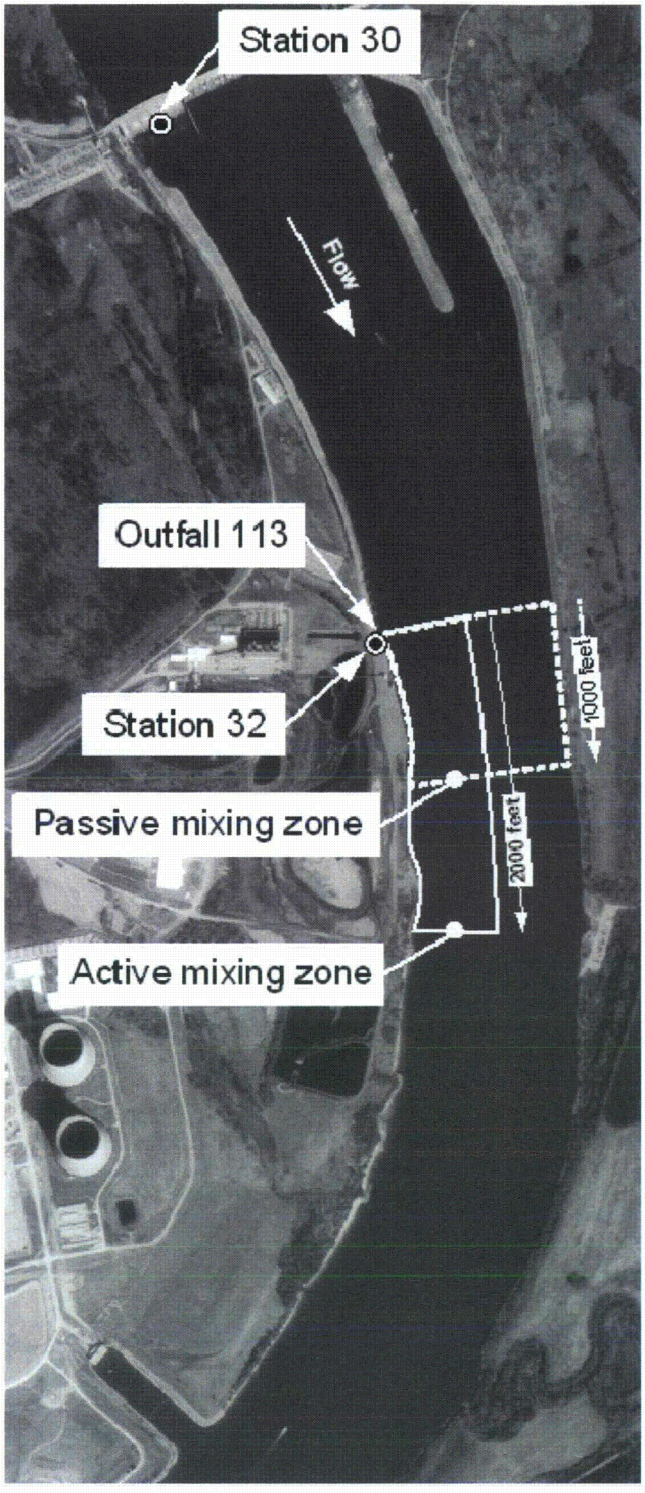

Figure 1. Watts Bar Nuclear Plant Outfall 113 (SCCW) Mixing Zones

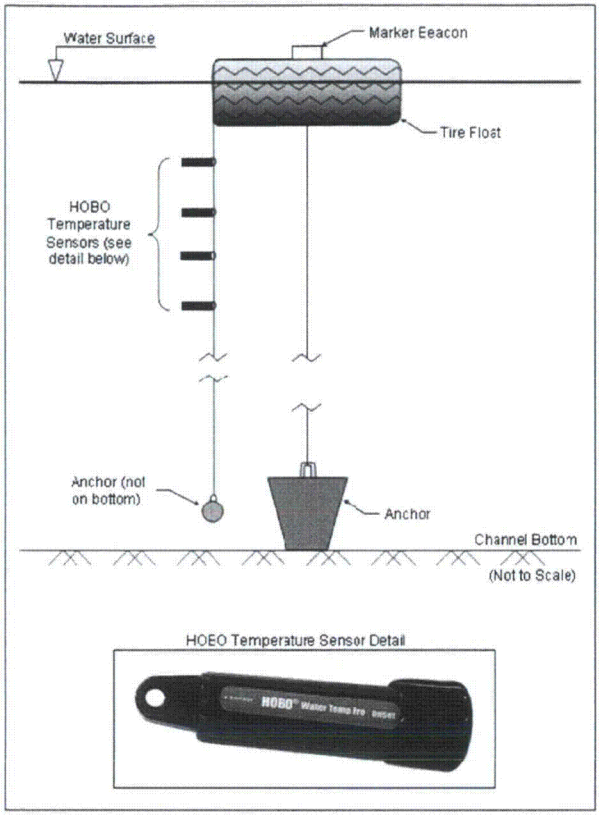

Figure 2. Schematic of HOBO Water Temperature Monitoring Stations

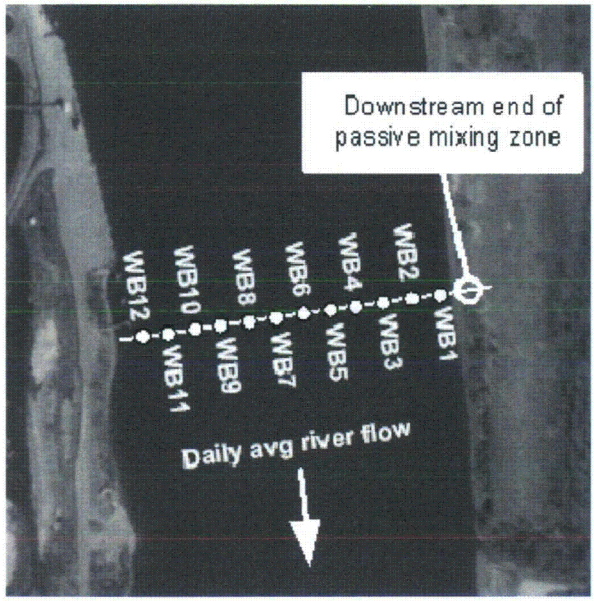

Figure 3. Location of HOBO Monitoring Stations

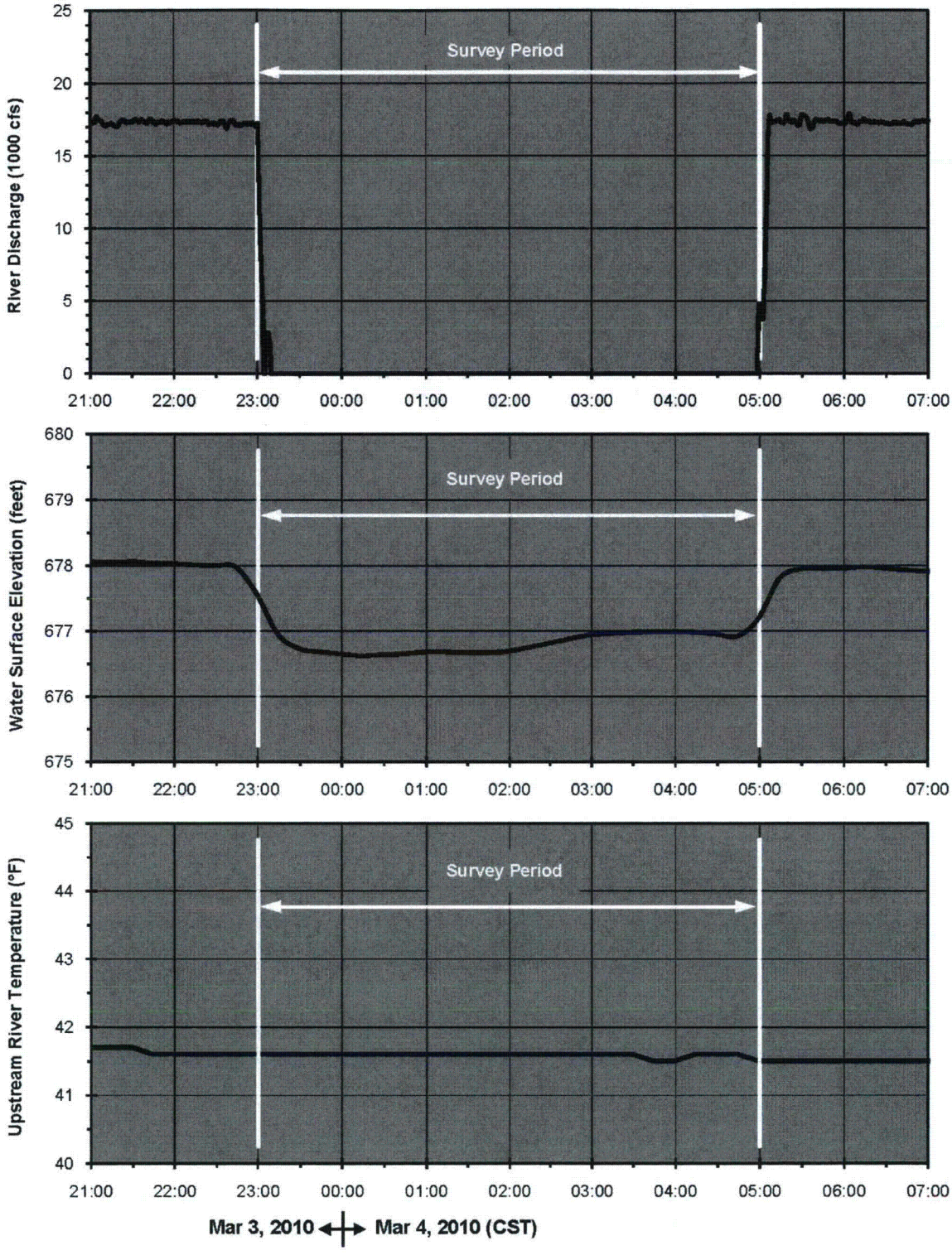

Figure 4. River Conditions

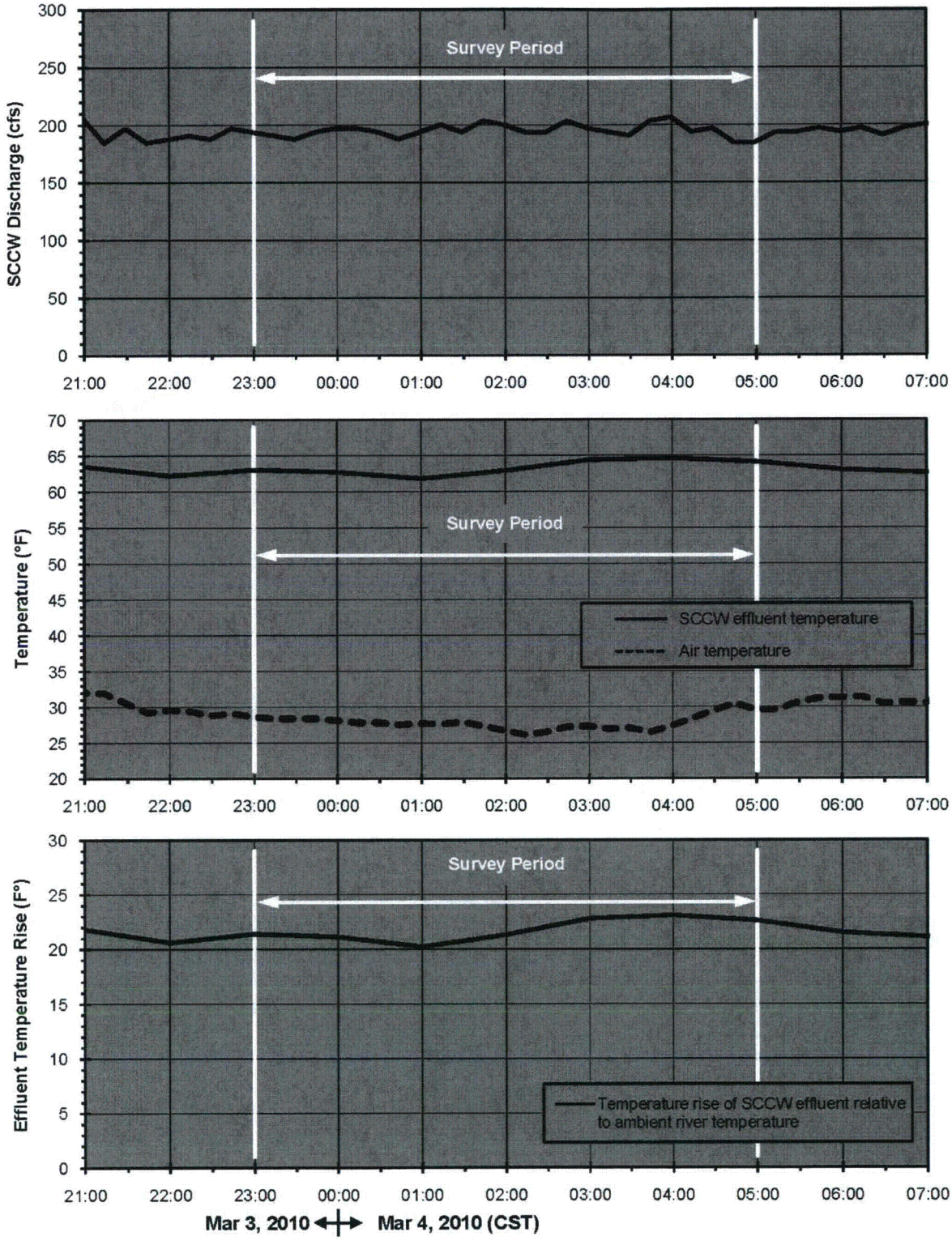

Figure 5. SCCW Conditions

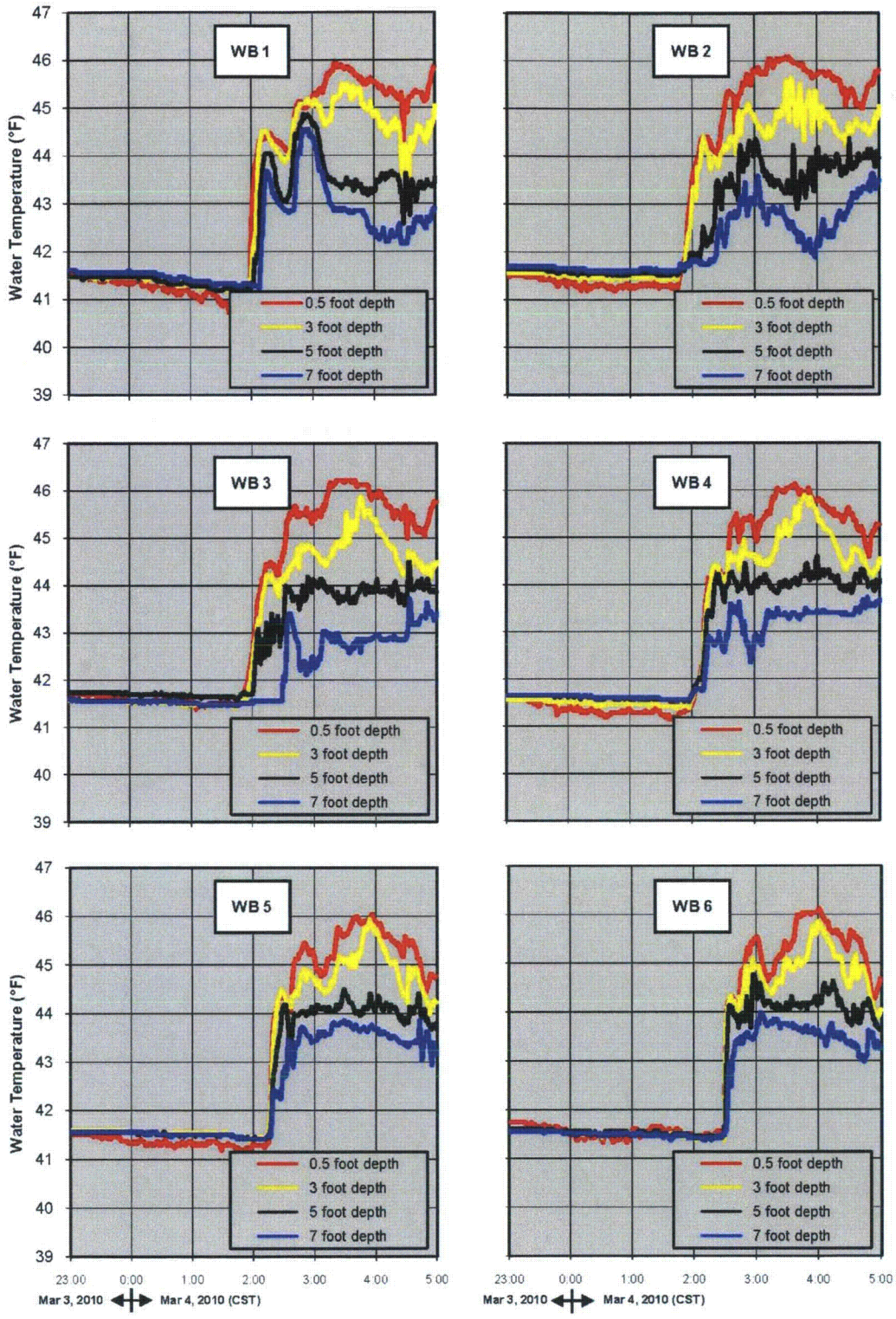

Figure 6. HOBO Water Temperature Measurements During Survey

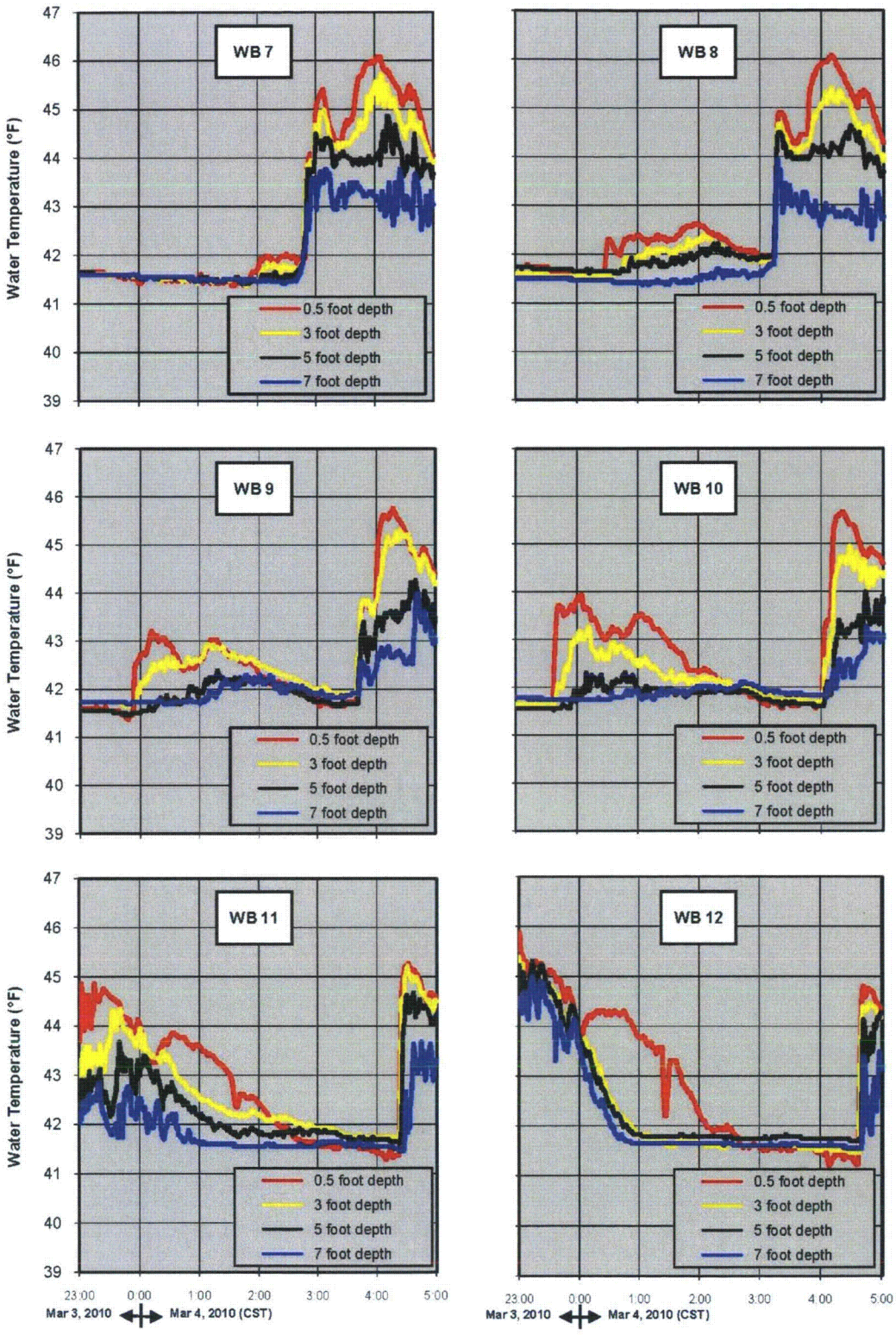

Figure 6 (Continued). HOBO Water Temperature Measurements During Survey

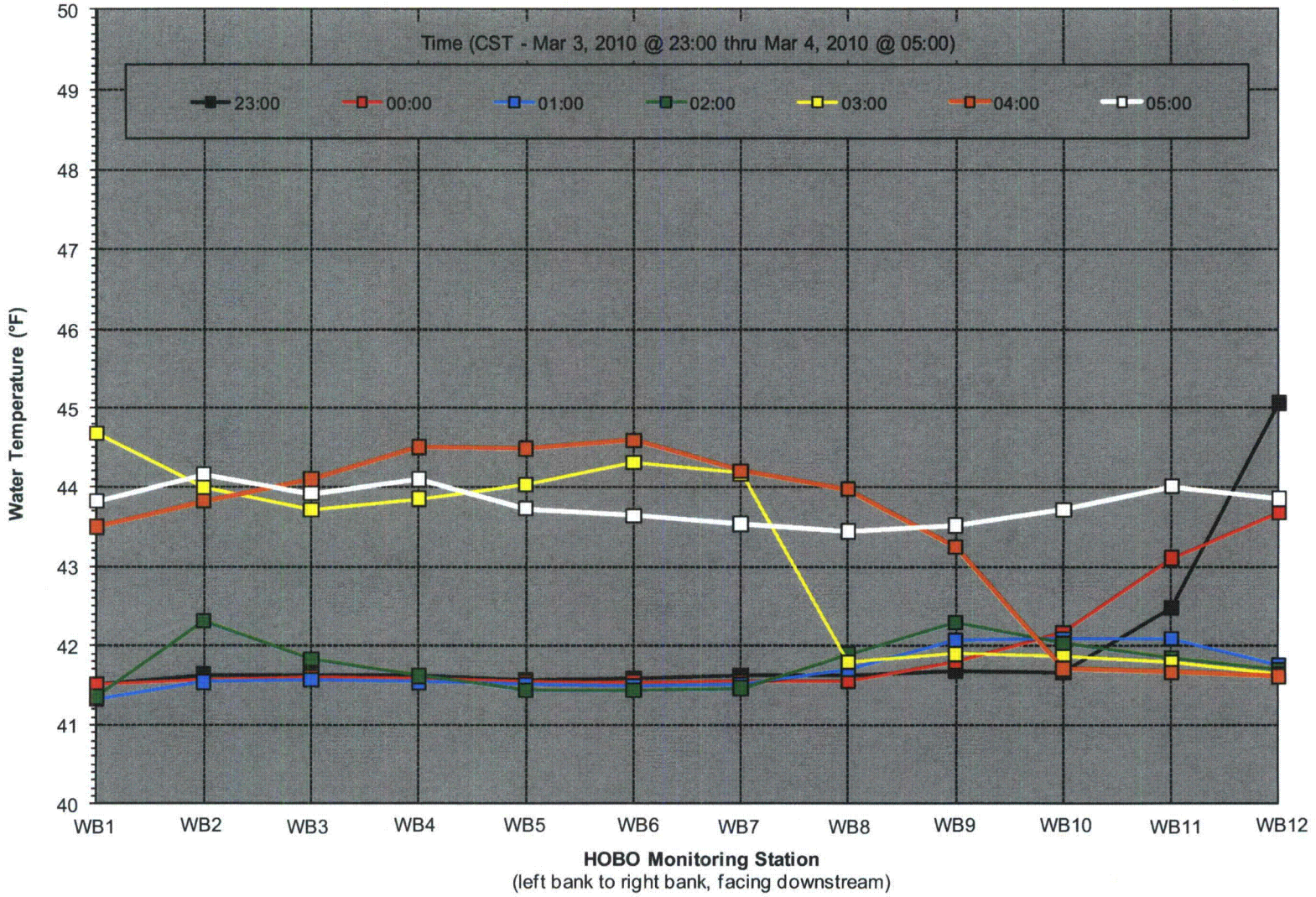

Figure 7. Profiles of Instantaneous Compliance Temperature across Downstream End of Passive Mixing Zone (Average of Readings at 3-Foot, 5-Foot, and 7-Foot Depths)

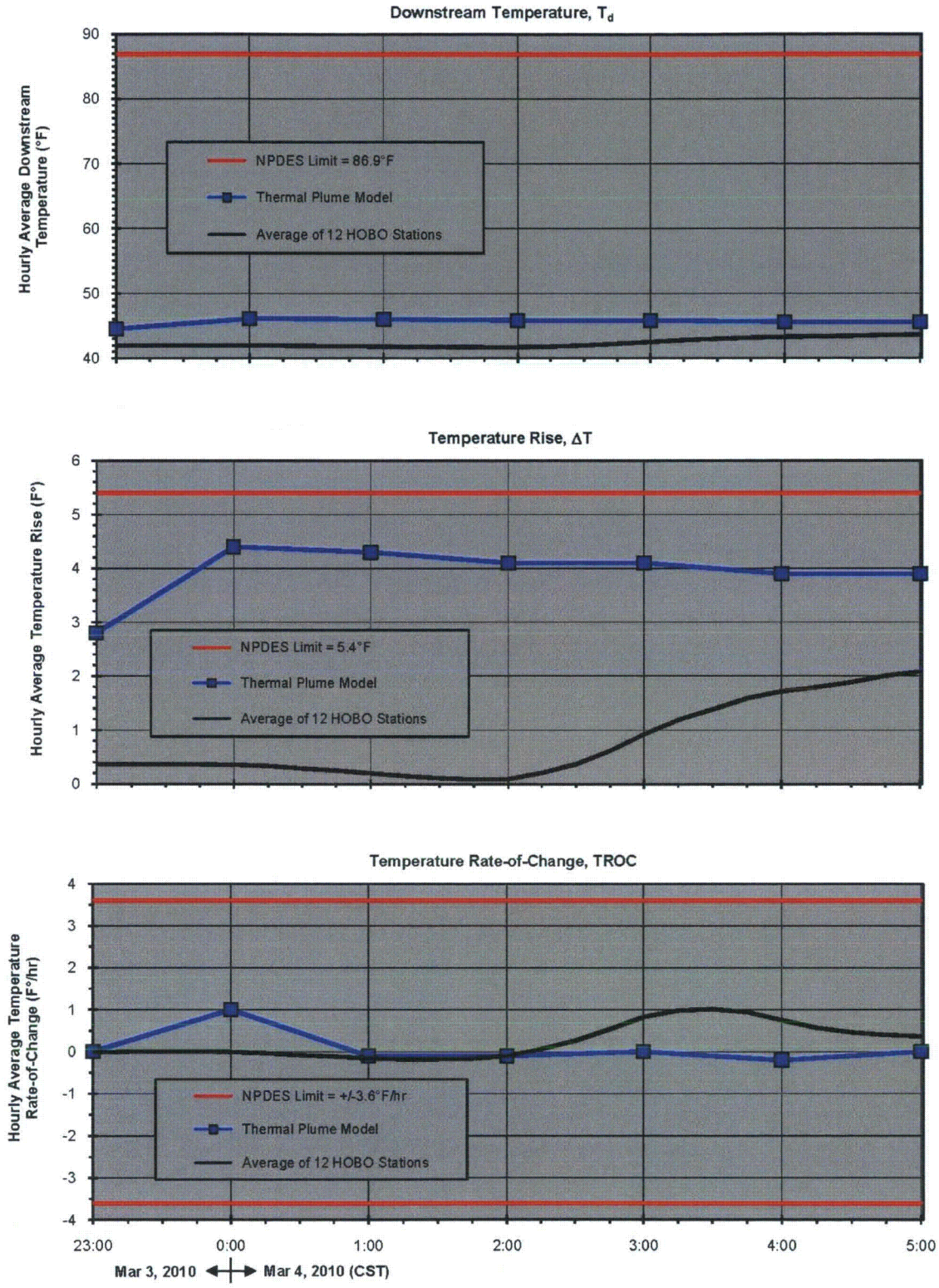

Figure 8. Measured and Computed Compliance Parameters for Passive Mixing Zone

APPENDIX A

(The following information is provided per request of Mike Kelly of TDEC on August 26, 2008)

All sensors used by TVA for monitoring compliance of NPDES water temperature requirements are certified and maintained to meet the following industry and regulatory standards:

- ISO/IEC 17025—Quality assurance requirements for the competence to carry out sampling, testing, and calibrations using standard, non-standard, and laboratory-developed methods (ISO=International Organization for Standardization, IEC=International Electrotechnical Commission).

- 10CFR50 Appendix B—Quality assurance criteria for design, fabrication, construction, and testing of the structures, systems, and components of nuclear power plants (CFR=Code of Federal Regulations).

- 40CFR136—Guidelines establishing test procedures for the analysis of pollutants under the Clean Water Act.

- ANSI N45.2. 1971—Quality assurance requirements for Nuclear Power Plants (ANSI= American National Standards Institute).

- ANSI/NCSL Z540-1-1994—General requirements for calibration laboratories and equipment used for measurements and testing (NCSL=National Conference of Standards Laboratories).

The standard used to certify the thermistors for the permanent EDS stations and the temporary HOBO stations is traceable to the National Institute of Standards and Technology (NIST). The standard includes two pieces of equipment—a platinum resistance temperature detector (RTD) manufactured by Burns Engineering, Inc. and an ohmmeter manufactured by Azonix Inc. The latter is used to measure the resistance of the RTD (i.e., the resistance of platinum varies with temperature). The NTIS traceable calibration certificates for the Burns RTDs and the Azonix ohmmeter that were used to calibrate the HOBO probes are provided below. The end result of the RTD calibration is a set of International Temperature Scale 1990 (ITS 90) coefficients that are used to compute water temperature from the measured RTD resistance. Based on the calibration certificates, the accuracy of the system for the temperature standard is about ±0.05°F. The tolerance of the thermistors used for the WBN field survey is about ±0.4°F, thus providing a calibration test accuracy ratio (TAR) of about 1:8. That is, the accuracy of temperature standard used for the sensor calibrations is 8 times greater than the minimum acceptable field accuracy of temperature sensors. This is twice the recommended maximum TAR of 1:4 for sensor calibrations.

The TVA procedure to calibrate the HOBO water temperature probes, Instruction No. 450.01-020, is provided below. Briefly, the HOBO probes are immersed in a stirred temperature-controlled water bath along with the standard (i.e., along with the Burns RTD probe). After the bath stabilizes, temperature readings from the HOBO probes are compared to the temperature readings from the standard. Experience has shown that in nearly all cases, the readings from both the HOBO probes and the standard and are essentially constant, so that the 95 percent confidence interval of the readings is diminutive. Under these conditions, the accuracy of each HOBO probe is recorded simply as the difference between the HOBO reading and that of the standard (negative difference = HOBO reading low/below standard, positive difference = HOBO reading high/above standard). The HOBO probes are tested at three temperatures between 30°F and 100°F, covering the range of expected water temperature for natural river conditions. Specifically, the three temperatures are at about the 10 percent, 50 percent, and 90 percent intervals, or 37°F, 65°F and 93°F, respectively. Any HOBO probe with measured accuracy (i.e., difference) in excess of the maximum allowable tolerance of ±0.4°F for any one temperature fails the calibration test and is removed from the field survey inventory. In general, based on TVA experience, most HOBO probes that pass the calibration test usually have measured accuracies better than about ±0.25°F for all three temperatures examined in the bath tests. The calibration certificates for HOBO probes used in field survey summarized herein are provided below. Included are certificates for both the pre- and post-survey calibration tests. A close examination of the certificates shows that all the HOBO probes passed the calibration test both before and after the field survey.

Calibration Certificates for Burns Platinum Resistance Thermometer (RTD)

RTD with ID No. 906535 was used for both pre-survey and post-survey calibrations.

REPORT of CALIBRATION

Asset ID:	906535
Certificate No:	17538
Page 1 of 6	

Tennessee Valley Authority
Central Laboratories Services
Mailing Address: 1101 Market Street, PSC-1B-C, Chattanooga, TN 37402
Shipping Address: 4601 North Access Road, Bldg. A, Chattanooga, TN 37415
Phone: (423) 876-4318 Fax: (423) 876-4137

QA RECORD

Customer:
CLS KNOXVILLE
400 W. SUMMIT HILL DR.
KNOXVILLE, TN 37902

Instrument Information:

Description:	RTD
Manufacturer:	BURNS
Model:	3925
Serial Number:	

Calibration Information:

Cal Date:	12/10/2009
Due Date:	12/10/2010
Interval:	12 Months
Cal Instruction:	307.04-004
As Found:	Out of Tolerance
As Left:	In Tolerance - Adjusted

AS FOUND OUT OF TOLERANCE

Ambient Temperature: 72°F +/- 9°F **Ambient Humidity:** <=80% RH

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10CFR50 Appendix B, ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced, except in full, without the written approval of CLS.

Technical Remarks:

Standards Utilized

TVA I.D.	Mfg.	Model No.	Description	Cal. Date	Due Date
891602	ASL	F17	TEMPERATURE MEASURING SYSTEM	08/28/2009	08/28/2010
891603	TINSLEY	5685-A	STANDARD RESISTOR,25 Ohms	12/09/2009	06/09/2010
905463	GUILDLINE	9330	STANDARD RESISTOR	12/07/2009	12/07/2010
905643	ISOTECH	MERCURY CELL	FIXED POINT CELL	12/08/2009	12/08/2014
905644	HART SCIENTIFIC	WATER TRIPLE CELL	TRIPLE POINT BATH & CELL	12/08/2009	12/08/2014
905645	ISOTECH	GALLIUM CELL	FIXED POINT CELL	12/08/2009	12/08/2014
905646	ISOTECH	TIN CELL	FIXED POINT CELL	12/08/2009	12/08/2014
905647	ISOTECH	ZINC CELL	FIXED POINT CELL	12/08/2009	12/08/2014

Calibrated by:	David R. Bird	Approved By:	Sam Bertram	12/15/2009
	Sr Metrology Tech		Calibration Supv.	Date

This report was electronically approved using Edison Mudcats Metrology Suite Ver. 2.2.1.

Tennessee Valley Authority

CENTRAL LABORATORIES SERVICES CHATTANOOGA, TENNESSEE	Cust. I.D. No.:	906535
	Page No.:	2 of 6
CALIBRATION REPORT	Date of Report:	12/10/09

Remarks: Accuracy +/- 0.02 Degrees C.
Recalculated coefficients prior to As Left test to bring within tolerance.
For As Left data and coefficients refer to page 3 of 6.

AS FOUND TEST

UUT °C	STD °C	ERROR °C	
-38.8536	-38.8344	0.0192	
0.01000	0.0100	0.0000	
29.7362	29.7646	0.0284	*Failed
231.9149	231.9280	0.0131	
419.4449	419.5270	0.0821	*Failed

As Found ITS 90 Coefficients

Rtpw	100.032105
a5	-4.15854650E-04
b5	-1.55621388E-04
a8	-2.72593907E-04
b8	-2.28004426E-04

Test current 1mA

Report for ITS-90 Coefficients

Model: 3925
Serial: TVA 906535
Date: December 03,2009

TPW:

Reference (°C)	UUT (Ohms)	Residual (°C)
0.0100	100.0317	N/A

Low Range:

Reference (°C)	UUT (Ohms)	Residual (°C)
-38.8344	84.4397	0.0026
29.7646	111.8350	-0.0008

High Range:

Reference (°C)	UUT (Ohms)	Residual (°C)
231.9280	189.2937	0.0001
419.5270	256.8467	0.0000

Coefficients:

RTPW = 100.031701

Low Range:

a5 = -6.56647710 E-04
b5 = -4.73559772 E-03

High Range:

a8 = -1.32503333 E-04
b8 = -4.29922201 E-04

Model: 3925 Serial: TVA 906535 ITS-90 Temperature vs. Resistance Table

°C	Resistance	dr/dT	°C	Resistance	dr/dT	°C	Resistance	dr/dT
-39.00	84.371755	0.4041701	20.00	107.98165	0.3964075	79.00	131.16111	0.3892309
-38.00	84.775925	0.4040197	21.00	108.37805	0.3962850	80.00	131.55034	0.3891100
-37.00	85.179945	0.4038700	22.00	108.77434	0.3961626	81.00	131.93945	0.3889891
-36.00	85.583815	0.4037209	23.00	109.17050	0.3960401	82.00	132.32844	0.3888683
-35.00	85.987536	0.4035724	24.00	109.56654	0.3959178	83.00	132.71731	0.3887474
-34.00	86.391108	0.4034245	25.00	109.96246	0.3957954	84.00	133.10605	0.3886266
-33.00	86.794533	0.4032772	26.00	110.35826	0.3956731	85.00	133.49468	0.3885058
-32.00	87.197810	0.4031305	27.00	110.75393	0.3955508	86.00	133.88319	0.3883851
-31.00	87.600940	0.4029843	28.00	111.14948	0.3954285	87.00	134.27157	0.3882643
-30.00	88.003925	0.4028387	29.00	111.54491	0.3953063	88.00	134.65984	0.3881436
-29.00	88.406764	0.4026937	30.00	111.94021	0.3951841	89.00	135.04798	0.3880229
-28.00	88.809457	0.4025492	31.00	112.33540	0.3950620	90.00	135.43600	0.3879022
-27.00	89.212006	0.4024052	32.00	112.73046	0.3949399	91.00	135.82391	0.3877816
-26.00	89.614412	0.4022617	33.00	113.12540	0.3948178	92.00	136.21169	0.3876609
-25.00	90.016673	0.4021187	34.00	113.52022	0.3946957	93.00	136.59935	0.3875403
-24.00	90.418792	0.4019762	35.00	113.91491	0.3945737	94.00	136.98689	0.3874197
-23.00	90.820768	0.4018341	36.00	114.30949	0.3944517	95.00	137.37431	0.3872992
-22.00	91.222602	0.4016925	37.00	114.70394	0.3943297	96.00	137.76161	0.3871786
-21.00	91.624295	0.4015513	38.00	115.09827	0.3942078	97.00	138.14879	0.3870581
-20.00	92.025846	0.4014105	39.00	115.49248	0.3940859	98.00	138.53584	0.3869376
-19.00	92.427257	0.4012701	40.00	115.88656	0.3939640	99.00	138.92278	0.3868171
-18.00	92.828527	0.4011301	41.00	116.28053	0.3938422	100.00	139.30960	0.3866966
-17.00	93.229657	0.4009904	42.00	116.67437	0.3937204	101.00	139.69630	0.3865762
-16.00	93.630647	0.4008511	43.00	117.06809	0.3935986	102.00	140.08287	0.3864558
-15.00	94.031498	0.4007121	44.00	117.46169	0.3934768	103.00	140.46933	0.3863354
-14.00	94.432210	0.4005734	45.00	117.85516	0.3933551	104.00	140.85566	0.3862150
-13.00	94.832784	0.4004350	46.00	118.24852	0.3932334	105.00	141.24188	0.3860946
-12.00	95.233219	0.4002969	47.00	118.64175	0.3931117	106.00	141.62797	0.3859743
-11.00	95.633516	0.4001589	48.00	119.03486	0.3929900	107.00	142.01395	0.3858540
-10.00	96.033675	0.4000212	49.00	119.42785	0.3928684	108.00	142.39980	0.3857337
-9.00	96.433696	0.3998837	50.00	119.82072	0.3927468	109.00	142.78553	0.3856134
-8.00	96.833579	0.3997464	51.00	120.21347	0.3926252	110.00	143.17115	0.3854931
-7.00	97.233326	0.3996091	52.00	120.60609	0.3925037	111.00	143.55664	0.3853729
-6.00	97.632935	0.3994720	53.00	120.99860	0.3923821	112.00	143.94201	0.3852527
-5.00	98.032407	0.3993350	54.00	121.39098	0.3922606	113.00	144.32727	0.3851325
-4.00	98.431742	0.3991981	55.00	121.78324	0.3921392	114.00	144.71240	0.3850124
-3.00	98.830940	0.3990612	56.00	122.17538	0.3920177	115.00	145.09741	0.3848922
-2.00	99.230001	0.3989242	57.00	122.56740	0.3918963	116.00	145.48230	0.3847721
-1.00	99.628926	0.3987873	58.00	122.95929	0.3917749	117.00	145.86708	0.3846520
0.00	100.02771	0.3988660	59.00	123.35107	0.3916535	118.00	146.25173	0.3845319
1.00	100.42658	0.3987426	60.00	123.74272	0.3915322	119.00	146.63626	0.3844118
2.00	100.82532	0.3986193	61.00	124.13425	0.3914108	120.00	147.02067	0.3842918
3.00	101.22394	0.3984961	62.00	124.52567	0.3912895	121.00	147.40496	0.3841718
4.00	101.62244	0.3983729	63.00	124.91696	0.3911682	122.00	147.78913	0.3840518
5.00	102.02081	0.3982497	64.00	125.30812	0.3910470	123.00	148.17319	0.3839318
6.00	102.41906	0.3981266	65.00	125.69917	0.3909258	124.00	148.55712	0.3838119
7.00	102.81718	0.3980035	66.00	126.09010	0.3908045	125.00	148.94093	0.3836919
8.00	103.21519	0.3978805	67.00	126.48090	0.3906834	126.00	149.32462	0.3835720
9.00	103.61307	0.3977575	68.00	126.87158	0.3905622	127.00	149.70819	0.3834522
10.00	104.01083	0.3976346	69.00	127.26215	0.3904410	128.00	150.09165	0.3833323
11.00	104.40846	0.3975117	70.00	127.65259	0.3903199	129.00	150.47498	0.3832125
12.00	104.80597	0.3973889	71.00	128.04291	0.3901988	130.00	150.85819	0.3830926
13.00	105.20336	0.3972660	72.00	128.43311	0.3900778	131.00	151.24128	0.3829728
14.00	105.60063	0.3971433	73.00	128.82318	0.3899567	132.00	151.62426	0.3828531
15.00	105.99777	0.3970206	74.00	129.21314	0.3898357	133.00	152.00711	0.3827333
16.00	106.39479	0.3968979	75.00	129.60298	0.3897147	134.00	152.38984	0.3826136
17.00	106.79169	0.3967752	76.00	129.99269	0.3895937	135.00	152.77246	0.3824939
18.00	107.18846	0.3966526	77.00	130.38228	0.3894727	136.00	153.15495	0.3823742
19.00	107.58512	0.3965300	78.00	130.77176	0.3893518	137.00	153.53732	0.3822545

Model: 3925 Serial: TVA 906535 ITS-90 Temperature vs. Resistance Table

°C	Resistance	dr/dT	°C	Resistance	dr/dT	°C	Resistance	dr/dT
138.00	153.91958	0.3821349	197.00	176.26160	0.3751159	256.00	198.19174	0.3681726
139.00	154.30171	0.3820152	198.00	176.63671	0.3749976	257.00	198.55991	0.3680555
140.00	154.68373	0.3818957	199.00	177.01171	0.3748793	258.00	198.92797	0.3679384
141.00	155.06562	0.3817761	200.00	177.38659	0.3747611	259.00	199.29590	0.3678213
142.00	155.44740	0.3816565	201.00	177.76135	0.3746429	260.00	199.66373	0.3677042
143.00	155.82906	0.3815370	202.00	178.13599	0.3745247	261.00	200.03143	0.3675871
144.00	156.21059	0.3814175	203.00	178.51052	0.3744065	262.00	200.39902	0.3674701
145.00	156.59201	0.3812980	204.00	178.88493	0.3742884	263.00	200.76649	0.3673531
146.00	156.97331	0.3811785	205.00	179.25921	0.3741702	264.00	201.13384	0.3672361
147.00	157.35449	0.3810591	206.00	179.63338	0.3740521	265.00	201.50108	0.3671191
148.00	157 73555	0.3809397	207.00	180.00744	0.3739340	266.00	201.86820	0.3670021
149.00	158.11649	0.3808203	208.00	180 38137	0.3738160	267.00	202.23520	0.3668851
150.00	158 49731	0.3807009	209.00	180.75519	0.3736979	268.00	202.60208	0.3667681
151.00	158.87801	0.3805815	210.00	181.12888	0.3735799	269.00	202.96885	0.3666512
152.00	159.25859	0.3804622	211.00	181.50246	0.3734619	270.00	203.33550	0.3665343
153.00	159.63905	0.3803429	212.00	181.87593	0.3733439	271.00	203.70204	0.3664174
154.00	160.01939	0.3802236	213.00	182.24927	0.3732259	272.00	204.06845	0.3663005
155.00	160.39962	0.3801044	214.00	182.62250	0.3731080	273.00	204.43475	0.3661836
156.00	160.77972	0.3799851	215.00	182.99560	0.3729901	274.00	204.80094	0.3660667
157.00	161.15971	0.3798659	216.00	183.36859	0.3728722	275.00	205.16700	0.3659498
158.00	161.53957	0.3797467	217.00	183.74147	0.3727543	276.00	205.53295	0.3658330
159.00	161.91932	0.3796275	218.00	184.11422	0.3726365	277.00	205.89879	0.3657161
160.00	162.29895	0.3795084	219.00	184.48686	0.3725186	278.00	206.26450	0.3655993
161.00	162.67846	0.3793893	220.00	184.85938	0.3724008	279.00	206.63010	0.3654825
162.00	163.05785	0.3792702	221.00	185.23178	0.3722830	280.00	206.99559	0.3653657
163.00	163.43712	0.3791511	222.00	185.60406	0.3721653	281.00	207.36095	0.3652489
164.00	163.81627	0.3790320	223.00	185.97622	0.3720475	282.00	207.72620	0.3651321
165.00	164.19530	0.3789130	224.00	186.34827	0.3719298	283.00	208.09133	0.3650154
166.00	164.57421	0.3787940	225.00	186.72020	0.3718121	284.00	208.45635	0.3648986
167.00	164.95301	0.3786750	226.00	187.09201	0.3716944	285.00	208.82125	0.3647819
168.00	165.33168	0.3785560	227.00	187.46371	0.3715767	286.00	209.18603	0.3646651
169.00	165.71024	0.3784371	228.00	187.83529	0.3714591	287.00	209.55069	0.3645484
170.00	166.08867	0.3783182	229.00	188.20674	0.3713415	288.00	209.91524	0.3644317
171.00	166.46699	0.3781993	230.00	188.57809	0.3712238	289.00	210.27967	0.3643150
172.00	166.84519	0.3780804	231.00	188.94931	0.3711063	290.00	210.64399	0.3641983
173.00	167.22327	0.3779615	232.00	189.32042	0.3709887	291.00	211.00819	0.3640816
174.00	167.60123	0.3778427	233.00	189.69140	0.3708711	292.00	211.37227	0.3639649
175.00	167.97908	0.3777239	234.00	190.06228	0.3707536	293.00	211.73623	0.3638483
176.00	168.35680	0.3776051	235.00	190.43303	0.3706361	294.00	212.10008	0.3637316
177.00	168.73440	0.3774863	236.00	190.80367	0.3705186	295.00	212.46381	0.3636150
178.00	169.11189	0 3773676	237.00	191.17418	0.3704011	296.00	212.82743	0.3634983
179.00	169.48926	0.3772489	238.00	191.54459	0.3702837	297.00	213.19093	0.3633817
180.00	169.86651	0.3771302	239.00	191.91487	0.3701662	298.00	213.55431	0.3632651
181.00	170.24364	0.3770115	240.00	192.28503	0.3700488	299.00	213.91757	0.3631484
182.00	170.62065	0.3768929	241.00	192.65508	0.3699314	300.00	214.28072	0.3630318
183.00	170.99754	0.3767743	242.00	193.02502	0.3698141	301.00	214.64375	0.3629152
184.00	171.37432	0.3766557	243.00	193.39483	0.3696967	302.00	215.00667	0.3627986
185.00	171.75097	0.3765371	244.00	193.76453	0.3695793	303.00	215.36947	0.3626820
186.00	172.12751	0.3764185	245.00	194.13411	0.3694620	304.00	215.73215	0.3625655
187.00	172.50393	0.3763000	246.00	194.50357	0.3693447	305.00	216.09471	0.3624489
188.00	172.88023	0.3761815	247.00	194.87291	0.3692274	306.00	216.45716	0.3623323
189.00	173.25641	0.3760630	248.00	195.24214	0.3691102	307.00	216.81950	0.3622157
190.00	173.63247	0.3759445	249.00	195.61125	0.3689929	308.00	217.18171	0.3620992
191.00	174.00842	0.3758261	250.00	195.98024	0.3688757	309.00	217.54381	0.3619826
192.00	174.38424	0.3757077	251.00	196.34912	0.3687584	310.00	217.90579	0.3618661
193.00	174.75995	0.3755893	252.00	196.71788	0.3686412	311.00	218.26766	0.3617495
194.00	175.13554	0.3754709	253.00	197.08652	0.3685241	312.00	218.62941	0.3616330
195.00	175.51101	0.3753525	254.00	197.45504	0.3684069	313.00	218.99104	0.3615164
196.00	175.88636	0.3752342	255.00	197.82345	0.3682897	314.00	219.35256	0.3613999

Calibration Certificate for Azonix Ohmmeter

Instrument used to read resistance of Burns RTD thermometers.

REPORT of CALIBRATION

Asset ID:	906527
Certificate No:	18904
Page 1 of 2	

Tennessee Valley Authority
Central Laboratories Services
Mailing Address: 1101 Market Street, PSC-1B-C, Chattanooga, TN 37402
Shipping Address: 4601 North Access Road, Bldg. A, Chattanooga, TN 37415
Phone: (423) 876-4318 Fax: (423) 876-4137

QA RECORD

Customer:
CLS KNOXVILLE
400 W. SUMMIT HILL DR.
KNOXVILLE, TN 37902

Instrument Information:

Description:	DIGITAL THERMOMETER
Manufacturer:	AZONIX
Model:	A1011-RS-A0-RT41
Serial Number:	

Calibration Information:

Cal Date:	01/11/2010
Due Date:	01/11/2011
Interval:	12 Months
Cal Instruction:	308.02-003
As Found:	In Tolerance
As Left:	In Tolerance

Ambient Temperature: 72°F +/- 2°F **Ambient Humidity:** <=50% RH

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10CFR50 Appendix B, ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced, except in full, without the written approval of CLS.

Technical Remarks:

Standards Utilized

TVA I.D.	Mfg.	Model No.	Description	Cal. Date	Due Date
259304	HONEYWELL	1190	RESISTANCE STANDARD,1 OHM	05/25/2005	05/25/2010
906374	ERTCO	ASTM 17F	GLASS THERMOMETER	12/08/2009	12/08/2010
E29099	GUILDLINE	6675A	DC RESISTANCE BRIDGE	11/10/2009	11/10/2010

Calibrated by:	Matthew R. Snyder	Approved By:	Sam Bertram	01/12/2010
	Sr Metrology Tech		Calibration Supv	Date

This report was electronically approved using Edison Mudcats Metrology Suite Ver. 2.2.1.

Tennessee Valley Authority

CENTRAL LABORATORIES SERVICES CHATTANOOGA, TENNESSEE	Cust. I. D. No.:	906527
	Page No.:	2 of 2
CALIBRATION REPORT	Date of Report:	1/11/10

Remarks: Accuracy = 0.004 Ohms

Certification is limited to channels 1 and 2; channels 3 and 4 are not certified.
Limited certification label is attached.

Left as found.

*Denotes out of tolerance.

AS FOUND

Probe	Standard Resistance (Ohms)	UUT Reading (Ohms)	Error (Ohms)
1	89.9999	90.001	0.001
	100.0000	100.001	0.001
	119.9999	120.002	0.002
2	89.9999	90.001	0.001
	100.0000	100.001	0.001
	119.9999	120.000	0.000

TVA Procedure for Calibration of HOBO Water Temperature Probes

CENTRAL LABORATORIES SERVICES QUALITY PROGRAM INSTRUCTION	TITLE Certification of HOBO Water Temp Pro Data Acquisition SystemsH_20-001	Instruction No. 450.01-020 Rev. No. 0 Page No. 1 of 7 Effective Date 5/19/03

LEVEL OF USE ☐ Continuous ☒ Reference ☐ Information

QA RECORD

Dennis T. Darby — Preparer — 5/19/03 — Date

Paul B. Loiseau, Jr. — Technical Reviewer — 5/19/03 — Date

Administrative Review — 6/5/03 — Date

APPROVAL

Jerry D. Hubble — Department Manager — 5/19/03 — Date

REVISION LOG

Revision Number	Effective Date	Pages Affected	Description of Revision
0	5/19/03	All	Initial Issue.

1.0 PURPOSE

To provide uniform and effective certifications of Hobo Water Temp Pro data acquisition systems meeting the accuracy and performance requirements of TVA's water temperature-monitoring programs. This technical instruction uses the method of comparison with a laboratory standard thermometer.

2.0 SCOPE

This instruction applies to the certification of Hobo Water Temp Pro data loggers manufactured by Onset Computer Corporation of Bourne, Massachusetts. The Hobo Water Temp Pro is a data acquisition system containing a temperature sensor, data logger and battery sealed in a single submersible case. The Hobo Water Temp Pro is programmed and data retrieved by use of an infrared interface located in one end of the case. Hobo Water Temp Pros are certified upon receipt from the manufacturer at no greater than 12 month intervals during use or when requested.

3.0 SUMMARY

In this three-point certification systems are tested as actually used over the historical water temperature range of 30° to 100°F and submerged in water. The three test points are 37°, 65° and 93°F. The systems are required to perform within Onset Computer Corporation tolerances. System conformity at each temperature point is determined by comparing system temperature, logged by the Hobo Water Temp Pro and a laboratory standard thermometer.

Systems are programmed and submerged with a standard thermometer in a stirred, temperature-controlled temperature bath. The systems are read after the test by an infrared interface adapter connected to a computer running Onset Computer Corporation's Boxcar Pro software. Traceability of the certification is through the thermometer.

"As-found" certifications are performed on new systems as an acceptance test and on sensors returned from field service. "As-left" certifications are performed before delivery for field service if more than 12 months has elapsed since the last certification. "As-found" and "as-left" certifications may be combined on the same record if there is clear indication which type each system is undergoing.

Multiple HOBOs may be certified at the same time in the temperature bath.

- Accuracy of ±0.2°C at 25°C (0.33°Flat 70°F)
- Waterproof case, submersible to 100 feet
- Capacity to store up to 21,580 temperature measurements
- Selectable sampling interval from 1 second to 9 hours
- Programmable start time/date
- Two data recording modes: Stop when full or wrap around when full.
- Two data offload modes: Halt then offload or offload while logging.
- Nonvolatile EEPROM memory that retains data even if batteries fail
- Light-emitting diode (LED) operation, indicator, which can be disabled during logging by selecting "Stealth"1 mode
- High-speed IR communications for offloading data; can readout full logger in less than 30 seconds while logging continues
- Battery life of 6 years with typical usage

4.0 PRACTICES/EXCEPTIONS

N/A

5.0 SAFETY

5.1 Standard electrical equipment safety.

6.0 STANDARDS USED

6.1 Laboratory reference thermometer, range 30° to 100°F or greater, 0.01°F resolution, 0.1°F accuracy or better, with current calibration sticker.

7.0 EQUIPMENT/APPARATUS

7.1 Temperature bath, stirred, temperature-controlled.
7.2 Computer with Onset Boxcar Pro software installed (version 4.3 or later)
7.3 IR Base station, Onset Part # BST -IR

8.0 PREREQUISITE ACTIONS

8.1 Turn on temperature bath and set for 37°F.
8.2 Check the IR interface to verify that it is plugged into the correct serial port on the PC. Set the correct time on the PC.
8.3 Align the IR port on the Base station with the HOBO Water Temp Pro communications window. Place the logger no further than 4 to 5 inches away from the Base station (see Figure 2) and make sure the IR windows in both devices point at each other. There is a 30° acceptance angle for the IR beam, so some misalignment is acceptable.

8.4 Start the Onset Box Car Software and select **Logger** then **Hobo Water Temp Pro** and **Launch.**

8.5 The computer will respond with a list of loggers found. The serial number in this list should match the serial number printed on the side of the logger. If these numbers do not match, click the **Refresh** button. Record this serial number on the certification form. Either wait or click the **Stop Searching** button. Using the mouse select the logger and click the **Launch** button.

8.6 After a few seconds the screen will display the status of the HOBO Water Temp Pro. Record the battery percentage on the certification form.

8.7 Verify that the Hobo is set to Fahrenheit and program it to a recording interval of 0:1:0 for a reading once a minute. Verify that the start logging immediately box is checked and that the set data logger clock with host launch is also checked.

8.8 Using the mouse click the **Launch Immediately** button.

8.9 If last HOBO is programmed click the **DONE** button, else select the **Launch Another** and repeat steps 8.5 through 8.9.

9.0 TEST PROCEDURE/METHOD

9.1 On the certification form record the serial number of the laboratory reference thermometer.

9.2 *Place the HOBO Water Temp Pro in the temperature bath, making sure the end* opposite the IR windows is submerged, and allow the bath to stabilize at 37°F ±0.5°F on the thermometer. Adjust the bath set point if needed. After the bath reaches the desired temperature allow 20 minutes 'soak time' for the HOBO to reach its final temperature.

9.3 Record the thermometer reading on the certification form and the time. (The time will be needed to get the correct reading from the HOBO.)

9.4 Repeat steps 9.2 and 9.3 for bath settings of 65.0°F ± 0.5°F and 93°F ± 0.5°F.

9.5 Remove the HOBO from the temperature bath and align the IR port on the Base station with the HOBO Water Temp Pro communications window.

9.6 Restart Onset BoxCar Pro if it is not running and select **Logger** then **Hobo Water Temp Pro** and **Readout.**

9.7 The computer will respond with a list of loggers found. Using the mouse select the logger and click the **Readout** button. The computer will ask to download data and continue logging or the stop logging and offload data. Select the **Stop Logging and Offload data.** After a few seconds the computer will respond with a suggested file name. Select **Save** and allow the HOBO to transfer the data.

9.8 After a successful download click the **OK** button. The computer will then ask if the data should be displayed in Centigrade or Fahrenheit. Deselect °C and select °F and click **OK.** The computer should display a graph of the collected data. Click the view details button (this is the button just left of the question mark button.)

9.9 Scroll down the displayed list until the time recorded for the 37°F point is found. Record the corresponding temperature on the certification form. Repeat this step for 65° and 93°.

9.10 Close the view details windows and repeat steps 9.6 through 9.9 for additional HOBOs.

9.11 Fill out the rest of the certification form.

10.0 ACCEPTANCE CRITERIA

10.1 Based upon the manufacturer specifications the HOBO Water Temp Pro should be within ±0.4°F over the range of 32°F to 100°F. Any HOBO with an error of greater than ±0.5°F at any of the three measured points shall fail certification.

11.0 POST PROCEDURE ACTIVITY

11.1 Close the BoxCar Software.

12.0 RECORDS

12.1 Completed HOBO Water Temperature Pro Certification form and associated Report of Certification cover sheet is a QA record.

13.0 REFERENCE

13.1 *HOBO Water Temp Pro User's Manual, version 1.0 or later*

13.2 Onset BoxCar Pro4 Manual Version 1.0 or later

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	SN Page Date

WATER TEMPERATURE HOBO WATER TEMP PRO CALIBRATION RECORD

Date of Certification: April 25, 2001

Type of Certification: As-found ____ As-Left X

SENSOR INFO For As-Found List Plant S/N & PLNT	37 deg F BATH TEMP Limits 0.40 degF -0.40 degF	OBSVD ERROR	65 degF BATH TEMP Limits 0.40 degF -0.40 degF	OBSVD ERROR	93 degF BATH TEMP Limits 0.40 degF -0.40 degF	OBSVD ERROR	PASS	FAIL	Battery LIFE
1		0.00		0.00		0.00	✓		
2		0.00		0.00		0.00	✓		
3		0.00		0.00		0.00	✓		
4		0.00		0.00		0.00	✓		
5		0.00		0.00		0.00	✓		
6		0.00		0.00		0.00	✓		
7		0.00		0.00		0.00	✓		
8		0.00		0.00		0.00	✓		
9		0.00		0.00		0.00	✓		
10		0.00		0.00		0.00	✓		

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks: _____

Calibration Certificates for HOBO Water Temperature Probes

Table of HOBO Probes Used for the WBN Survey Summarized Herein

Station (Figure 3)	Depth (feet)	HOBO Logger (Serial Number)
WB1	0.5	1304864
	3	1304872
	5	1305177
	7	1304860
WB2	0.5	1305152
	3	1304888
	5	1304891
	7	1304874
WB3	0.5	1305159
	3	1305144
	5	1304887
	7	1304867
WB4	0.5	1305168
	3	1304854
	5	1304865
	7	1304889
WB5	0.5	1304882
	3	1305164
	5	1304853
	7	1305182
WB6	0.5	1304883
	3	1304868
	5	1305161
	7	1304863

Station (Figure 3)	Depth (feet)	HOBO Logger (Serial Number)
WB7	0.5	1304856
	3	1305160
	5	1305147
	7	1304890
WB8	0.5	1305139
	3	1304886
	5	1305174
	7	1305143
WB9	0.5	1304866
	3	1305140
	5	1305150
	7	1304870
WB10	0.5	1304861
	3	1305156
	5	1304877
	7	1305179
WB11	0.5	1134040
	3	1305176
	5	1304878
	7	1305153
WB12	0.5	1305141
	3	1304851
	5	1304857
	7	1305155

Pre-Survey Calibrations

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43163 Page 1 of 2 Date 02/22/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance — Date of Report: 02/22/2010

Item Description: HOBO WATER PRO — TVA I.D. No.: E43163

Manufacturer: Onset Computer Corporation

Model: H20-001 — CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab — As-Left calibration in tolerance

Standards Used Log

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS

Calibrated By: Debbie Houser

Approved By: Randy Coyer

Date Approved: 3/9/10

TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES SERVICES
400 W. Summit Hill Drive, Mail Stop SPB BA-K
Knoxville, Tennessee 37902
Phone: (865) 632-2304 Fax: (865) 632-4996

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.941			BATH TEMP 64.986			BATH TEMP 92.970			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR			
WB11 - ½ ft	1134040	36.99		0.04	65.06		0.07	93.00		0.03	✓		3.57
WB12 - 3 ft	1304851	36.89		-0.05	65.02		0.03	93.00		0.03	✓		3.60
WB5 - 5 ft	1304853	36.94		0.00	65.06		0.07	93.09		0.12	✓		3.57
WB4 - 3 ft	1304854	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.60
WB7 - ½ ft	1304856	37.04		0.09	65.15		0.16	93.14		0.17	✓		3.57
WB12 - 5 ft	1304857	37.08		0.14	65.23		0.24	93.19		0.22	✓		3.57
WB1 - 7 ft	1304860	36.99		0.04	65.15		0.16	93.19		0.22	✓		3.57
WB10 - ½ ft	1304861	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.57
WB6 - 7 ft	1304863	36.89		-0.05	65.06		0.07	93.09		0.12	✓		3.60
WB1 - ½ ft	1304864	36.94		0.00	65.10		0.12	93.09		0.12	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Pre Cal Test

Pre-Survey Calibrations (Continued)

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METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 02/22/2010

Item Description: HOBO WATER PRO
TVA I D. No.: E43164

Manufacturer: Onset Computer Corporation

Model: H20-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log.

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Calbrie Howard
Approved By: Randy Logan
Date Approved: 3/9/10

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WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.941			BATH TEMP 64.986			BATH TEMP 92.970			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR			
WB4 - 5 ft	1304865	36.99		0.04	65.15		0.16	93.19		0.22	✓		3.51
WB9 - ½ ft	1304866	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.54
WB3 - 7 ft	1304867	36.94		0.00	65.06		0.07	93.09		0.12	✓		3.54
WB6 - 3 ft	1304868	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.48
WB9 - 7 ft	1304870	37.08		0.14	65.23		0.24	93.23		0.26	✓		3.51
WB1 - 3 ft	1304872	36.89		-0.05	65.02		0.03	93.05		0.08	✓		3.51
WB2 - 7 ft	1304874	37.04		0.09	65.19		0.20	93.23		0.26	✓		3.54
WB10 - 5 ft	1304877	36.84		-0.10	64.97		-0.01	93.00		0.03	✓		3.48
WB11 - 5 ft	1304878	37.04		0.09	65.19		0.20	93.23		0.26	✓		3.48

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN PRE CAL TEST

Pre-Survey Calibrations (Continued)

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METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 02/24/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E43165
Manufacturer: Onset Computer Corporation
Model: H20-001
CLS Instruction No.: 450.01-020
S/N No.: See Attached Sheet
Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log.

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS

Calibrated By: Gillie Howard
Approved By: Randy Cooper
Date Approved: 3/9/10

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CENTRAL LABORATORIES SERVICES
400 W. Summit Hill Drive, Mail Stop SPB BA-K
Knoxville, Tennessee 37902
Phone: (865) 632-2304 Fax: (865) 632-4996

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.941			BATH TEMP 64.988			BATH TEMP 92.970			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB5 - ½ ft	1304882	36.89		-0.05	65.06		0.07	93.09		0.12	✓		3.57
WB6 - ½ ft	1304883	37.13		0.19	65.23		0.24	93.19		0.22	✓		3.60
WB8 - 3 ft	1304886	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.60
WB3 - 5 ft	1304887	37.08		0.14	65.23		0.24	93.23		0.26	✓		3.60
WB2 - 3 ft	1304888	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.57
WB4 - 7 ft	1304889	37.04		0.09	65.15		0.16	93.09		0.12	✓		3.60
WB7 - 7 ft	1304890	36.94		0.00	65.10		0.11	93.09		0.12	✓		3.57
WB2 - 5 ft	1304891	37.04		0.09	65.19		0.20	93.19		0.22	✓		3.60
WB8 - ½ ft	1305139	37.13		0.19	65.27		0.28	93.28		0.31	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Pre Cal Test

Pre-Survey Calibrations (Continued)

E44404

TENNESSEE VALLEY AUTHORITY CENTRAL LABORATORIES SERVICES 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E~~444484~~ Page 1 of 2 Date 02/24/2010

DSH 3-9-10

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 02/24/2010

Item Description: HOBO WATER PRO

E44404
TVA I.D. No.: E~~444484~~

Manufacturer: Onset Computer Corporation

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log.

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS

Calibrated By: Robbie Howard

Approved By: Randy Cooper

Date Approved: 3/9/10

E44404

TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES SERVICES
400 W. Summit Hill Drive, Mail Stop SPB BA-K
Knoxville, Tennessee 37902
Phone: (865) 632-2304 Fax: (865) 632-4996

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					Battery
		BATH TEMP 36.941			BATH TEMP 64.988			BATH TEMP 92.970			PASS	FAIL	LIFE
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR			
WB9 - 3 ft	1305140	37.08		0.14	65.23		0.24	93.23		0.26	✓		3.60
WB12 - ½ ft	1305141	36.94		0.00	65.15		0.16	93.23		0.26	✓		3.51
WB8 - 7 ft	1305143	36.84		-0.10	64.97		-0.01	93.00		0.03	✓		3.60
WB3 - 3 ft	1305144	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.60
WB7 - 5 ft	1305147	36.94		0.00	65.10		0.11	93.09		0.12	✓		3.60
WB9 - 5 ft	1305150	36.84		-0.10	65.02		0.03	93.00		0.03	✓		3.60
WB2 - ½ ft	1305152	36.89		-0.05	65.10		0.11	93.14		0.17	✓		3.60
WB11 - 7 ft	1305153	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.60
WB12 - 7 ft	1305155	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.60
WB10 - 3 ft	1305156	36.94		0.00	65.10		0.11	93.09		0.12	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Pre Cal Test

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44405 Page 1 of 2 Date 02/26/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 02/26/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44405

Manufacturer: Onset Computer Corporation

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994 Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants This report shall not be reproduced except in full, without the written approval of CLS

Calibrated By: Debbie Howell

Approved By: Randy Cooper

Date Approved: 3/9/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44405 Page 2 of 2 Date 02/26/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP			BATH TEMP			BATH TEMP			P	F	Battery
		36.945			64.986			92.969			A	A	L
	Sensor	Limits			Limits			Limits			S	I	I
	Serial	0.40	deg F	OBSVD	0.40	deg F	OBSVD	0.40	deg F	OBSVD	S	L	F
	Number	-0.40	deg F	ERROR	-0.40	deg F	ERROR	-0.40	deg F	ERROR			E
WB3 - ½ ft	1305159	37.04		0.09	65.19		0.20	93.19		0.22	✓		3.60
WB7 - 3 ft	1305160	36.94		-0.01	64.97		-0.01	93.09		0.12	✓		3.57
WB6 - 5 ft	1305161	36.94		-0.01	65.10		0.12	93.09		0.12	✓		3.57
WB5 - 3 ft	1305164	36.94		-0.01	65.10		0.12	93.09		0.12	✓		3.57
WB4 - ½ ft	1305168	36.94		-0.01	65.06		0.07	93.09		0.12	✓		3.57
WB8 - 5 ft	1305174	37.04		0.09	65.19		0.20	93.19		0.22	✓		3.57
WB11 - 3 ft	1305176	37.13		0.19	65.27		0.29	93.33		0.36	✓		3.57
WB1 - 5 ft	1305177	36.89		-0.05	65.02		0.03	93.00		0.03	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Pre Cal Test

Pre-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44406 Page 1 of 2 Date 02/26/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 02/26/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44406

Manufacturer: Onset Computer Corporation

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	01/11/2010	01/11/2011
906535	Burns Engineering 12001 PRT	12/10/2009	12/10/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45 2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Melissa Hawkins

Approved By: Randy Cooper

Date Approved: 3/9/10

TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES SERVICES
400 W. Summit Hill Drive, Mail Stop SPB BA-K
Knoxville, Tennessee 37902
Phone: (865) 632-2304 Fax: (865) 632-4996

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			P	F	Battery
		BATH TEMP 36.945			BATH TEMP 64.986			BATH TEMP 92.969			A	A	L
	Sensor Serial Number	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	S S	I L	I F E
WB10 - 7 ft	1305179	37.08		0.14	65.19		0.20	93.23		0.27	✓		3.57
WB5 - 7 ft	1305182	36.89		-0.05	65.06		0.07	93.09		0.12	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Pre Cal Test

Post-Survey Calibrations

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43163 Page 1 of 2 Date 03/30/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 03/30/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E43163

Manufacturer: Onset Computer Corporation

Model: H20-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	12/30/2008	12/30/2009
906534	Burns Engineering 12001 PRT	01/12/2009	01/12/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994 Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS

Calibrated By: Debbie Howard
Approved By: Randy Cooper
Date Approved: 4/26/10

TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES SERVICES
400 W. Summit Hill Drive, Mail Stop SPB BA-K
Knoxville, Tennessee 37902
Phone: (865) 632-2304 Fax: (865) 632-4996

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.939			BATH TEMP 64.987			BATH TEMP 92.967			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB11 - ½ ft	1134040	36.99		0.05	65.06		0.07	93.00		0.03	✓		3.60
WB12 - 3 ft	1304851	36.89		-0.05	65.02		0.03	93.00		0.03	✓		3.60
WB5 - 5 ft	1304853	36.94		0.00	65.06		0.07	93.09		0.13	✓		3.57
WB4 - 3 ft	1304854	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.60
WB7 - ½ ft	1304856	37.04		0.10	65.15		0.16	93.14		0.17	✓		3.57
WB12 - 5 ft	1304857	37.08		0.14	65.23		0.24	93.23		0.27	✓		3.57
WB1 - 7 ft	1304860	37.04		0.10	65.19		0.20	93.19		0.22	✓		3.57
WB10 - ½ ft	1304861	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.57
WB6 - 7 ft	1304863	36.89		-0.05	65.06		0.07	93.09		0.13	✓		3.57
WB1 - ½ ft	1304864	36.89		-0.05	65.10		0.12	93.09		0.13	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Test

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43164 Page 1 of 2 Date 03/30/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 03/30/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E43164

Manufacturer: Onset Computer Corporation

Model: H20-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	12/30/2008	12/30/2009
906534	Burns Engineering 12001 PRT	01/12/2009	01/12/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Melissa Hensley
Approved By: Randy Cooper
Date Approved: 4/26/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43164 Page 2 of 2 Date 03/30/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			P A S S	F A I L	Battery L I F E
		BATH TEMP 36.939			BATH TEMP 64.987			BATH TEMP 92.967					
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR			
WB4 - 5 ft	1304865	37.04		0.10	65.15		0.16	93.19		0.22	✓		3.57
WB9 - ½ ft	1304866	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.60
WB3 - 7 ft	1304867	36.94		0.00	65.06		0.07	93.09		0.13	✓		3.60
WB6 - 3 ft	1304868	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.57
WB9 - 7 ft	1304870	37.08		0.14	65.23		0.24	93.23		0.27	✓		3.60
WB1 - 3 ft	1304872	36.94		0.00	65.02		0.03	93.05		0.08	✓		3.60
WB2 - 7 ft	1304874	37.08		0.14	65.23		0.24	93.23		0.27	✓		3.60
WB10 - 5 ft	1304877	36.89		-0.05	65.02		0.03	93.00		0.03	✓		3.57
WB11 - 5 ft	1304878	37.04		0.10	65.19		0.20	93.23		0.27	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Test

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43165 Page 1 of 2 Date 03/31/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 03/31/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E43165

Manufacturer: Onset Computer Corporation

Model: H20-001
CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log.

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	12/30/2008	12/30/2009
906534	Burns Engineering 12001 PRT	01/12/2009	01/12/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Melissa Houser
Approved By: Randy Cooper
Date Approved: 4/26/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E43165 Page 2 of 2 Date 03/31/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF			P A S S	F A I L	Battery L I F E
		BATH TEMP 36.939			BATH TEMP 64.986			BATH TEMP 92.968					
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR			
WB5 - ½ ft	1304882	36.94		0.00	65.06		0.07	93.09		0.12	✓		3.57
WB6 - ½ ft	1304883	37.13		0.19	65.23		0.24	93.19		0.22	✓		3.57
WB8 - 3 ft	1304886	36.94		0.00	65.06		0.07	93.09		0.12	✓		3.57
WB3 - 5 ft	1304887	37.08		0.14	65.23		0.24	93.23		0.27	✓		3.57
WB2 - 3 ft	1304888	36.94		0.00	65.06		0.07	93.09		0.12	✓		3.57
WB4 - 7 ft	1304889	37.04		0.10	65.10		0.12	93.09		0.12	✓		3.57
WB7 - 7 ft	1304890	36.94		0.00	65.10		0.12	93.09		0.12	✓		3.57
WB2 - 5 ft	1304891	37.08		0.14	65.19		0.20	93.23		0.27	✓		3.60
WB8 - ½ ft	1305139	37.13		0.19	65.27		0.29	93.28		0.31	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Test

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44404 Page 1 of 2 Date 03/31/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance

Date of Report: 03/31/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44404

Manufacturer: Onset Computer Corporation

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log

I.D. No	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	12/30/2008	12/30/2009
906534	Burns Engineering 12001 PRT	01/12/2009	01/12/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Houser

Approved By: Randy Cooper

Date Approved: 4/26/10

TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES SERVICES
400 W. Summit Hill Drive, Mail Stop SPB BA-K
Knoxville, Tennessee 37902
Phone: (865) 632-2304 Fax: (865) 632-4996

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.939			BATH TEMP 64.986			BATH TEMP 92.968			PASS	FAIL	Battery LIFE
	Sensor Serial Number	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F	OBSVD ERROR			
WB9 - 3 ft	1305140	37.08		0.14	65.23		0.24	93.28		0.31	✓		3.57
WB12 - ½ ft	1305141	36.94		0.00	65.15		0.16	93.23		0.27	✓		3.57
WB8 - 7 ft	1305143	36.84		-0.10	64.97		-0.01	93.00		0.03	✓		3.57
WB3 - 3 ft	1305144	36.99		0.05	65.06		0.07	93.05		0.08	✓		3.57
WB7 - 5 ft	1305147	36.99		0.05	65.10		0.12	93.14		0.17	✓		3.60
WB9 - 5 ft	1305150	36.84		-0.10	65.02		0.03	93.05		0.08	✓		3.57
WB2 - ½ ft	1305152	36.89		-0.05	65.10		0.12	93.19		0.22	✓		3.57
WB11 - 7 ft	1305153	36.94		0.00	65.06		0.07	93.09		0.12	✓		3.57
WB12 - 7 ft	1305155	36.94		0.00	65.06		0.07	93.05		0.08	✓		3.57
WB10 - 3 ft	1305156	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

WBN Post Cal Test

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44405 Page 1 of 2 Date 04/01/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

Calibrated For: Hydrothermal Compliance
Date of Report: 04/01/2010

Item Description: HOBO WATER PRO
TVA I.D. No.: E44405

Manufacturer: Onset Computer Corporation

Model: H20-001
CLS Instruction No.: 450.01-020

S/N No.. See Attached Sheet

Dispositioned to: CLS Norris Lab
As-Left calibration in tolerance

Standards Used Log

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	12/30/2008	12/30/2009
906534	Burns Engineering 12001 PRT	01/12/2009	01/12/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS

Calibrated By: Debbie Hansen
Approved By: Randy Cooper
Date Approved: 4/26/10

TENNESSEE VALLEY AUTHORITY
CENTRAL LABORATORIES SERVICES
400 W. Summit Hill Drive, Mail Stop SPB BA-K
Knoxville, Tennessee 37902
Phone: (865) 632-2304 Fax: (865) 632-4996

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F Accuracy ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.939			BATH TEMP 64.983			BATH TEMP 92.970			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR	Limits 0.40 deg F -0.40 deg F		OBSVD ERROR			
WB3 - ½ ft	1305159	37.08		0.14	65.19		0.20	93.19		0.22	✓		3.60
WB7 - 3 ft	1305160	36.94		0.00	65.10		0.12	93.09		0.12	✓		3.57
WB6 - 5 ft	1305161	36.94		0.00	65.10		0.12	93.09		0.12	✓		3.57
WB5 - 3 ft	1305164	36.94		0.00	65.10		0.12	93.14		0.17	✓		3.57
WB4 - ½ ft	1305168	36.94		0.00	65.06		0.08	93.09		0.12	✓		3.57
WB8 - 5 ft	1305174	37.04		0.10	65.19		0.20	93.19		0.22	✓		3.57
WB11 - 3 ft	1305176	37.08		0.14	65.27		0.29	93.33		0.36	✓		3.57
WB1 - 5 ft	1305177	36.94		0.00	65.02		0.03	93.00		0.03	✓		3.57

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

KBN Post Cal Test

Post-Survey Calibrations (Continued)

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 *Phone: (865) 632-2304 Fax: (865) 632-4996*	ID E44406 Page 1 of 2 Date 04/01/2010

METEOROLOGICAL MONITORING INSTRUMENTATION
REPORT OF CALIBRATION

QA RECORD

Calibrated For: Hydrothermal Compliance

Date of Report: 04/01/2010

Item Description: HOBO WATER PRO

TVA I.D. No.: E44406

Manufacturer: Onset Computer Corporation

Model: H20-001

CLS Instruction No.: 450.01-020

S/N No.: See Attached Sheet

Dispositioned to: CLS Norris Lab

As-Left calibration in tolerance

Standards Used Log:

I.D. No.	Description	Calibration Date	Calibration Due Date
906527	Azonix A1011-RS-XX Therm/Ohmmeter	12/30/2008	12/30/2009
906534	Burns Engineering 12001 PRT	01/12/2009	01/12/2010

This is to certify that all instrumentation, testing methods and personnel used comply with the requirements of the Central Laboratories Services (CLS) Quality Assurance Program which is designed to meet the requirements of ISO/IEC 17025, 10 CFR 50 Appendix B and ANSI N45.2-1971, and ANSI/NCSL Z540-1-1994. Standards used are traceable to the National Institute of Standards and Technology (NIST), officially recognized agencies, commercially accepted practices or natural physical constants. This report shall not be reproduced except in full, without the written approval of CLS.

Calibrated By: Debbie Howell

Approved By: Randy Lyon

Date Approved: 4/26/10

TENNESSEE VALLEY AUTHORITY **CENTRAL LABORATORIES SERVICES** 400 W. Summit Hill Drive, Mail Stop SPB BA-K Knoxville, Tennessee 37902 Phone: (865) 632-2304 Fax: (865) 632-4996	ID E44406 Page 2 of 2 Date 04/01/2010

WATER TEMPERATURE HOBO WATER PRO CALIBRATION RECORD

Range 0 to 100°F **Accuracy** ±0.4°F

		37 deg F			65 degF			93 degF					
		BATH TEMP 36.939			BATH TEMP 64.983			BATH TEMP 92.970			P A S S	F A I L	Battery L I F E
	Sensor Serial Number	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR	Limits 0.40 -0.40	deg F deg F	OBSVD ERROR			
WB10 - 7 ft	1305179	37.08		0.14	65.19		0.20	93.23		0.26	✓		3.57
WB5 - 7 ft	1305182	36.94		0.00	65.06		0.08	93.09		0.12	✓		3.60

SENSOR TYPE: HOBO Water Temp Pro H20-001

Remarks These Instruments are submerged in water for a long period of time and no calibration label will be attached.

The current calibration report will be in the Instrument Log.

1305180 is an extra Hobo put into this calibration. Was not used at WBN.

APPENDIX B

WBN Outfall 113 NPDES Compliance Parameters

- Current Instantaneous Upstream Temperature:

  Tu_i (measured at EDS Station 30 by the first sensor below a depth of 5 feet)

- Current 1-Hour Average Upstream Temperature:

$$Tul_i = \frac{Tu_i + Tu_{i-1} + Tu_{i-2} + Tu_{i-3} + Tu_{i-4}}{5},$$

  where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of Tu

- Current Instantaneous Downstream Temperature:

$$Td_i = \frac{Td3_i + Td5_i + Td7_i}{3},$$

  where $Td3_i$, $Td5_i$, and $Td7_i$ denote the current measurements of river temperature at the downstream end of the mixing zone at water depths 3 feet, 5 feet, and 7 feet, respectively

- Current 1-Hour Average Downstream Temperature:

$$Tdl_i = \frac{Td_i + Td_{i-1} + Td_{i-2} + Td_{i-3} + Td_{i-4}}{5},$$

  where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of Td

- Current Instantaneous Temperature Rise:

$$\Delta T_i = Td_i - Tu_i$$

- Current 1-Hour Average Temperature Rise:

$$\Delta Tl_i = \frac{\Delta T_i + \Delta T_{i-1} + \Delta T_{i-2} + \Delta T_{i-3} + \Delta T_{i-4}}{5},$$

where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of ΔT

- Current Temperature Rate-of-Change:

$$TROC_i = \frac{Td_i - Td_{i-4}}{1\,\text{hour}},$$

- Current 1-Hour Average Temperature Rate-of-Change:

$$TROCl_i = \frac{TROC_i + TROC_{i-1} + TROC_{i-2} + TROC_{i-3} + TROC_{i-4}}{5}$$

where the subscripts i, i-1, i-2, i-3, and i-4 denote the current and previous four 15-minute (0.25 hour) values of TROC