# Texas Commission on Environmental Quality

*Protecting Texas by Reducing and Preventing Pollution*

May 8, 2024

Richard E. Leggett
Hach Company
5600 Lindberg Drive
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Subject: Clarification for the Use of an Alternative Technology to Monitor the Turbidity in Drinking Water Produced by Membrane Units at Public Water Systems in Texas, Hach TU5300 Turbidimeter

Dear Mr. Leggett:

On January 9, 2023, the Texas Commission on Environmental Quality (TCEQ) received your email of the same date, requesting the approval to use an alternative membrane turbidity monitor method to the Hach FilterTrak Method 10133 specified in Title 30 of the Texas Administrative Code (30 TAC) §290.42(g)(3)(C) and 30 TAC §290.111(f)(3)(B) for individual filter effluent turbidity measurements from membrane units provided for pathogen removal. The request is for the use of the following laser turbidimeter manufactured by the Hach Company (Hach), which does not utilize Hach FilterTrak (FT) Method 10133:

- Hach TU5300 sc

The method for the Hach TU5300 sc turbidimeter, the Hach TU5300 sc instrument manual, test site data and a validation study report submitted to the Environmental Protection Agency (EPA) for the approval of alternative test procedures for the analysis of contaminants under the Safe Drinking Water Act were reviewed by the TCEQ to determine the suitability of the Hach TU5300 sc for low Nephelometric Turbidity Unit (NTU) membrane applications. The TCEQ review notes that the Federal Register, Vol. 81, No. 138, Thursday, July 19, 2016, Rules and Regulations, contains EPA approval for the Hach TU5300 sc turbidimetric method (Hach Method 10258). The TCEQ evaluated the information submitted by Hach to consider the use of the Hach turbidity measurement method as an alternative membrane turbidity monitor method to the Hach FT Method 10133.

Based on the TCEQ review of the supporting information submitted by Hach, the proposed Hach method and turbidimeter described below **are approved** by the TCEQ as an alternative membrane turbidity monitor method and technology for individual filter effluent turbidity measurements from membrane units provided for pathogen removal, as required by 30 TAC §290.42(g)(3)(C) and §290.111(f)(3)(B). A public water system (PWS) **will not be required** to submit an exception request to the TCEQ Technical Review and Oversight Team for the use of the TCEQ-approved Hach method and turbidimeter listed below for membrane units provided for pathogen removal:

- The Hach Method 10258, Revision 1.0, January 2016, using the Hach TU5300 sc (laser) turbidimeter.
- The Hach Method 10258, Revision 2.0, March 2018, using the Hach TU5300 sc (laser) turbidimeter.

**Site Specific Design, Operation, Maintenance and Reporting Requirements**

The TCEQ has determined that to satisfy the intent of 30 TAC §290.42(g)(3)(C) and §290.111(f)(3)(B), PWS's that utilize a TCEQ-approved Hach turbidimeter will be required to meet TCEQ's rules to use an alternative membrane-turbidity-monitor. The following requirements apply to the use of a Hach TU5300 sc turbidimeter used by a Texas PWS to meet the indirect integrity monitoring requirements for individual filter effluent turbidity measurements from membrane units provided for pathogen removal stated in 30 TAC §290.42(g)(3)(C) and §290.111(f)(3)(B):

- This TCEQ alternative membrane-turbidity-monitor method approval applies only to the Hach methods and turbidimeter stated in this approval letter. The approval does not apply to future revisions of the Hach method and does not apply any design changes to the TU5300 sc turbidimeter;
- Accuracy of an alternative turbidity method turbidimeter must be verified once every seven (7) days, as required by 30 TAC §290.46(s)(2)(B)(iv) and *TCEQ Regulatory Guidance (RG) document 211 (RG-211), Monthly Testing and Reporting at Surface Water Treatment Plants, Section 7.2 Calibrating Instruments and Other Equipment* (Enclosure 1);
- Calibration of the alternative turbidity method turbidimeter must be performed once every ninety (90) days, as required in 30 TAC §290.46(s)(2)(B)(iii), and must meet Quality Control Sample (QCS) criteria specified in the vendor methods;
- Records of calibrations and verifications must be maintained onsite by a PWS for a period of at least three (3) years and be available for TCEQ staff to review upon request as required by 30 TAC §290.46(f)(3)(B)(iv);
- Individual Filter Effluent (IFE) readings must be maintained by a PWS for a period of at least five (5) years and be available for TCEQ staff to review upon request as required by 30 TAC §290.46(f)(3)(C)(iv); and
- Records of a PWS's turbidity monitoring data must be recorded in the PWS Monthly Operating Reports (MOR) and a PWS is required to keep MORs onsite for ten (10) years, in accordance with 30 TAC §290.46(f)(3)(E)(i). MORs are required to be available for TCEQ staff to review upon request.

**Basis for Approving the Request**

Calibration options specified in 30 TAC §290.46(s)(2)(B)(iv) allow for the use of a comparison method to verify the accuracy of an on-line turbidimeter. Guidance for the comparison method in 30 TAC §290.46(s)(2)(B)(iv) is detailed in Section 7.2 of RG–211. RG–211 provides a method for comparing on-line turbidimeters with bench top turbidimeters but does not provide criteria for comparing on-line turbidimeters in use on membrane units with other on-line turbidimeters. The TCEQ used the RG-211 comparison criteria as the basis for determining comparison criteria when the instruments being compared are on-line turbidimeters for use on membrane systems provided for pathogen removal. For the studies summarized in this letter, the criteria in RG–211 was adjusted to account for the low turbidity levels found in water treated by membrane units and the low regulatory turbidity trigger levels set by the EPA and TCEQ (see Figure 1).

Figure 1: Comparison Criteria used to Analyze Alternative Turbidity Methods for Individual Filter Effluent Turbidity Measurements from Membrane Units Provided for Pathogen Removal

| NTU* Range | Requirement |
|---|---|
| ≤1.0 NTU | On-line turbidimeter reading cannot differ by more than 0.05 NTU from a reference turbidimeter reading (±0.05 NTU difference). |
| >1.0 NTU | On-line turbidimeter reading cannot differ by more than 10% from a reference turbidimeter reading (±10% difference). |

*Nephelometric Turbidity Unit

The decision to approve this turbidimeter for use by a Texas PWS for individual filter effluent turbidity measurements from membrane units provided for pathogen removal was based on the following substantiated documentation. This documentation was used to determine if the Hach TU5300 sc turbidimeter generated results that are comparable to a Hach FT 660 turbidimeter.

- The TCEQ reviewed the following documentation for the TU5300 sc turbidimeter:
    - The Hach Method 10258, Determination of Turbidity by 360˚ Nephelometry, Revision 1.0, January 2016, which is the applicable method for the Hach TU5300 sc turbidimeter.
    - The Hach Method 10258, Determination of Turbidity by 360˚ Nephelometry, Revision 2.0, March 2018, which is the applicable method for the Hach TU5300 sc turbidimeter.
    - The Federal Register, Vol. 81, No. 138, Tuesday, July 19, 2016, where the Hach 10258 method is approved by the EPA as "equally effective as the approved Hach FilterTrak Method 10133."
    - The Hach TU5300 sc Basic User Manual, Edition 6, August 2021 (Hach Doc 023.97.90501). The manual contains specifications, operation details, calibration, and calibration verification instructions for the Hach TU5300 sc turbidimeter.
    - Report of Hach Method 10258, Measurement of Turbidity in Drinking Water by 360 Degree Nephelometry, December 5, 2014. This is the validation study submitted by Hach to the EPA, which summarizes results obtained from the comparison of a Hach TU series turbidimeter with a turbidimeter using the EPA approved Hach Filter Trak Method 10133. The Federal Register, Vol. 81, No. 138, Tuesday, July 19, 2016, Rules and Regulations document denotes the Hach Company 2014 validation study report as the source of the information used to base the EPA approval of the Hach 10258 method as "equally effective as the approved Hach FilterTrak Method 10133." This report contains response summary graphs which display data comparison of each turbidimeter in a study and are included in the review of the TU5300 sc turbidimeter due to both turbidimeters using Hach Method 10258. In addition, the report includes appendices which contain:
        - Hach Method 10133;
        - Hach Method 10258;
        - Proof of Concept Results and Validation Study Plan, Draft Study Plan for the Validation of Hach Method 10258, Determination of Turbidity in Water Using 360° Nephelometry;
        - Test Stand Fluidics Diagram: This diagram denotes how the matrix spike solution is delivered to the turbidimeters used in comparison testing;
        - Validation Study Standard Operating Procedure, Standard Operating Procedure for the Validation Study of Hach Method 10258, which contains photographic instructions of the procedure used to perform the comparison testing; and
        - Log Sheets: These are the raw data sheets used to collect information during testing, such as standard lot numbers and turbidimeter models / serial numbers.

- Mr. Richard Leggett of the Hach Company, submitted the following information for the TU5300 sc turbidimeter:
        - A description which detailed that the Report of Hach Method 10258, Measurement of Turbidity in Drinking Water by 360 Degree Nephelometry, December 5, 2014 (validation study), which stated that the TU5 turbidimeter in the study is the current TU5400 sc turbidimeter. The description also noted that a TU5400 sc turbidimeter was also configured to replicate a

TU5300 sc turbidimeter during the validation, meaning that the calibration and verification information performed for the 2014 validation study applies to the TU5300 sc request.

- Matrix Spike Data: This is the test site comparison raw data which is presented in a series of tables representing three NTU levels of turbidity data. The comparison data is derived from testing which was performed at seven (7) facilities. Due to the request to use an alternative membrane turbidity monitor method and technology for individual filter effluent turbidity measurements from membrane units provided for pathogen removal, only comparison data from the following facilities using membrane filtration was reviewed by the TCEQ:
  - Facility 1M: Located in Dusseldorf, Germany;
  - Facility 2M: Located in southeast Netherlands;
  - Facility 3M: Located in Westphalia, Germany; and
  - Facility 5M: Larimer County, west of Loviland, Colorado; and
  - Facility 7M: Adams County, east of Bighton, Colorado.

  Please note that the TCEQ did not use the Facility 1M: Dusseldorf, Germany data in its assessment due to differences in the study protocol.

  The test site data includes the following:
  - Quality assurance information, to include standard traceability information, and analytical results for calibration verification and quality control standards; and
  - Spike recovery comparisons at three different levels between a Hach TU5300 sc and a Hach FT 660 turbidimeter.

**Facility 2M**: The results of the tests conducted at the Facility 2M water treatment plant are summarized in Tables 1 and 2. The data included a total of 1098 measurements recorded using primary standards to create solutions containing 0.00141 and 0.09361 NTU (calculated turbidity concentrations).

Table 1: Facility 2M Comparison of 0.00141 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.00141 NTU Spike | 0.00141 NTU Range of %Recovery | %Difference from Hach FT 660 (AVG) | Minimum %Difference from Hach FT 660 | Maximum %Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.00114 NTU | 53.1 – 92.6% or 0.00075 – 0.00131 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.00119 NTU | 71.0 – 95.0% or 0.00100 – 0.00134 NTU | 4.92% or 0.00098 NTU | 0.00% or 0.00000 NTU | 23.7% or 0.00047 NTU |

Table 2: Facility 2M Comparison of 0.09361 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.09361 NTU Standard | 0.09361 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.10314 NTU | 103.8 – 116.8% or 0.09717 – 0.10934 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.10037 NTU | 101.3 – 113.0% or 0.09485 – 0.10576 NTU | 1.36% or 0.00277 NTU | 0.09% or 0.00017 NTU | 2.02% or 0.00426 NTU |

The spike recovery comparisons at 0.00141 and 0.09361 NTU demonstrate that at turbidity levels below 0.15 NTU, the Hach TU5300 sc turbidimeter **produces comparable results** to a Hach FT 660 turbidimeter. The maximum NTU difference documented in the 0.00141 and 0.09361 NTU comparisons is 0.00426 NTU, which is well below the 0.05 NTU turbidimetric comparison criteria stated in Figure 1 for this study. Additionally, the review of the study notes that %recoveries outside of 90 – 110% where obtained in the 0.00141 and 0.09361 NTU comparisons, with differences that meet the comparison criteria stated in Figure 1 for results <1.0 NTU.

Table 3: Facility 2M Comparison of 0.49174 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.49174 NTU Standard | 0.49174 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.50306 NTU | 96.6 – 108.7% or 0.47500 – 0.0.53437 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.49025 NTU | 94.9 – 110.0% or 0.46641 – 0.54092 NTU | 1.49% or 0.01486 NTU | 0.016% or 0.00015 NTU | 4.55% or 0.04625 NTU |

The 0.500 NTU comparison study detailed in Table 3 is greater than 0.15 NTU, thus the study was evaluated using the ±10% calibration verification standard criteria detailed in the Hach 10258 Methods. The Hach TU5300 sc readings were also compared to their respective Hach FT 660 readings using the Figure 1 study criteria of ±0.05 NTU difference for readings less than 1.04 (≤1.0) NTU.

- All of the Hach TU5300 sc turbidity readings yielded differences of less than 0.05 NTU from their respective Hach FT 660 readings and only three of the 610 readings evaluated by the TCEQ was outside of the ±10% calibration verification standard criteria detailed in the Hach 10258 Methods.

The TCEQ notes that while RG-211 contains a provision which allows for the use of a laboratory-based comparison method to verify the accuracy of an online turbidimeter, none of the Hach comparison studies included the comparison of an on-line turbidimeter to a calibrated benchtop turbidimeter. Verification with secondary standards is also acceptable and was performed for all of the comparison studies submitted by Hach, as documented in Tables 4, 8 12, and 16.

Table 4: Facility 2M Quality Control Samples

| Day | Verification Standard | Hach TU5300 sc | Hach FT 660 |
|---|---|---|---|
| Day 1 | 1 NTU | 0.993 NTU | |
| | 10 NTU | 9.85 NTU | |
| | 20 NTU | 19.8 NTU | |
| | 0.807 NTU | | 0.783 NTU |
| Day 2 | 10 NTU | 9.99 NTU | |
| | 0.807 NTU | | 0.873 NTU |
| Day 3 | 10 NTU | 9.83 NTU | |
| | 0.82611 NTU | | 0.822 NTU |
| Day 4 | 10 NTU | 9.93 NTU | |
| | 0.82611 NTU | | 0.9138 NTU |

In addition, the following was noted regarding the quality control sample (QCS) analyses detailed in Table 4:

- The Hach FT 660 turbidimeter was factory calibrated and verified prior to comparison studies utilizing the Hach Stablcal standard listed in Table 4;
- The Hach TU5300 sc turbidimeter was factory calibrated and verified prior to comparison studies utilizing the Hach Stablcal standards listed in Table 4;
- The Hach Stablcal QCS samples are formazin standards prepared by the Hach Company, which certifies all standards and issues a certificate of analysis; and
- The accuracy of the two turbidimeters was verified according to the study criteria of ±10%. All but one of the verification standards, the 0.82611 NTU Stablcal standard for the Hach FT 660 analyzed on Day 4, met the ±10% criteria detailed in the Hach Method. The non-compliant Day 4 verification standard indicates the need to re-calibrate the Hach FT 660 when a verification standard does not meet the QCS sample criteria of ±10%. Verification standard requirements are detailed in 30 TAC §290.46(s)(2)(B)(iv) and apply to on-line instruments used for compliance testing.

**Facility 3M**: The results of the tests conducted at the Facility 3M water treatment plant are summarized in Tables 5 and 6. The data included a total of 2440 measurements recorded using primary standards to create solutions containing 0.00164 and 0.10144 NTU (calculated turbidity concentrations).

Table 5: Facility 3M Comparison of 0.00164 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.00164 NTU Spike | 0.00164 NTU Range of %Recovery | %Difference from Hach FT 660 (AVG) | Minimum %Difference from Hach FT 660 | Maximum %Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.00138 NTU | 67.1 – 105.7% or 0.00110 – 0.00173 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.00137 NTU | 69.6 – 98.1% or 0.01142 – 0.00161 NTU | 1.61% or 0.00006 NTU | 0.00% or 0.00000 NTU | 11.5% or 0.00036 NTU |

Table 6: Facility 3M Comparison of 0.10144 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.10144 NTU Standard | 0.10144 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.10594 NTU | 102.7 – 106.5% or 0.10418 – 0.10802 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.10236 NTU | 99.6 – 102.4% or 0.101023 – 0.10385 NTU | 1.71% or 0.00357 NTU | 1.21% or 0.00252 NTU | 2.31% or 0.00488 NTU |

The spike recovery comparisons at 0.00164 and 0.10144 NTU demonstrate that at turbidity levels below 0.15 NTU, the Hach TU5300 sc turbidimeter **produces comparable results** to a Hach FT 660 turbidimeter. The maximum NTU difference documented in the 0.00164 and 0.10144 NTU comparisons is 0.00488 NTU, which is well below the 0.05 NTU turbidimetric comparison criteria stated in Figure 1 for this study. Additionally, the review of the study notes that %recoveries outside of 90 – 110% were obtained in the 0.00164 NTU comparison, with differences that meet the comparison criteria stated in Figure 1 for results <1.0 NTU. The TCEQ review also notes the downward trend in %Recovery for the 0.00164 NTU spikes, with Spike No. 15 having an average spike recovery of 72.8%. Spike recoveries greater than ±25% can be avoided by a water system establishing standard recovery criteria as well as adhering to the ±0.05 NTU criteria stated in Figure 1 for results <1.0 NTU.

Table 7: Facility 3M Comparison of 0.50101 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.50101 NTU Standard | 0.50101 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.53432 NTU | 105.4 – 107.8% or 0.52813 – 0.54013 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.51546 NTU | 102.1 – 103.7% or 0.51142 – 0.51941 NTU | 1.80% or 0.01886 NTU | 1.42% or 0.01485 NTU | 2.10% or 0.02213 NTU |

The results of the 0.500 NTU comparison study detailed in Table 7 were evaluated using the ±10% calibration verification standard criteria detailed in the Hach 10258 Methods and the Figure 1 study criteria of ±0.05 NTU difference for readings less than 1.04 (≤1.0) NTU.

- All of the Hach TU5300 sc turbidity readings yielded differences of less than 0.05 NTU from their respective Hach FT 660 readings and none of the 610 readings evaluated by the TCEQ were outside of the ±10% calibration verification standard criteria detailed in the Hach 10258 Methods.

Note: The Table 7: Facility 3M Comparison observations also apply to Table 11: Facility 5M Comparison and Table 16: Facility 7M Comparison.

Table 8: Facility 3M Quality Control Samples

| Day | Verification Standard | Hach TU5300 sc | Hach FT 660 |
|---|---|---|---|
| Day 1 | 1 NTU | 0.969 NTU | |
| | 10 NTU | 10.08 NTU | |
| | 20 NTU | 19.64 NTU | |
| | 0.826 NTU | | 0.871 NTU |
| Day 2 | 10 NTU | 10.03 NTU | |
| | 0.826 NTU | | 0.809 NTU |
| Day 3 | 10 NTU | 10.13 NTU | |
| | 0.826 NTU | | 0.810 NTU |
| Day 4 | 10 NTU | 9.81 NTU | |
| | 0.826 NTU | | 0.814 NTU |

In addition, the following was noted regarding the QCS analyses detailed in Table 8:

- The Hach FT 660 turbidimeter was factory calibrated and verified prior to comparisons studies utilizing the Hach Stablcal standard listed in Table 8;
- The Hach TU5300 sc turbidimeter was factory calibrated and verified prior to comparisons studies utilizing the Hach Stablcal standards listed in Table 8;
- The Hach Stablcal QCS samples are formazin standards prepared by the Hach Company, which certifies all standards and issues a certificate of analysis; and
- The accuracy of the two turbidimeters was verified according to the study protocol of ±10% recovery for all verification standards.

Note: The Table 8: Facility 3M QCS analyses observations also apply to Table 12: Facility 5M Quality Control Samples and Table 16: Facility 7M Quality Control Samples.

**Facility 5M**: The results of the tests conducted at the Facility 5M water treatment plant are summarized in Tables 9 and 10. The data included a total of 1952 measurements recorded using primary standards to create solutions containing 0.00143 and 0.09656 NTU (calculated turbidity concentrations).

Table 9: Facility 5M Comparison of 0.00143 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.00143 NTU Spike | 0.00143 NTU Range of %Recovery | %Difference from Hach FT 660 (AVG) | Minimum %Difference from Hach FT 660 | Maximum %Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.00147 NTU | 52.4 – 149.4% or 0.00075 – 0.00214 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.00146 NTU | 71.8 – 137.9% or 0.00103 – 0.00197 NTU | 4.96% or 0.00014 NTU | 0.06% or 0.000001 NTU | 27.2% or 0.00077 NTU |

Table 10: Facility 5M Comparison of 0.09656 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.09656 NTU Standard | 0.09656 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.10886 NTU | 109.1 – 116.7% or 0.10532 – 0.11268 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.10753 NTU | 108.0 – 131.4% or 0.10432 – 0.12690 NTU | 0.84% or 0.00183 NTU | 0.02% or 0.00005 NTU | 8.25% or 0.01933 NTU |

The spike recovery comparisons at 0.00143 and 0.09656 NTU demonstrate that at turbidity levels below 0.15 NTU, the Hach TU5300 sc turbidimeter **produces comparable results** to a Hach FT 660 turbidimeter. The maximum NTU difference documented in the 0.00143 and 0.09656 NTU comparisons is 0.01933 NTU, which is well below the 0.05 NTU turbidimetric comparison criteria stated in Figure 1 for this study. Additionally, the review of the study notes that %recoveries outside of 90 – 110% were obtained in the 0.00143 and 0.09656 NTU comparisons, with differences that meet the comparison criteria stated in Figure 1 for results <1.0 NTU. The TCEQ review also notes that %Recoveries for the 0.00143 NTU spikes can vary by greater than 25%, with Spike No. 18 having an average spike recovery of 138.0%. Spike recoveries greater than 25% can be avoided by a water system establishing standard recovery criteria as well as adhering to the ±0.05 NTU criteria stated in Figure 1 for results <1.0 NTU.

Table 11: Facility 5M Comparison of 0.48865 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.48865 NTU Standard | 0.48865 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.53543 NTU | 106.5 – 110.8% or 0.52052 – 0.54118 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.53030 NTU | 100.1 – 113.9% or 0.48928 – 0.55659 NTU | 0.63% or 0.00672 NTU | 0.00% or 0.00002 NTU | 4.31% or 0.04409 NTU |

The results of the 0.500 NTU comparison study detailed in Table 11 were evaluated using the ±10% calibration verification standard criteria detailed in the Hach 10258 Methods and the Figure 1 study criteria of ±0.05 NTU difference for readings less than 1.04 (≤1.0) NTU.

- All of the Hach TU5300 sc turbidity readings yielded differences of less than 0.05 NTU from their respective Hach FT 660 readings and 13 of the 610 readings evaluated by the TCEQ were outside of the ±10% calibration verification standard criteria detailed in the Hach 10258 Methods.

Table 12: Facility 5M Quality Control Samples

| Day | Verification Standard | Hach TU5300 sc | Hach FT 660 |
|---|---|---|---|
| Day 1 | 1 NTU | 1.09 NTU | |
| | 10 NTU | 10.34 NTU | |
| | 20 NTU | 20.64 NTU | |
| | 0.786 NTU | | 0.851 NTU |
| Day 2 | 10 NTU | 10.31 NTU | |
| | 0.786 NTU | | 0.861 NTU |
| Day 3 | 10 NTU | 10.27 NTU | |
| | 0.786 NTU | | 0.842 NTU |
| Day 4 | 10 NTU | 10.36 NTU | |
| | 0.786 NTU | | 0.852 NTU |

All of the verification standards in Table 12 met the ±10% study protocol criteria.

**Facility 7M**: The results of the tests conducted at the Facility 7M water treatment plant are summarized in Tables 13 and 14. The data included a total of 2440 measurements recorded using primary standards to create solutions containing 0.00151 and 0.09870 NTU (calculated turbidity concentrations).

Table 13: Facility 7M Comparison of 0.00151 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.00151 NTU Spike | 0.00151 NTU Range of %Recovery | %Difference from Hach FT 660 (AVG) | Minimum %Difference from Hach FT 660 | Maximum %Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.00143 NTU | 5.50 – 163.5% or 0.00008 – 0.00247 | n/a | n/a | n/a |
| Hach TU5300 sc | 0.00146 NTU | 2.78 – 223.7% or 0.00004 – 0.00338 NTU | 22.4% or 0.00039 NTU | 0.08% or 0.000002 NTU | 99.9% or 0.00221 NTU |

Table 14: Facility 7M Comparison of 0.09870 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.09870 NTU Standard | 0.09870 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.10612 NTU | 104.7 – 114.3% or 0.10334 – 0.11282 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.10409 NTU | 103.3 – 108.5% or 0.10192 – 0.10714 NTU | 0.97% or 0.00205 NTU | 0.012% or 0.00003 NTU | 3.37% or 0.00736 NTU |

The spike recovery comparisons at 0.00151 and 0.09870 NTU demonstrate that at turbidity levels below 0.15 NTU, the Hach TU5300 sc turbidimeter **produces comparable results** to a Hach FT 660 turbidimeter. The maximum NTU difference documented in the 0.00151 and 0.09870 NTU comparisons is 0.00736 NTU, which is well below the 0.05 NTU turbidimetric comparison criteria stated in Figure 1 for

this study. The review of the study does note that while %recoveries outside of 90 – 110% were obtained in the 0.00151 and 0.09870 NTU comparisons, the maximum difference obtained based on the Range of % Recovery was 0.00736 NTU, which is well below the comparison criteria stated in Figure 1 for result <1.0 NTU. In addition, the 0.00151 NTU study exhibited much more variability than the 1st Level 0.0015 NTU studies for the 2M, 3M, and 5M facilities. Due to the variability, results included in the following categories were excluded from the TCEQ evaluation:

- Matrix spike results which generated a negative matrix spike recovery.

Additionally, the TCEQ review notes the following regarding quality control employed by a PWS for monitoring low level turbidity:

1. A PWS utilizing an on-line turbidimeter for monitoring low level turbidity on a membrane unit provided for pathogen removal should employ analytical and physical quality control verifications to assure that a turbidimeter is functioning within established quality control criteria.
2. The TCEQ recommends that in addition to the criteria specified in Figure 1, a PWS also establish %Recovery criteria for standard checks to assure accuracy of the turbidimeter is also monitored along with a comparison of an on-line turbidimeter to a benchtop unit.
3. Due to results obtained in the 7M comparison study, the TCEQ recommends that a PWS incorporate physical checks into the quality assurance employed to assure that an on-line turbidimeter is functioning within established quality control criteria. The 7M study emphasizes the following:
   - ✓ Persistent variability can occur when an issue such as intermittent background turbidity is occurring; and
   - ✓ Background turbidity can occur but not be evident by performing verifications with a known standard.

   Due to this issue, the TCEQ recommends that a PWS also physically inspect a turbidimeter when negative spike values or variability in %Recovery beyond ±25% occur.

Table 15: Facility 7M Comparison of 0.48080 NTU Calculated Turbidity Concentration from Hach FT 660 and Hach TU5300 sc turbidimeters

| Turbidimeter | Average Result of 0.48080 NTU Standard | 0.48080 NTU Range of % Recovery | %Difference from Hach FT 660 (AVG) | Minimum % Difference from Hach FT 660 | Maximum % Difference from Hach FT 660 |
|---|---|---|---|---|---|
| Hach FT 660 | 0.52394 NTU | 107.8 – 110.1% or 0.51827 – 0.52941 NTU | n/a | n/a | n/a |
| Hach TU5300 sc | 0.51648 NTU | 106.6 – 109.5% or 0.51232 – 0.52649 NTU | 0.72% or 0.00746 NTU | 0.02% or 0.00018 NTU | 1.25% or 0.01300 NTU |

The comparison studies did include a comparison at the 0.500 NTU level, which is detailed in Table 15. The Hach TU5300 sc readings were compared to their respective Hach FT 660 readings using the Figure 1 study criteria of ±0.05 NTU difference for readings less than 1.04 (≤1.0) NTU.

- All of the Hach TU5300 sc turbidity readings yielded differences of less than 0.05 NTU from their respective Hach FT 660 readings and none of the 610 readings evaluated by the TCEQ were outside of the ±10% calibration verification standard criteria detailed in the Hach 10258 Methods.

Table 16: Facility 7M Quality Control Samples

| Day | Verification Standard | Hach TU5300 sc | Hach FT 660 |
|---|---|---|---|
| Day 1 | 1 NTU | 1.02 NTU | |
| | 10 NTU | 10.43 NTU | |
| | 20 NTU | 20.72 NTU | |
| | 0.786 NTU | | 0.852 NTU |
| Day 2 | 10 NTU | 10.48 NTU | |
| | 0.786 NTU | | 0.847 NTU |
| Day 3 | 10 NTU | 10.50 NTU | |
| | 0.786 NTU | | 0.849 NTU |
| Day 4 | 10 NTU | 10.44 NTU | |
| | 0.786 NTU | | 0.862 NTU |
| | 1 NTU | 1.05 NTU | |
| | 20 NTU | 20.68 NTU | |

All of the verification standards in Table 16 met the ±10% study protocol criteria.

**Conclusion**: The comparability studies data indicate that the Hach TU5300 sc turbidimeter is adequate for meeting the requirements in 30 TAC §290.111(f)(2)(D)(v) for reading turbidity levels in the 0.15 NTU range for direct integrity testing of a membrane unit when using Hach Method 10258, Revision 1.0 (January, 2016) and Revision 2.0 (March, 2018).

**Approval for Use in Texas**

Please provide a copy of this letter to each of your Texas PWS customers. This letter is **not approval** of:

- Future revisions to the TCEQ approved Hach methods or design changes to the approved turbidimeter;
- Software updates. If there are software updates that impact the method, this TCEQ approval does not cover future revisions of the TCEQ approved Hach methods;
- The use of an unapproved Hach turbidimeter(s) by a Texas PWS to report regulatory individual filter effluent turbidity data from water produced by a membrane unit used for pathogen removal, or
- Changes to a membrane filtration plant. Prior to initiating changes to a treatment plant, a water system is required to notify the TCEQ of the changes, submit plan and specifications to the TCEQ Plan Review Team, and receive TCEQ approval. Plans and specification documentation (engineering documents and other public water system information) can be submitted directly to the TCEQ Plan Review team at PTRS@tceq.texas.gov.

  Additional information regarding the TCEQ plans and specification process is available on the TCEQ website:

  https://www.tceq.texas.gov/drinkingwater/planrev.html

If you have any questions concerning this letter, or if we can be of additional assistance, please contact Mr. Richard Bosch, at Richard.Bosch@tceq.texas.gov, by telephone at (512) 239-3465, or any member of the Technical Review and Oversight Team at PTRS@tceq.texas.gov.

Sincerely,

Joel Klumpp, Manager
Plan & Technical Review Section
Water Supply Division
Texas Commission on Environmental Quality

JPK/rb

Enclosure 1: *TCEQ Regulatory Guidance (RG) document 211 (RG-211), Monthly Testing and Reporting at Surface Water Treatment Plants, Section 7.2 Calibrating Instruments and Other Equipment*

# Appendix G: Equipment Calibration

## SWTP Calibration Requirements and Procedures

SWTPs are responsible for ensuring the accuracy of data used for monthly compliance reporting. One extremely important way to ensure accuracy is to properly calibrate your instruments and equipment. Proper calibration includes written calibration procedures, acceptance criteria, traceable standards, good record keeping, and corrective action, when necessary.

This document describes the calibration requirements for instruments and equipment used to generate data for monthly reporting. It also provides or references procedures to implement the requirements. In addition to the requirements and procedures described herein, all calibration procedures and acceptance criteria must comply with manufacturer instructions, applicable EPA approved methods of analysis, and other standards, as applicable.

> The calibration requirements and acceptance criteria specified in this document reflect the minimum requirements defined by 30 TAC Chapter 290, Subchapter F, Section 290.46(s). More stringent or detailed requirements may be specified in the analytical methods, manufacturer instrument instructions, QA Standards, SOPs, etc. To ensure you meet all applicable requirements, follow the most stringent requirements.

### *Flowmeters*

Flowmeters and other flow monitoring devices must be calibrated at least once every 12 months. The flowmeters may be checked using a pitot tube, a calibrated ultrasonic flowmeter, or similar calibration device. The accuracy of the meters may also be checked by filling or draining a known volume with water into (or from) a basin. If the meter does not read within the accuracy range specified by the manufacturer, recalibrate the unit, or implement corrective action.

### *pH Meters*

#### Benchtop pH Meters

Bench top pH meters must be calibrated at least once each day according to manufacturer specifications. Each time you run a batch of samples you must verify the calibration with at least one buffer. If the pH meter does not accurately read the buffer, per the manufacturer instructions or analytical method, recalibrate the unit or implement other corrective action.

## Online pH Meters

Online pH meters must be calibrated at least once every 30 days. The calibration must also be verified at least once each week with one of the following:

- Primary standard.
- Comparing the results from the online unit with the results from a properly calibrated benchtop unit.

If necessary, recalibrate the unit with primary standards or implement corrective action.

# *Turbidity Meters*

## Benchtop Turbidity Meters

Benchtop turbidity meters must be calibrated using primary standards at least once every 3 months. Each time you calibrate your meter with primary standards, you must standardize your secondary standards again.

Each time you run batch samples, you must verify the calibration with secondary standards. If the unit does not produce an acceptable reading, per the analytical manufacturer's instructions or analytical method, then recalibrate with primary standards or implement corrective action.

## Online Turbidity Meters

Once every three months, you must calibrate online turbidity meters using primary standards.

Once every week you must verify the calibration of online turbidity meters with one of the following:

- Primary standards.
- Secondary standards.
- Manufacturer proprietary confirmation device.
- Comparing the results with a properly calibrated benchtop turbidity meter. (See next section.)

Regardless of which method you use to verify the calibration of the online turbidity meter, you must recalibrate the unit using primary standards if the unit does not provide an acceptable reading.

### *Calibration Verification Procedure*

To verify the calibration of an online turbidity meter against a bench top meter, we recommend the following procedure:

1. Ensure your benchtop turbidity meter is properly calibrated by verifying it against a primary or secondary standard.
2. Record a turbidity reading shown on the online turbidity meter.

3. Immediately collect a sample from the inlet or outlet of the online turbidity meter.
4. Measure and record the turbidity of the sample from the online turbidity meter with the benchtop turbidity meter.
5. Compare the turbidity readings from the two instruments. If the values differ by 0.10 NTU or less, a complete calibration of the online meter is not required.
6. If the values differ by more than 0.10 NTU, follow the manufacturer's instructions and recalibrate both the online monitor using primary turbidity standards.
7. Repeat Steps 1–6. If the values still differ by more than 0.10 NTU, implement corrective action which may include contacting the instrument manufacturer for further instructions.
8. If a continuous recorder is used, compare the value reported by the recorder with the value reported by the monitor. No adjustment of the recorder is needed if the values differ by 0.05 NTU or less.
9. Adjust the recorder, if the values differ by more than 0.05 NTU.

*Note*: If the calibration is conducted when turbidity levels are above 1.0 NTU, you may accept differences of up to 10% when comparing the results of two turbidity meters and of up to 5% when comparing the recorder results with that of the turbidity meter.

## *Chemical Disinfectant Residual Analyzers*

### Manual Method

If you are using a manual method to test for chemical residuals, you must verify the instrument's calibration at least once every 90 days using a solution with a known concentration. If the instrument or method does not produce an accurate reading (i.e., within 15% of the expected value) you must recalibrate the instrument or take other corrective actions.

### Continuous Monitoring Method

If you are using a continuous chemical analyzer, you must verify the instrument's accuracy at least once every 7 days using one of the following:

- Solution of known concentration.
- Comparing the results with a calibrated benchtop instrument (see next subsection).

#### *Calibration Verification Procedure*

If you compare the results with a calibrated bench top instrument, we recommend the following procedure:

1. Ensure your benchtop meter is properly calibrated by verifying its accuracy against a solution of known concentration.