



Methods for Chemical Analysis of Water and Wastes



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**METHODS FOR CHEMICAL ANALYSIS
OF WATER AND WASTES**

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**ENVIRONMENTAL MONITORING AND SUPPORT
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U S ENVIRONMENTAL PROTECTION AGENCY
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FOREWORD

The accomplishment of our objective in protecting the environment requires a reliable assessment of the present condition and a determination of the effectiveness of corrective measures. Decisions which must be made on the need for pollution abatement and the most efficient means of achieving environmental quality depend upon the availability of sound data. Test procedures for measurement of the presence and concentration of substances hazardous to human health as well as an evaluation of the quality of the environment are essential to satisfactory decision-making.

This manual of chemical methods was prepared by the staff of the Environmental Monitoring and Support Laboratory of the Environmental Research Laboratory, Cincinnati to provide procedures for monitoring water supplies, waste discharges, and the quality of ambient waters. These test methods have been carefully selected to meet the needs of Federal Legislation and to provide guidance to laboratories engaged in protecting human health and the aquatic environment. The contributions and counsel of scientists in other EPA laboratories are gratefully acknowledged.

Test procedures contained herein, that are approved for water and waste monitoring under the Safe Drinking Water Act (SDWA) and the National Pollutant Discharge Elimination System (NPDES), of PL 92-500 are so indicated at the bottom of each title page. These approved methods are also recommended for ambient monitoring needs of Section 106 and 208 of PL 92-500. Methods without this stated approval are presented for information only. Correspondence on these methods is invited.



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ABSTRACT

This manual provides test procedures approved for the monitoring of water supplies, waste discharges, and ambient waters, under the Safe Drinking Water Act, the National Pollutant Discharge Elimination System, and Ambient Monitoring Requirements of Section 106 and 208 of Public Law 92-500. The test methods have been selected to meet the needs of federal legislation and to provide guidance to laboratories engaged in the protection of human health and the aquatic environment.

TURBIDITY
Method 180.1 (Nephelometric)

STORET NO. 00076

- 1 Scope and Application
 - 1 1 This method is applicable to drinking, surface, and saline waters in the range of turbidity from 0 to 40 nephelometric turbidity units (NTU) Higher values may be obtained with dilution of the sample
NOTE 1: NTU's are considered comparable to the previously reported Formazin Turbidity Units (FTU) and Jackson Turbidity Units (JTU)
- 2 Summary of Method
 - 2.1 The method is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension The higher the intensity of scattered light, the higher the turbidity Readings, in NTU's, are made in a nephelometer designed according to specifications outlined in Apparatus A standard suspension of Formazin, prepared under closely defined conditions, is used to calibrate the instrument
 - 2 1 1 Formazin polymer is used as the turbidity reference suspension for water because it is more reproducible than other types of standards previously used for turbidity standards
 - 2 1 2 A commercially available polymer standard is also approved for use for the National Interim Primary Drinking Water Regulations This standard is identified as AMCO-AEPA-1 available from Amco Standard International, Inc
- 3 Sample Handling and Preservation
 - 3 1 Preservation of the sample is not practical, analysis should begin as soon as possible Refrigeration or icing to 4°C, to minimize microbiological decomposition of solids, is recommended
- 4 Interferences
 - 4 1 The presence of floating debris and coarse sediments which settle out rapidly will give low readings Finely divided air bubbles will affect the results in a positive manner
 - 4 2 The presence of true color, that is the color of water which is due to dissolved substances which absorb light, will cause turbidities to be low, although this effect is generally not significant with finished waters
- 5 Apparatus
 - 5 1 The turbidimeter shall consist of a nephelometer with light source for illuminating the sample and one or more photo-electric detectors with a readout device to indicate the intensity of light scattered at right angles to the path of the incident light The turbidimeter should be so designed that little stray light reaches the detector in the

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absence of turbidity and should be free from significant drift after a short warm-up period

- 5 2 The sensitivity of the instrument should permit detection of a turbidity difference of 0.02 unit or less in waters having turbidities less than 1 unit. The instrument should measure from 0 to 40 units turbidity. Several ranges will be necessary to obtain both adequate coverage and sufficient sensitivity for low turbidities.
- 5 3 The sample tubes to be used with the available instrument must be of clear, colorless glass. They should be kept scrupulously clean, both inside and out, and discarded when they become scratched or etched. They must not be handled at all where the light strikes them, but should be provided with sufficient extra length, or with a protective case, so that they may be handled.
- 5 4 Differences in physical design of turbidimeters will cause differences in measured values for turbidity even though the same suspension is used for calibration. To minimize such differences, the following design criteria should be observed:
 - 5 4 1 Light source Tungsten lamp operated at a color temperature between 2200–3000°K.
 - 5 4 2 Distance traversed by incident light and scattered light within the sample tube. Total not to exceed 10 cm.
 - 5 4 3 Detector Centered at 90° to the incident light path and not to exceed ±30° from 90°. The Detector, and filter system if used, shall have a spectral peak response between 400 and 600nm.
- 5 5 The Hach Turbidimeter, Model 2100 and 2100 A, is in wide use and has been found to be reliable, however, other instruments meeting the above design criteria are acceptable.

6 Reagents

- 6.1 Turbidity-free water Pass distilled water through a 0.45 μ pore size membrane filter if such filtered water shows a lower turbidity than the distilled water.
- 6 2 Stock formazin turbidity suspension
 - Solution 1 Dissolve 1.00 g hydrazine sulfate, (NH₂)₂•H₂SO₄, in distilled water and dilute to 100 ml in a volumetric flask.
 - Solution 2 Dissolve 10.00 g hexamethylenetetramine in distilled water and dilute to 100 ml in a volumetric flask.In a 100 ml volumetric flask, mix 5.0 ml Solution 1 with 5.0 ml Solution 2. Allow to stand 24 hours at 25 ±3°C, then dilute to the mark and mix.
- 6 3 Standard formazin turbidity suspension Dilute 10.00 ml stock turbidity suspension to 100 ml with turbidity-free water. The turbidity of this suspension is defined as 40 units. Dilute portions of the standard turbidity suspension with turbidity-free water as required.
 - 6 3 1 A new stock turbidity suspension should be prepared each month. The standard turbidity suspension and dilute turbidity standards should be prepared weekly by dilution of the stock turbidity suspension.
- 6 4 The AMCO-AEPA-1 standard as supplied requires no preparation or dilution prior to use.

7 Procedure

7 1 Turbidimeter calibration The manufacturer's operating instructions should be followed Measure standards on the turbidimeter covering the range of interest If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales At least one standard should be run in each instrument range to be used Some instruments permit adjustments of sensitivity so that scale values will correspond to turbidities Reliance on a manufacturer's solid scattering standard for setting overall instrument sensitivity for all ranges is not an acceptable practice unless the turbidimeter has been shown to be free of drift on all ranges If a pre-calibrated scale is not supplied, then calibration curves should be prepared for each range of the instrument

7 2 Turbidities less than 40 units Shake the sample to thoroughly disperse the solids Wait until air bubbles disappear then pour the sample into the turbidimeter tube Read the turbidity directly from the instrument scale or from the appropriate calibration curve

7 3 Turbidities exceeding 40 units Dilute the sample with one or more volumes of turbidity-free water until the turbidity falls below 40 units The turbidity of the original sample is then computed from the turbidity of the diluted sample and the dilution factor For example, if 5 volumes of turbidity-free water were added to 1 volume of sample, and the diluted sample showed a turbidity of 30 units, then the turbidity of the original sample was 180 units

7 3 1 The Hach Turbidimeters, Models 2100 and 2100A, are equipped with 5 separate scales 0-0.2, 0-1.0, 0-100, and 0-1000 NTU The upper scales are to be used only as indicators of required dilution volumes to reduce readings to less than 40 NTU
NOTE 2: Comparative work performed in the MDQAR Laboratory indicates a progressive error on sample turbidities in excess of 40 units

8 Calculation

8 1 Multiply sample readings by appropriate dilution to obtain final reading

8 2 Report results as follows

<u>NTU</u>	<u>Record to Nearest</u>
0.0 - 1.0	0.05
1 - 10	0.1
10 - 40	1
40 - 100	5
100 - 400	10
400 - 1000	50
> 1000	100

9 Precision and Accuracy

9 1 In a single laboratory (EMSL), using surface water samples at levels of 26, 41, 75 and 180 NTU, the standard deviations were ± 0.60 , ± 0.94 , ± 1.2 and ± 4.7 units, respectively

9 2 Accuracy data are not available at this time

Bibliography

- 1 Annual Book of ASTM Standards, Part 31, "Water", Standard D1889-71, p 223 (1976)
2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 132, Method 214A, (1975)