MINISTRY OF NATURAL RESOURCES AND ENVIRONMENT

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CIRCULAR

ON ENVIRONMENTAL MONITORING TECHNIQUES

THE MINISTER OF NATURAL RESOURCES AND ENVIRONMENT

Pursuant to the Law on Environmental Protection dated June 23, 2014;

Pursuant to the Government's Decree No. 36/2017/ND-CP dated April 04, 2017 on functions, tasks, rights and organizational structure of the Ministry of Natural Resources and Environment;

Pursuant to the Government's Decree No. 127/2014/ND-CP dated December 31, 2014 on conditions applicable to environmental monitoring service providers;

Pursuant to the Government's Decree No. 38/2015/ND-CP dated April 04, 2017 on management of waste and discarded materials;

At the request of the Director General of the Vietnam Environment Administration, Director General of the Department of Science and Technology and Director General of the Department of Legal Affairs;

The Minister of Natural Resources and Environment hereby adopts a Circular on environmental monitoring techniques.

Chapter I

GENERAL PROVISIONS

Article 1. Scope

This Circular provides for environmental monitoring techniques, including:

1. Techniques for monitoring environmental components on a periodic basis, including: outdoor air, noise and vibration; inland surface water; groundwater; seawater; rain water; wastewater; exhaust gases; soil; sediment.

2. Quality assurance and quality control in periodic environmental monitoring.

3. Basic requirements and technical specifications of automatic and continuous wastewater and exhaust gas monitoring systems.

4. Requirements for receipt, transfer and management of data of automatic and continuous environmental monitoring system.

5. Management and use of environmental monitoring equipment.

Article 2. Regulated entities

1. This Circular shall apply to organizations and individuals involved in environmental monitoring.

2. Chapter II of this Circular shall not apply to environmental monitoring for offshore oil and gas operations.

Article 3. Rules for application of environmental monitoring methods

1. The application of environmental monitoring methods shall be compliant with the methods specified in this Circular and applicable national technical regulations on environment.

2. In the cases where international, regional or foreign methods and standards are yet to be specified in this Circular, the ones with equal or higher accuracy shall be considered to be

used.

3. In the cases where the environmental monitoring methods specified in this Circular are amended or replaced by new methods, new methods shall apply.

Article 4. Definitions and abbreviations

For the purposes of this Circular, the terms and abbreviations below shall be construed as follows:

1. “quality assurance” (abbreviated to QA) in environmental monitoring is an integrated system of management and technical activities involving an organization to ensure the environmental monitoring satisfies the defined standards.

2. “quality control” (abbreviated to QC) in environmental monitoring is the implementation of measures to evaluate, monitor and promptly adjust to achieve the precision and accuracy of the measurements to ensure the environmental monitoring satisfies the defined standards.

3. “quality control sample” (hereinafter collectively referred to as “QC sample”) is a real sample or sample made from the standard used to control the quality of field monitoring and laboratory environmental analysis.

4. “precision” is the closeness of agreement between independent test results obtained under stipulated conditions.

5. “repeatability” is the precision under repeatability conditions.

6. “reproducibility” is the precision under reproducibility conditions.

7. “accuracy” is the closeness of agreement between a test result and the accepted reference value.

8. “sample batch” is a group of up to 20 field samples, which are processed and analyzed under the same conditions, procedures, methods and time. Each sample batch must consist of QC sample.

9. “field blank sample” is a clean sample material used to control contamination during the field environmental monitoring. The field blank sample is handled, preserved, transported and is sent to the laboratory for analysis as the real sample.

10. “field replicate/duplicate sample” is the two abovementioned samples that are taken from the same source and at the same time, similarly handled, preserved, transported and sent to the same laboratory for analysis. The field replicate/duplicate sample is used to control the error in the field monitoring, laboratory analysis and evaluate the precision of the monitoring results.

11. “trip blank sample” is a clean sample used to control contamination during sample transport. The trip blank sample is transported under the same condition, preserved and sent to the same laboratory for analysis as the real sample.

12. “equipment blank sample” is a clean sample used to control the contamination of the sampling device and evaluate the stability and interference of the device. The equipment blank sample is handled as the real sample with a sampling device, preserved, transported and sent to the same laboratory for analysis as the real sample.

13. “method blank sample” is a clean sample used to control contamination resulting from instruments, chemicals and reference materials during sample analysis. The method blank sample is handled and analyzed as the real sample.

14. “laboratory replicate/duplicate sample” includes more than two or more parts of the same sample, which are analyzed using the same method. The laboratory replicate/duplicate sample is a sample used to evaluate the precision of the analytical results.

15. “reference material” is a material which is sufficiently homogeneous and stable with respect to one or more specified properties, which has been established to be fit for its intended use in a measurement process.

16. “certified reference material” (abbreviated to CRM) is a reference material, accompanied by a certificate, one or more of whose property values are certified by a procedure which establishes traceability to an accurate realization of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence.

17. “laboratory control sample” is a sample that has had a known concentration and derived from a reference material whose concentration is set to be in the same range as that of the calibration curve and is used to inspect the operation of equipment and monitor the analysis.

18. “spike sample/ matrix spike” is a sample that has a known amount of analyte added to the real sample. The spike sample/ matrix spike is prepared and analyzed as the real sample to evaluate the analysis.

19. “interlaboratory comparisons” is the organization, performance and evaluation of measurements or tests on the same or similar items by two or more laboratories in accordance with predetermined conditions.

20. “proficiency testing” is the evaluation of participant performance against pre-established criteria by means of interlaboratory comparisons.

21. “quality assurance project plan” (abbreviated to "QAPP”) is a formal document describing the detailed quality assurance procedures, quality control and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria.

22. “method detection limit” (abbreviated to "MDL”) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

23. “instrument detection limit” (abbreviated to “IDL”) is the minimum value of a substance that can be measured and is five times greater than the interference signal of the equipment.

24. “technical check” is the checking of normal operating state and calibration mechanism of a measuring instrument according to the technical document.

25. Inspection (first inspection before the first use, periodic inspection during the use and post-repair inspection) is the evaluation and confirmation of technical specifications of the environmental monitoring equipment according to the meteorological and technical requirements and implementation of metrological control measures.

26. “calibration” is a process of determination and establishment of relationship between the values of a measurement standard, measuring instrument and quantity.

27. “periodic environmental monitoring” is the field sampling and measurement or sample preservation and transport for handling and laboratory analysis according to a set plan in terms of space and time.

28. “TCVN” refers to National Standard.

29. “QCVN” refers to National Technical Regulation.

30. “QCVN-MT" refers to National Technical Regulation on Environment.

31. “ISO” refers to standard of the International Organization for Standardization.

32. “SMEWW” stands for Standard Methods for the Examination of Water and Waste Water.

33. “US EPA method” refers to the methods of the US Environmental Protection Agency

34. “NIOSH” is the standard of the National Institute for Occupational Safety and Health.

35. “OSHA” stands for Occupational Safety and Health Administration.

36. “MASA” stands for Method of Air Sampling and Analysis, Intersociety Committee.

37. “ASTM” stands for American Society for Testing and Materials.

38. “AS” stands for Australian Standard.

39. “JIS” stands for Japanese Industrial Standard.

40. “IS” stands for Indian Standard.

41. “isokinetic sampling method” is a method that maintains the velocity at the sampling point inlet at the same speed as the velocity of stack gas at that point.

42. “direct measuring equipment” promptly displays parameters required upon its placement in the measured environment.

Chapter II

TECHNICAL PROCEDURES FOR PERIODIC ENVIRONMENTAL MONITORING

Section 1. OUTDOOR AIR, NOISE AND VIBRATION MONITORING

Article 5. Monitoring parameters

1. The outdoor air monitoring parameters include: meteorological parameters (wind speed and direction, temperature, relative humidity, pressure) SO_2, CO, NO_2, O_3, H_2S, NH_3, benzene, naphthalene, acetaldehyde, aniline, chloroform, formaldehyde, tetrachloroethylene, vinyl chloride, phenol, CH4, methyl mercaptan, acrylonitrile, acrolein, hydrocarbon, n-acetate, cyanide, PAHs, cyclohexane, n-heptane, Cl_2, HF, HCN, H_3PO_4, H_2SO_4, HBr, HNO_3, HCl, Ni, Hg, Mn, As, Cd, Cr (VI), arsine (AsH_3), total suspended particulates (TSP), PM_{10}, $PM_{2,5}$, Pb, total polycarbobiphenyl (PCB), total dioxin/furan (PCDD/PCDF), dioxin-like polychlorinated biphenyls (dl-PCB).

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities’ requirements.

2. The noise monitoring parameters include: A-weighted equivalent sound level (L_{eq}), maximum A-weighted sound level (L_{max}) and traffic intensity (applicable to traffic noise).

3. The vibration monitoring parameters include vibration acceleration level (dB) or acceleration (m/s^2).

Article 6. Monitoring frequency and time

1. The outdoor air monitoring frequency: at least 06 times per year, every 2 months.

2. The noise monitoring frequency and time

a) The noise monitoring frequency: at least 04 times per year, every 03 months;

b) The noise monitoring time

b.1) Each measurement is continuously carried out within a 10-minute interval. At least 03 measurements are carried out within 01 hour. Then, the mean value of such three measurements shall be taken. The achieved result shall be considered as the mean value of such measuring hour;

b.2) The noise that is generated from factories and affects the ambient sounds must be measured within the working time.

3. The noise vibration frequency: at least 04 times per year, every 03 months.

Article 7. Monitoring methods

1. Outdoor air monitoring methods

a) Field sampling and measurement: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 1 below.

Table 1

No.	Parameters	Code of method
1.	SO_2	• TCVN 5971:1995;

		• TCVN 7726:2007; • MASA 704A; • MASA 704B
2.	CO	• TCVN 5972:1995; • TCVN 7725:2007; • IS 5182-10 (1999) (the section 3 shall not be applied); • MASA 128
3.	NO_2	• TCVN 6137:2009; • MASA 406
4.	O_3	• TCVN 6157:1996; • TCVN 7171:2002; • MASA 411
5.	H_2S	• MASA 701
6.	NH_3	• TCVN 5293:1995; • MASA 401
7.	Benzene	• ASTM D 3686-95; • ISO 16017-1:2000; • MASA 834; • NIOSH method 1501
8.	Toluene	• ASTM D 3686-95; • ISO 16017-1:2000; • MASA 834; • NIOSH method 1501
9.	Xylene	• ASTM D 3686-95; • ISO 16017-1:2000; • MASA 834; • NIOSH method 1501
10.	Styrene	• ISO 16017-1:2000; • NIOSH method 1501
11.	Acetonitrile	• NIOSH method 1606
12.	Benzidin	• NIOSH method 5509
13.	Naphtalene	• OSHA method 35
14.	Acetaldehyde	• NIOSH method 2538
15.	Aniline	• NIOSH method 2002
16.	Chloroform	• NIOSH method 1003
17.	Formaldehyde	• OSHA method 52; • NIOSH method 2541; • NIOSH method 3500
18.	Tetrachloroethylene	• NIOSH 1003;

		• USEPA method TO-17
19.	Vinyl clorua	• NIOSH 1007; • USEPA method TO-17
20.	Phenol	• NIOSH 3502; • NIOSH method 1501; • OSHA 32
21.	CH_4	• ASTM 1945; • MASA 101
22.	Mercaptan (Methyl mercaptan)	• ASTM D2913 - 96(2007); • MASA 118
23.		• NIOSH method 1604
24.	Acrolein	• NIOSH method 2501
25.	Hydrocarbon	• NIOSH method 1500
26.	n-acetate	• NIOSH method 1500
27.	Cyanide	• MASA 808
28.	PAHs	• NIOSH method 5515
29.	Cyclohexane	• NIOSH method 1500
30.	n-heptane	• NIOSH method 1500
31.	Cl_2	• TCVN 4877-89; • MASA 202
32.	HF	• MASA 809; • MASA 205; • MASA 203F; • NIOSH method 7906
33.	HCN	• NIOSH method 6017; • NIOSH method 6010
34.	H_3PO_4	• NIOSH method 7908
35.	H_2SO_4	• NIOSH method 7908
36.	HBr	• NIOSH method 7907
37.	HNO_3	• NIOSH method 7907
38.	HCl	• NIOSH method 7907
39.	Ni	• ASTM D4185-96; • NIOSH method 7300; • OSHA method ID 121
40.	Hg	• ISO 6978-92; • NIOSH method 6009; • OSHA method ID 140 • US EPA method IO-5

41.	Mn	• OSHA method ID 121; • ASTM D4185-96
42.	As	• OSHA method ID 105
43.	Cd	• ASTM method D4185-96; • NIOSH method 7048
44.	Cr (VI)	• OSHA method ID 215; • NIOSH method 7600
45.	Arsine (AsH_3)	• NIOSH method 6001
46.	Total suspended particulates (TSP)	• TCVN 5067:1995
47.	PM_{10}	• 40 CFR part 50 method appendix J; • AS/NZS 3580.9.7:2009; • AS/NZS 3580.9.6:2003; • MASA 501
48.	$PM_{2,5}$	• 40 CFR Part 50 method Appendix L; • AS/NZS 3580.9.7:2009; • MASA 501
49.	Pb	• TCVN 5067:1995; • ASTM D4185-96; • NIOSH method 7300; • NIOSH method 7301; • NIOSH method 7302; • NIOSH method 7303; • NIOSH method 7082; • NIOSH method 7105
50.	Total polycarbobiphenyl (PCB)	• US EPA method TO-9A
51.	Total dioxin/furan (PCDD/PCDF)	• US EPA method TO-9A
52.	dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method TO-9A
53.	Meteorological parameters (wind speed and direction, temperature, relative humidity, pressure)	• QCVN 46:2012/BTNMT

b) Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 2 below.

Table 2

No.	Parameters	Code of standard or method
1.	$SOSO_2$	• TCVN 5971:1995; • TCVN 7726:2007;

		• MASA 704A; • MASA 704B
2.	CO	• TCVN 5972:1995; • TCVN 7725:2007; • IS 5182-10 (1999) (the section 3 shall not be applied) • MASA 128
3.	NO_2	• TCVN 6137:2009; • MASA 406
4.	O_3	• TCVN 6157:1996; • TCVN 7171:2002; • MASA 411
5.	H_2S	• MASA 701
6.	NH_3	• TCVN 5293:1995; • MASA 401
7.	Benzene	• ASTM D 3686-95; • ISO 16017-1:2000; • MASA834; • NIOSH method 1501
8.	Toluene	• ASTM D 3686-95; • ISO 16017-1:2000; • MASA 834; • NIOSH method 1501
9.	Xylene	• ASTM D 3686-95; • ISO 16017-1:2000; • MASA 834; • NIOSH method 1501;
10.	Styrene	• ISO 16017-1:2000; • NIOSH method 1501
11.	Acetonitrile	• NIOSH method 1606
12.	Benzidin	• NIOSH method 5509
13.	Naphtalene	• OSHA method 35
14.	Acetaldehyde	• NIOSH method 2538
15.	Aniline	• NIOSH method 2002
16.	Chloroform	• NIOSH method 1003
17.	Formaldehyde	• NIOSH method 2541; • NIOSH method 3500; • OSHA method 52
18.	Tetrachloroethylene	• US.EPA method TO-17; • NIOSH method 1003

19.	Vinyl clorua	• USEPA method TO-17; • NIOSH method 1007
20.	Phenol	• NIOSH method 3502; • NIOSH method 1501; • OSHA method 32
21.	CH_4	• MASA 101; • ASTM 1945
22.	Mercaptan (Methyl mercaptan)	• ASTM D2913 - 96(2007); • MASA 118
23.	Acrylonitrile	• NIOSH method 1604
24.	Acrolein	• NIOSH method 2501
25.	Hydrocacbon	• NIOSH method 1500
26.	n-acetate	• NIOSH method 1500
27.	Cyanide	• MASA808
28.	PAHs	• NIOSH method 5515
29.	Cyclohexane	• NIOSH method 1500
30.	n-heptane	• NIOSH method 1500
31.	Cl_2	• TCVN 4877-89; • MASA202
32.	HF	• MASA 809; • MASA 205; • MASA 203F; • NIOSH method 7906
33.	HCN	• NIOSH method 6017; • NIOSH method 6010
34.	H_3PO_4	• NIOSH method 7908
35.	H_2SO_4	• NIOSH method 7908; • NIOSH method 7903
36.	HBr	• NIOSH method 7907
37.	HNO_3	• NIOSH method 7907
38.	HCl	• NIOSH method 7903; • NIOSH method 7907
39.	Ni	• ASTM D4185-96; • NIOSH 7 method 300 • OSHA method ID 121
40.	Hg	• ISO 6978-92; • NIOSH method 6009; • OSHA method ID 140
41.	Mn	• ASTM D4185-96;

		• OSHA method ID 121
42.	As	• OSHA method ID 105
43.	Cd	• ASTM D4185-96; • NIOSH method 7048
44.	Cr (VI)	• NIOSH method 7600; • OSHA method ID 215
45.	Arsine (AsH_3)	• NIOSH method 6001
46.	Total suspended particulates (TSP)	• TCVN 5067:1995
47.	PM_{10}	• 40 CFR part 50 method appendix J; • AS/NZS 3580.9.7:2009; • AS/NZS 3580.9.6:2003; • MASA 501
48.	$PM_{2,5}$	• 40 CFR Part 50 method appendix L; • AS/NZS 3580.9.7:2009; • MASA 501
49.	Pb	• TCVN 5067:1995; • NIOSH method 7300; • NIOSH method 7301; • NIOSH method 7302; • NIOSH method 7303; • NIOSH method 7082; • NIOSH method 7105; • ASTM D4185-96
50.	Total polycarbobiphenyl (PCB)	• US EPA method TO-9A; • US EPA method 1668B
51.	Total dioxin/furan (PCDD/PCDF)	• US EPA method TO-9A
52.	Dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method TO-9A; • US EPA method 1668B

2. Noise monitoring methods

a) Noise monitoring methods: TCVN 7878 Acoustic – Description, measurement and assessment of environmental noise, including 2 parts TCVN 7878-1:2008 and TCVN 7878-2:2010 shall be complied with.

b) For traffic noise caused by vehicles, in addition to measuring noise, it is required to determine the traffic intensity (vehicle/hour) by manual counting or automatic equipment. Type of vehicle in the traffic flow must be classified, including:

b.1) Motorbikes, mopeds;

b.2) Cars;

b.3) Light trucks and coaches;

b.4) Heavy trucks and buses.

3. Vibration monitoring methods: TCVN 6963:2001 Vibration and shock - Vibration emitted by construction works and factories - Method of measurement shall be complied with.

Article 8. Environmental monitoring data processing

1. Data examination: examine the rationality of the environmental monitoring and analysis data. The examination shall be carried out according to the profile of the sample (record on field monitoring, sample delivey record, field measurement record, laboratory analysis result reports, etc.), QC sample results (blank samples, replicate samples, reference samples, etc.).

2. Statistical processing: according to the number of samples and reports, various methods may be used for statistical processing as long as the minimum value, maximum value, mean value and standard deviation must be available;

3. Data assessment: compare the examined and processed data and relevant technical standards and regulations.

Section 2. INLAND SURFACE WATER MONITORING

Article 9. Monitoring parameters

The inland surface water monitoring parameters include: temperature, pH, DO, EC, TDS, ORP, turbidity, salinity, color, alkalinity, total hardness, TSS, BOD_5, COD, TOC, NH_4^+, NO_2^-, NO_3^-, SO_4^{2-}, PO_4^{3-}, CN^-, Cl^-, F^-, S^{2-}, total N, total P, Na, K, Ca, Mg, Fe, Mn, Cu, Zn, Ni, Pb, Cd, As, Hg, total Cr, Cr (Vl), coliform, E.Coli, total oil, grease; total phenols, chlorinated organic pesticides, phosphorus organic pesticides, total radioactivity α, total radioactivity β, total polycarbobiphenyl (PCB), total dioxin/furan (PCDD/PCDF), dioxin-like polychlorinated biphenyls (dl-PCB), phytoplankton, zooplankton, zoobenthos, surfactants.

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities' requirements.

Article 10. Monitoring frequency

The inland surface water monitoring frequency: at least 06 times per year, every 02 months.

Article 11. Monitoring methods

1. Field sampling and measurement

a) Field sampling and measurement of inland surface water: methods shall be selected in accordance with the applicable national technical regulations or Table 3 below.

Table 3

No.	Types of samples	Code of method
1.	River water, stream water	• TCVN 6663-6:2008
2.	Lake water	• TCVN 5994:1995
3.	Microbiological sample	• TCVN 8880:2011
4.	Phytoplankton	• SMEWW 10200B:2012
5.	Zooplankton	• SMEWW 10200B:2012
6.	Zoobenthos	• SMEWW 10500B:2012

a) Field measurement of inland surface water: methods shall be selected in accordance with the applicable national technical regulations or Table 4 below.

Table 4

No.	Parameters	Code of method
1.	Temperature	• SMEWW 2550B:2012
2.	pH	• TCVN 6492:2011

3.	DO	• TCVN 7325:2004
4.	EC	• SMEWW 2510B:2012
5.	Turbidity	• TCVN 6184:2008; • SMEWW 2130B:2012
6.	TDS	• Use of direct measuring equipment
7.	ORP	• SMEWW 2580B:2012; • ASTM 1498:2008
8.	Salinity	• SMEWW 2520B:2012

2. Preservation and transport of samples: Water samples taken shall be preserved and stored in accordance with TCVN 6663-3:2008.

3. Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 5 below.

Table 5

No.	Parameters	Code of method
1.	Color	• TCVN 6185:2015; • ASTM D1209-05; • SMEWW 2120C:2012
2.	Alkalinity	• TCVN 6636:1-2000; • SMEWW 2320B:2012
3.	Total hardness	• TCVN 6224:1996; • SMEWW 23400:2012
4.	TSS	• TCVN 6625:2000; • SMEWW 2540D:2012
5.	BOD_5	• TCVN 6001-1:2008; • TCVN 6001-2:2008; • SMEWW 5210B :2012; • SMEWW 5210D :2012; • US EPA method 405.1
6.	COD	• SMEWW 5220B:2012; • SMEWW 5220C:2012; • US EPA method 410.1; • US EPA method 410.2
7.	TOC	• TCVN 6634:2000; • SMEWW 5310B:2012; • SMEWW 5310C:2012
8.	NH_4^+	• TCVN 6179-1:1996; • TCVN 6660:2000; • SMEWW 4500-NH_3.B&D:2012; • SMEWW 4500-NH_3.B&F:2012;

		• SMEWW 4500-NH_3.B&H:2012; • USEPA method 350.2
9.	NO_2^-	• TCVN 6178:1996; • TCVN 6494-1:2011; • SMEWW 4500-NO_2^-.B:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • US EPA method 300.0; • US EPA method 354.1
10.	NO_3^-	• TCVN 6180:1996; • TCVN 7323-2:2004; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500-NO_3^-.D:2012; • SMEWW 4500-NO_3^-.E:2012; • US EPA method 300.0; • US EPA method 352.1
11.	SO_4^{2-}	• TCVN 6200:1996; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500-SO_4^{2-}.E:2012; • US EPA method 300.0; • US EPA method 375.3; • US EPA method 375.4
12.	PO_4^{3-}	• TCVN 6202:2008; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500-P.D:2012; • SMEWW 4500-P.E:2012; • US EPA method 300.0
13.	CN^-	• TCVN 6181:1996; • TCVN 7723:2007; • SMEWW 4500-CN^-.C&E:2012; • ISO 14403-2: 2012
14.	Cl^-	• TCVN 6194:1996; • TCVN 6494-1:2011;

		• SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500.Cl^-:2012; • US EPA method 300.0
15.	F^-	• TCVN 6195-1996; • TCVN 6494-1:2011; • SMEWW 4500-F^-.B&C:2012; • SMEWW 4500-F^-.B&D:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • US EPA method 300.0
16.	S^{2-}	• TCVN 6637:2000; • SMEWW 4500-S^{2-}.B&D:2012
17.	Total N	• TCVN 6624:1-2000; • TCVN 6624:2-2000; • TCVN 6638:2000; • SMEWW 4500-N.C:2012
18.	Total P	• TCVN 6202:2008; • SMEWW 4500P.B&D:2012; • SMEWW 4500P.B&E:2012
19.	Na	• TCVN 6196-1:1996; • TCVN 6196-2:1996; • TCVN 6196-3:1996; • TCVN 6660:2000; • TCVN 6665:2011; • SMEWW 3111B:2012; • SMEWW 3120B:2012; • US EPA method 200.7
20.	K	• TCVN 6196-1:1996; • TCVN 6196-2:1996; • TCVN 6196-3:1996; • TCVN 6660:2000; • TCVN 6665:2011; • SMEWW 3111B:2012; • SMEWW 3120B:2012; • US EPA method 200.7
21.	Ca	• TCVN 6201:1995; • TCVN 6198:1996; • TCVN 6660:2000;

		• TCVN 6665:2011; • SMEWW 3111B:2012; • SMEWW 3120B.-2012; • US EPA method 200.7
22.	Mg	• TCVN 6201:1995; • TCVN 6660:2000; • SMEWW 3111B:2012; • SMEWW 3120B:2012; • US EPA method 200.7
23.	Fe	• TCVN 6177:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3500-Fe.B.2012; • SMEWW 3111B:2012; • SMEWW 3113B:2012 • SMEWW 3120B:2012 • US EPA method 200.7
24.	Mn	• TCVN 6002:1995; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012 • SMEWW 3113B:2012 • SMEWW 3120B:2012 • SMEWW 3125B:2012 • US EPA method 200.7 • US EPA method 200.8 • US EPA method 243.1
25.	Cu	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B.2012 • SMEWW 3113B:2012 • SMEWW 3120B:2012 • SMEWW 3125B:2012 • US EPA method 200.7 • US EPA method 200.8
26.	Zn	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586:2003;

		• SMEWW 3111B:2012 • SMEWW 3113B:2012 • SMEWW 3120B:2012 • SMEWW 3125B:2012 • US EPA method 200.7 • US EPA method 200.8
27.	Ni	• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012 • SMEWW 3113B:2012; • SMEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
28.	Pb	• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3113B:2012; • SMEWW 3125B:2012 • SMEWW 3130B:2012; • US EPA method 200.8; • US EPA method 239.2
29.	Cd	• TCVN 6197:2008; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3113B:2012; • SMEWW 3125B:2012; • US EPA method 200.8
30.	As	• TCVN 6626:2000; • ISO 15586:2003; • SMEWW 3114B:2012; • SMEWW 3114C:2012; • SMEWW 3113B:2012; • SMEWW 3125B:2012; • US EPA method 200.8
31.	Hg	• TCVN 7724:2007; • TCVN 7877:2008; • SMEWW 3112B:2012; • US EPA method 7470A; • US EPA method 200.8

32.	Total Cr	• TCVN 6222:2008; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3113B:2012; • SMEWW 3125B:2012; • US EPA method 200.8; • US EPA method 218.2
33.	Cr (VI)	• TCVN 6658:2000; • TCVN 7939:2008; • SMEWW 3500-Cr.B:2012; • USEPA method 218.4; • US EPA method 218.5
34.	Coliform	• TCVN 6187-2:1996; • TCVN 6187-1:2009; • SMEWW 9221B:2012
35.	E.Coli	• TCVN 6187-2:1996; • TCVN 6187-1:2009; • SMEWW 9221B:2012; • SMEWW 9222B:2012
36.	Total oil, grease	• TCVN 7875: 2008; • SMEWW 5520B:2012; • SMEWW 5520C:2012
37.	Total phenols	• TCVN 6216:1996; • TCVN 7874:2008; • SMEWW 5530C:2012; • US EPA method 420.1; • US EPA method 420.2; • US EPA method 420.3; • ISO 14402:1999
38.	Chlorinated organic pesticides	• TCVN 7876:2008; • TCVN 9241:2012; • SMEWW 6630B:2012; • SMEWW 6630C:2012; • US EPA method 8081B; • US EPA method 8270D
39.	Phosphorous organic pesticides	• US EPA method 8141B; • US EPA method 8270D
40.	Total radioactivity α	• TCVN 6053:2011; • TCVN 8879:2011;

		• SMEWW 7110B:2012
41.	Total radioactivity β	• TCVN 6219:2011; • TCVN 8879:2011; • SMEWW 7110B:2012
42.	Total polycarbobiphenyl (PCB)	• TCVN 8601:2009; • TCVN 9241:2012; • SMEWW 6630C:2012; • US EPA method 1668B; • US EPA method 8082A; • US EPA method 8270D
43.	Total dioxin/furan (PCDD/PCDF)	• US EPA method 1613B
44.	Dioxin (dl-PCB) Dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method 1668B
45.	Phytoplankton	• SMEWW 10200:2012
46.	Zooplankton	• SMEWW 10200:2012
47.	Zoobenthos	• SMEWW 10500:2012
48.	Surfactants	• TCVN 6622-1:2009; • SMEWW 5540C:2012; • US EPA method 425.1

Article 12. Environmental monitoring data processing

The environmental monitoring data shall be processed in accordance with Article 8, Chapter II of this Circular.

Section 3. GROUNDWATER MONITORING

Article 13. Monitoring parameters

The groundwater monitoring parameters include: temperature, pH, DO, EC, TDS, ORP, turbidity, salinity, color, alkalinity, total hardness, TSS, BODs, COD, permanganate index, NH_4^+, PO_4^{3-}, NO_2^-, NO_3^-, HCO_3^-, SO_4^{2-}, CO_3^{2-}, CN^-, Cl^-, F^-, S^{2-}, total N, total P, Fe, Mn, Pb, Cu, Zn, Ni, Cd, As, Hg, Se, Al, total Cr, Cr (VI), Co, coliform, E.Coli, total oil, grease; total phenols, total radioactivity α, total radioactivity β, PAHs, chlorinated organic pesticides, phosphorus organic pesticides, total polycarbobiphenyl (PCB), total dioxin/furan (PCDD/PCDF), dioxin-like polychlorinated biphenyls (dl-PCB), surfactants.

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities' requirements.

Article 14. Monitoring frequency

The groundwater monitoring frequency: at least 04 times per year, every 03 months.

Article 15. Monitoring methods

1. Field sampling and measurement

a) Field sampling of groundwater: TCVN 666311:2011 shall be complied with;

b) Field measurement of groundwater parameters: methods shall be selected in accordance with the equivalent applicable national technical standard or Table 6 below.

Table 6

No.	Parameters	Code of method
1.	Temperature	• SMEWW 2550B:2012
2.	pH	• TCVN 6492:2011; • SMEWW 4500 H^+ B:2012
3.	DO	• TCVN 7325:2004; • SMEWW 4500O.G:2012
4.	EC	• SMEWW 2510B:2012
5.	TDS	• Use of direct measuring equipment
6.	Turbidity	• TCVN 6184:2008; • SMEWW 2130B:2012
7.	ORP	• SMEWW 2580B:2012; • ASTM 1498:2008
8.	Salinity	• SMEWW 2520B:2012

2. Preservation and transport of samples: Groundwater samples taken shall be preserved and stored in accordance with TCVN 6663-3:2008.

3. Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 7 below.

Table 7

No.	Parameters	Code of method
1.	Alkalinity	• TCVN 6636-1:2000; • TCVN 6636-2:2000; • SMEWW 2320B:2012
2.	Color	• TCVN 6185:2008; • ASTM D1209-05; • SMEWW 2120C:2012
3.	Total hardness	• TCVN 6224:1996; • SMEWW 2340C:2012
4.	TSS	• TCVN 6625:2000; • SMEWW 2540D:2012
5.	BOD_5	• TCVN 6001-1:2008; • TCVN 6001-2:2008; • SMEWW 5210B:2012; • SMEWW 5210D:2012; • US EPA method 405.1
6.	COD	• TCVN 6491:1999; • SMEWW 5220B:2012; • SMEWW 5220C:2012; • US EPA method 410.1; • US EPA method 410.2

7.	Pecmanganat index	• TCVN 6186:1996
8.	NH_4^+	• TCVN 6179-1:1996; • TCVN 6660:2000; • SMEWW 4500-NH_3.B&D:2012; • SMEWW 4500-NH_3.B&F:2012; • SMEWW 4500-NH_3.B&H:2012; • USEPA method 350.2
9.	PO_4^{3-}	• TCVN 6202:2008; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • SMEWW 4500-P.D:2012; • SMEWW 4500-P.E:2012; • US EPA method 300.0
10.	NO_2^-	• TCVN 6178:1996; • TCVN 6494-1:2011; • SMEWW 4500-NO2-.B:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • US EPA method 300.0; • US EPA method 354.1
11.	NO_3^-	• TCVN 6180:1996 • TCVN 7323-2:2004; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500-NO_3^-.D:2012; • SMEWW 4500-NO_3^-.E:2012; • US EPA method 300.0; • US EPA method 352.1
12.	HCO_3^-	• SMEWW 2320B:2012; • TCVN 6636-1:2000
13.	SO_4^{2-}	• TCVN 6200:1996; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500-SO_4^{2-}.E:2012; • US EPA method 300.0; • US EPA method 375.3;

		• US EPA method 375.4
14.	CO_3^{2-}	• SMEWW 2320B:2012; • TCVN 6636-2:2000
15.	CN^-	• TCVN 6181:1996; • TCVN 7723:2007; • SMEWW 4500-CN^-.C&E:2012; • ISO 14403-2: 2012
16.	Cl^-	• TCVN 6194:1996; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500.Cl^-:2012; • US EPA method 300.0
17.	F^-	• TCVN 6195-1996; • TCVN 6494-1:2011; • SMEWW 4500-F^-.B&C:2012; • SMEWW 4500-F^-.B&D:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • US EPA method 300.0
18.	S^{2-}	• TCVN 6637:2000; • SMEWW 4500-S^{2-}.D:2012; • SMEWW 4500-S^{2-}.F:2012
19.	Total N	• TCVN 6624:1-2000; • TCVN 6624:2-2000; • TCVN 6638:2000
20.	Total P	• TCVN 6202:2008; • SMEWW 4500-P.B&D:2012; • SMEWW 4500-P.B&E:2012
21.	Fe	• TCVN 6177:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3500-Fe.B.2012; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120B:2012, • US EPA method 200.7
22.	Mn	• TCVN 6665:2011; • ISO 15586:2003;

		• SMEWW 3111B:2012; • SMEWW 3113B:2012, • SMEWW 3120B:2012, • SMEWW 3125B: 2012; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 243.1
23.	Pb	• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3113B:2012; • SMEWW 3125B:2012 • SMEWW 3130B:2012; • US EPA method 200.8; • US EPA method 239.2
24.	Cu	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012, • SMEWW 3120B:2012, • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
25.	Zn	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012 • SMEWW 3113B:2012; • MEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
26.	Ni	• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3113B.2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPAmethod 200.8
27.	Cd	• TCVN 6197:2008;

		• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3113B.2012; • SMEWW 3125B:2012; • US EPA method 200.8
28.	As	• TCVN 6626:2000; • ISO 15586:2003; • SMEWW 3114B.2012; • SMEWW 3113B2012, • SMEWW 3125B:2012 • US EPA method 200.8
29.	Hg	• TCVN 7724:2007; • TCVN 7877:2008; • SMEWW 3112B:2012; • US EPA method 7470A; • US EPA method 200.8
30.	Se	• TCVN 6183:1996; • ISO 15586:2003; • SMEWW 3114B:2012; • US EPA method 200.7; • US EPA method 200.8
31.	Al	• TCVN 6657:2000; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111D:2012; • SMEWW 3113B:2012; • MEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
32.	Total Cr	• TCVN 6222:2008; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012, • MEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8;

		• US EPA method 218.2
33.	Cr (VI)	• TCVN 6658:2000; • TCVN 7939:2008; • SMEWW 3500-Cr.B:2012; • US EPA method 218.4; • US EPA method 218.5
34.	Co	• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012, • MEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
35.	Coliform	• TCVN 6187-2:1996; • TCVN 6187-1:2009; • SMEWW 9221B:2012; • SMEWW 9222B:2012
36.	E.coli	• TCVN 6187-2:1996; • TCVN 6187-1:2009; • SMEWW 9221B:2012; • SMEWW 9222B:2012
37.	Total oil, grease	• TCVN 7875: 2008; • SMEWW 5520B:2012; • SMEWW 5520C:2012
38.	Total phenols	• TCVN 6216:1996; • TCVN 7874:2008; • ISO 14402:1999; • SMEWW 5530C:2012; • US EPA method 420.1; • US EPA method 420.2; • US EPA method 420.3
39.	Total radioactivity α	• TCVN 6053:2011; • TCVN 8879:2011; • SMEWW 7110B:2012
40.	Total radioactivity β	• TCVN 6219:2011; • TCVN 8879:2011; • SMEWW 7110B:2012
41.	PAHs	• SMEWW 6440B:2012;

		• SMEWW 64400:2012; • US EPA method 8100; • US EPA method 8310; • US EPA method 8270D
42.	Chlorinated organic pesticides	• TCVN 7876:2008; • TCVN 9241:2012, • SMEWW 6630B:2012; • SMEWW 6630C:2012; • US EPA method 8081B; • US EPA method 8270D
43.	Phosphorous organic pesticides	• US EPA method 8141B; • US EPA method 8270D
44.	Total polycarbobiphenyl (PCB)	• TCVN 8601: 2009; • TCVN 9241:2012; • SMEWW 6630C:2012; • US EPA method 1668B; • US EPA method 8082A; • US EPA method 8270D
45.	Total dioxin/furan (PCDD/PCDF)	• US EPA method 1613B
46.	Dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method 1668B
47.	Surfactants	• TCVN 6622-1:2009; • SMEWW 5540C:2012; • US EPA method 425.1

Article 16. Environmental monitoring data processing

The environmental monitoring data shall be processed in accordance with Article 8, Chapter II of this Circular.

Section 4. SEAWATER MONITORING

Article 17. Monitoring parameters

The seawater monitoring parameters include: temperature, pH, DO, EC, salinity, transparency, turbidity, TDS, oceanographic parameters, TSS, total hardness, TSS, BOD_5, NH_4^+, PO_4^{3-},NO_2^-, NO_3^-, F^-, S^{2-}, CN^-, Pb, Fe, Zn, Cu, Mn, Cd, Hg (only applicable to coastal and near-shore seawater), As, total Cr, Cr (Vl), total N, total P, total oil, grease; total mineral oil and grease, total phenols, zooplankton, zoobenthos, chlorinated organic pesticides, phosphorus organic pesticides, coliform.

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities' requirements.

Article 18. Monitoring frequency

1. The coastal seawater monitoring frequency: at least 04 times per year, every 03 months.

2. The near-shore seawater monitoring frequency: at least twice a year, every 06 months.

3. The off-shore seawater monitoring frequency: at least once a year.

Article 19. Monitoring methods

1. Field sampling and measurement

a) Field sampling and measurement: methods shall be selected in accordance with the applicable national technical regulations or Table 8 below.

Table 8

No.	Types of samples	Code of method
1.	Seawater	• TCVN 5998:1995; • ISO 5667-9:1992
2.	Phytoplankton	• SMEWW 10200B:2012
3.	Zooplankton	• SMEWW 10200B:2012
4.	Zoobenthos	• SMEWW 10500B:2012

b) Field measurement of seawater: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 9 below.

Table 9

No.	Parameters	Code of method
1.	Temperature	• SMEWW 2550B:2012
2.	Độ muối	• SMEWW 2520B:2012
3.	pH	• TCVN 6492:2011; • US EPA method 9040
4.	DO	• TCVN 7325:2004; • SMEWW 4500 O.G:2012
5.	EC	• SMEWW 2510B:2012
6.	Transparency	Measured with Secchi disk
7.	Turbidity	• TCVN 6184:2008; • SMEWW 2130B:2012
8.	TDS	• Use of direct measuring equipment
9.	Oceanographic parameters	• Use of direct measuring equipment

c) Preservation and transport of samples: Seawater samples taken shall be preserved and stored in accordance with TCVN 6663-3:2008.

2. Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 10 below.

Table 10

No.	Parameters	Code of method
1.	TSS	• TCVN 6625:2000; • SMEWW 2540D:2012
2.	BOD_5	• TCVN 6001-1:2008; • TCVN 6001-2:2008; • SMEWW 5210B:2012; • SMEWW 5210D:2012

3.	NH_4^+	• TCVN 6179-1:1996; • SMEWW 4500-NH_3.B&F:2012; • SMEWW 4500-NH_3.D:2012
4.	PO_4^{3-}	• TCVN 6202:2008; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500-P.D:2012; • SMEWW 4500-P.E:2012; • US EPA method 300.0
5.	NO_2^-	• TCVN 6178:1996; • TCVN 6494-1:2011; • SMEWW 4500-NO_2^-.B:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • US EPA method 300.0; • US EPA method 354.1
6.	NO_3^-	• TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • SMEWW 4500-NO_3^-.E:2012; • US EPA method 352.1
7.	F^-	• TCVN 6195-1996; • TCVN 6494-1:2011; • SMEWW 4110.B:2012; • SMEWW 4110C:2012; • SMEWW 4500-F^-.B&C:2012; • SMEWW 4500-F^-.B&D:2012; • US EPA method 300.0
8.	S^{2-}	• TCVN 6637:2000; • SMEWW 4500-S^{2-}.D:2012; • SMEWW 4500-S^{2-}.F:2012
9.	CN^-	• TCVN 6181:1996; • SMEWW 4500-CN^-.C&E:2012; • ISO 14403-2:2012
10.	Pb	• TCVN 6193:1996; • ISO 15586:2003; • SMEWW 3113B:2012; • SMEWW 3125B:2012;

		• US EPA method 200.8; • US EPA method 1640; • US EPA method 200.10; • US EPA method 200.13; • US EPA method 200.12
11.	Fe	• TCVN 6177:1996; • ISO 15586:2003; • SMEWW 3500-Fe.B.2012; • SMEWW 3111B:2012; • SMEWW 3113B:2012
12.	Zn	• TCVN 6193:1996; • ISO 15586:2003; • SMEWW 3111C:2012; • SMEWW 3113B:2012; • SMEWW 3125B:2012; • US EPA method 200.8
13.	Cu	• TCVN 6193:1996; • ISO 15586:2003; • SMEWW 3111C:2012; • SMEWW 3113B:2012; • SMEWW 3125B:2012, • US EPA method 200.8; • US EPA method 1640; • US EPA method 200.10; • US EPA method 200.12; • US EPA method 200.13
14.	Mn	• SMEWW 3111B:2012; • SMEWW 3113B:2012, • SMEWW 3125B:2012, • US EPA method 200.8; • US EPA method 243.1
15.	Cd	• TCVN 6197:2008; • ISO 15586:2003; • SMEWW 3113B:2012; • SMEWW 3125B:2012, • US EPA method 200.8; • US EPA method 1640; • US EPA method 200.10; • US EPA method 200.12;

		• US EPA method 200.13
16.	Hg (only applicable to coastal and near-shore seawater)	• TCVN 7724:2007; • TCVN 7877:2008; • SMEWW 3112B:2012; • SMEWW 3125B:2012; • US EPA method 200.8
17.	As	• TCVN 6626:2000; • ISO 15586:2003; • SMEWW 3114B:2012; • SMEWW 3113B:2012; • SMEWW 3125B:2012; • US EPA method 1640; • US EPA method 200.8; • US EPA method 200.12
18.	Total Cr	• TCVN 6222:2008; • ISO 15586:2003; • SMEWW 3111C:2012; • SMEWW 3113B:2012, • SMEWW 3125B:2012; • US EPA method 200.8
19.	Cr (VI)	• TCVN 6658:2000; • SMEWW 3500-Cr.B:2012; • US EPA method 218.4
20.	Total N	• TCVN 6624:1-2000; • TCVN 6624:2-2000; • TCVN 6638:2000; • SMEWW 4500-N.C:2012
21.	Total P	• TCVN 6202:2008; • SMEWW 4500-P.B&D:2012; • SMEWW 4500-P.B&E:2012
22.	Total oil, grease	• TCVN 7875:2008; • SMEWW 5520B:2012; • SMEWW 5520C:2012; • USEPA method 413.2
23.	Total mineral oil and grease	• SMEWW 5520B&F:2012; • SMEWW 5520C&F:2012
24.	Total phenols	• TCVN 6216:1996; • SMEWW 5530B&C:2012; • SMEWW 5530B&D:2012;

		• ISO 14402:1999
25.	Zooplankton	• SMEWW 10200:2012
26.	Zoobenthos	• SMEWW 10500:2012
27.	Chlorinated organic pesticides	• TCVN 7876:2008; • TCVN 9241:2012; • SMEWW 6630B:2012; • SMEWW 6630C:2012; • US EPA method 8081B; • US EPA method 8270D
28.	Phosphorous organic pesticides	• US EPA method 8141B; • US EPA method 8270D
29.	Coliform	• SMEWW 9221B:2012; • TCVN 6187-1:2009; • TCVN 6187-2:1996

Article 20. Environmental monitoring data processing

The environmental monitoring data shall be processed in accordance with Article 8, Chapter II of this Circular.

Section 5. RAINWATER QUALITY MONITORING

Article 21. Monitoring parameters

The rainwater quality monitoring parameters include: temperature, pH, EC, TDS, meteorological parameters, Cl^-, F^-, NO_2^-, NO_3^-, PO_4^{3-}, SO_4^{2-}, NH_4^+, Na^+, K^+, Ca^{2+}, Mg^{2+}.

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities' requirements.

Article 22. Monitoring frequency and time

1. Rainwater samples taken after each rain event: the rainwater samples are taken after each rain event. The starting and ending time of each rain event shall be determined.

2. Rainwater samples taken per diem: in case of failure to take and analyze samples after each rain event, samples shall be taken per diem (continuously 24 hours) Samples are taken from 08 am and must remain untouched while and after being taken (the samples should be refridgerated or have appropriate preservatives added).

3. Rainwater samples taken per week: in case of failure to take and analyze samples per diem, samples may be taken every week, which means daily samples taken within 01 week are combined or taken continuously for 01 week if they remain untouched while and after being taken (the samples should be refridgerated or have appropriate preservatives added).

Article 23. Monitoring methods

1. Field sampling and measurement

a) Field sampling of rainwater: TCVN 5997:1995 Guidance on the sampling of rainwater shall be complied with;

b) Field measurement of rainwater: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 11 below.

Table 11

No.	Parameters	Code of method

1.	Temperature	• SMEWW 2550B:2012
2.	pH	• TCVN 6492:2011; • SMEWW 4500 H^+.B:2012
3.	EC	• SMEWW 2510B:2012; • US EPA method 120.1
4.	TDS	• Use of environmental monitoring equipment
5.	Meteorological parameters	• QCVN 46:2012/BTNMT

2. Preservation and transport of samples: Rainwater samples taken shall be preserved and stored in accordance with TCVN 6663-3:2008.

3. Laboratory analysis

a) Laboratory analysis of rainwater parameters: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 12 below.

Table 12

No.	Parameters	Code of method
1.	Cl^-	• TCVN 6194:1996; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500.Cl^-:2012; • US EPA method 300.0
2.	F^-	• TCVN 6195-1996; • TCVN 6494-1:2011; • SMEWW 4500-F^-.B&C:2012; • SMEWW 4500-F^-.B&D:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • US EPA method 300.0
3.	NO_2^-	• TCVN 6178:1996; • TCVN 6494-1:2011; • SMEWW 4500-NO_2^-.B:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • US EPA method 300.0; • US EPA method 354.1
4.	NO_3^-	• TCVN 6180:1996; • TCVN 7323-2:2004; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012;

		• SMEWW 4500-NO_3^-.D:2012; • SMEWW 4500-NO_3^-.E:2012; • US EPA method 300.0; • US EPA method 352.1
5.	PO_4^{3-}	• TCVN 6202:2008; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500-P.D:2012; • SMEWW 4500-P.E:2012; • US EPA method 300.0
6.	SO_4^{2-}	• TCVN 6200:1996; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • SMEWW 4500-SO_4^{2-}.E:2012; • US EPA method 300.0; • US EPA method 375.3; • US EPA method 375.4
7.	NH_4^+	• TCVN 6179-1:1996; • TCVN 6660:2000; • SMEWW 4500-NH_3.D:2012; • SMEWW 4500-NH_3.F:2012; • SMEWW 4500-NH_3.H:2012; • USEPA method 350.2
8.	Na^+	• TCVN 6196-1:1996; • TCVN 6196-2:1996; • TCVN 6196-3:1996; • TCVN 6660:2000; • TCVN 6665:2011; • SMEWW 3111B:2012; • SMEWW 3120B:2012; • US EPA method 200.7
9.	K^+	• TCVN 6196-1:1996; • TCVN 6196-2:1996; • TCVN 6196-3:1996; • TCVN 6660:2000; • TCVN 6665:2011; • SMEWW 3111B:2012;

		• SMEWW 3120B:2012; • US EPA method 200.7
10.	Ca^{2+}	• TCVN 6201:1995; • TCVN 6198:1996; • TCVN 6660:2000; • TCVN 6665:2011; • SMEWW 3111B:2012; • SMEWW 3120B:2012; • US EPA method 200.7
11.	Mg^{2+}	• TCVN 6201:1995; • TCVN 6660:2000; • TCVN 6665:2011; • SMEWW 3111B:2012; • SMEWW 3120B:2012; • US EPA method 200.7

b) The following points should be carefully considered when analyzing rainwater samples:

b.1) Samples that are small in quantity but contain high concentrations of pollutants may be diluted to facilitate analysis. The diluted samples must not be used to measure pH and EC;

b.2) In case the samples are diluted with deionized water, the concentrations of ions to be analyzed that are present in the deionized water must also be measured.

Article 24. Environmental monitoring data processing

1. Data processing

After each analyzed sample batch, ion balance and electrical conductivity must be calculated. If the ion balance and electrical conductivity ratios exceed the tolerance, the samples must be checked and re-analyzed:

a) Calculation of ion balance, R_1

→ Total anion (A), expressed as µeq/L is calculated using the equation:

$A = \Sigma\ (nC_{Ai})(\mu mol/L) = [Cl^-] + [NO_3^-] + 2[SO_4^{2-}]$ (1)

Where:

- n, $[C_{Ai}]$: electric charge of ion and concentration (µmol/L) in anion “i”.

→ Total cation (C), expressed as µeq/L is calculated using the equation:

$C = \Sigma(nC_{Ci})\ (\mu mol/L) = 10^{(6-pH)} + [Na^+] + [NH_4^+] + [K^+] + 2[Mg^{2+}] + 2[Ca^{2+}]$ (2)

Where:

- n, $[C_{Ci}]$: electric charge of ion and concentration (µmol/L) in cation “i”.

→ Ratio R_1 is calculated using the equation:

$R_1 = 100 \times (C-A)/(C+A)\ (\%)$ (3)

The data is considered satisfactory if R_1 is within the tolerance specified in Table 13 below.

Table 13

(C+A), µeq/L	R_1 (%)
< 50	± 30

50-100	± 15
> 100	± 8

b) Comparison between calculations and measurement in electrical conductivity, R_2

→ Electrical conductivity should be calculated using the equation:

EC_{tt} (mS/m)= {349,7 x $10^{(6-pH)}$ + 80,0 x 2[SO_4^{2-}] + 71,4[NO_3^-] + 76,3[Cl^-] + 73,5[NH_4^+] + 50,1[Na^+] + 73,5[K^+] + 59,5 x 2[Ca^{2+}] + 53,0 x 2[Mg^{2+}]}/1000 (4)

Where:

- [ ]: ion concentrations in µmol/L;

- The factors that precede ion concentrations are the specific conductivity of the ion in S.cm^2/mol at 25°C.

→ Ratio R_2 is calculated using the equation:

R_2 = 100 x (EC_{tt} -EC_{dD})/(EC_{tt} + EC_{dD}) (%) (5)

Where:

- EC_{tt}: Calculated electrical conductivity;

- EC_{dD}: Electrical conductivity measured with a meter at 25°C.

The data is considered satisfactory if R2 is within the tolerance specified in Table 14 below.

Table 14

EC_{dD} (mS/m)	R_2 (%)
< 0.5	± 20
0.5-3	± 13
> 3	± 9

(1 mS/m = 10 µS/cm)

When R_2 is exceeds the tolerance, re-measurement, check with standard solution, or inspection of standard curves is necessary.

When the rainwater has a pH of over 6 and R_1 is greater than 0, bicarbonate (HCO_3^-) concentration should be evaluated to compute R1 and R2 again including bicarbonate contribution. HCO_3^- is calculated using the equation:

[HCO_3^-] = [H_2CO^3] x K_{a1}/[H^+] (6)

Where:

- K_{a1}: first-order decomposition of carbonic acid.

The atmospheric concentrations of CO2 is 360 ppm, $K_{a1} = 10^{-6,35}$

Then [HCO_3^-] = [H_2CO^3] x $10^{(pH-6,35)}$ = 1,24 x $10^{(pH-5,35)}$ (7)

2. Data assessment: compare the examined and processed data and relevant technical standards and regulations.

Section 6. WASTEWATER MONITORING

Article 25. Monitoring parameters

The wastewater monitoring parameters include: temperature, pH, TDS, ORP, velocity, flow, color, BOD_5, COD, TSS, NH_4^+, tổng N, tổng P, NO_2^-, NO_3^-, PO_4^{3-}, residual chlorine, As, Cd, Pb, Cr (VI), Cr (III), total Cr, Cu, p, Zn, Mn, Ni, total phenols, Fe, S^{2-}, CN^-, Sn, Hg, phosphorus organic pesticides, chlorinated organic pesticides, polychlorinated biphenyls (PCB), total dioxin/furan (PCDD/PCDF), dioxin-like polychlorinated biphenyls (dl-PCB), animal and plant oil and grease; total mineral oil and grease, total radioactivity α, total radioactivity β, coliform, salmonella, shigella, vibrio cholerae, adsorbable organically bound halogens (AOX), surfactants.

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities' requirements.

Article 26. Monitoring methods

1. Field sampling and measurement

a) Field sampling of wastewater: TCVN 6663-1:2011 and TCVN 5999-1995 shall be complied with;

b) Field measurement of wastewater parameters: methods shall be selected in accordance with the applicable national technical regulations or Table 15 below.

Table 15

No.	Parameters	Code of method/calculation
1.	Temperature	• TCVN 4557:1988; • SMEWW 2550B:2012
2.	pH	• TCVN 6492:2011; • SMEWW 4500 H^+.B:2012
3.	TDS	• Use of direct measuring equipment
4.	Velocity	• ISO 4064-5:2014
5.	Flow	• The wastewater flow must be measured during a production shift and in multiple number of times, each measurement shall be carried out at a maximum interval of 1 hour. Total volume of wastewater and average flow during the measurement period are calculated as follows: $V = \Sigma Qi.\Delta t_i$ $Q_{TB} = V/\Sigma\Delta t_i$ Where: V - Total volume of wastewater, m^3; Q_i - instantaneous flow at t_i; Δt_i - time interval between two instantaneous flow measurements; Q_{TB} - Average flow, m^3/h.

2. Preservation and transport of samples: Wastewater samples taken shall be preserved and stored in accordance with TCVN 6663-3:2008.

3. Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 16 below.

Table 16

No.	Parameters	Code of method
1.	Color	• TCVN 6185:2015; • ASTM D1209-05; • SMEWW 2120C:2012
2.	BOD_5	• TCVN 6001-1:2008; • TCVN 6001-2:2008; • SMEWW 5210B:2012; • SMEWW 5210D:2012
3.	COD	• TCVN 6491:1999;

		• SMEWW 5220B:2012; • SMEWW 5220C:2012; • SMEWW 5220D:2012
4.	TSS	• TCVN 6625:2000; • SMEWW 2540D:2012
5.	NH_4^+	• TCVN 5988-1995; • TCVN 6179-1:1996; • TCVN 6660:2000; • SMEWW 4500-NH_3.B&D:2012; • SMEWW 4500-NH_3.B&F:2012; • SMEWW 4500-NH_3.B&H:2012; • USEPA method 350.2
6.	Total N	• TCVN 6624:1-2000; • TCVN 6624:2-2000; • TCVN 6638:2000
7.	Total P	• TCVN 6202:2008; • SMEWW 4500-P.B&D:2012; • SMEWW 4500-P.B&E:2012
8.	NO_2^-	• TCVN 6178:1996; • TCVN 6494-1:2011; • SMEWW 4500-NO_2^-.B:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • US EPA method 300.0; • US EPA method 354.1
9.	NO_3^-	• TCVN 7323-2:2004; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • SMEWW 4500-NO_3^-.D:2012; • SMEWW 4500-NO_3^-.E:2012; • US EPA method 300.0; • US EPA method 352.1
10.	PO_4^{3-}	• TCVN 6202:2008; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012, • SMEWW 4500-P.D:2012; • SMEWW 4500-P.E:2012;

		• US EPA method 300.0
11.	Residual chlorine	• TCVN 6225-3:2011; • TCVN 6225-1:2012; • TCVN 6225-2:2012; • SMEWW 4500-Cl:2012
12.	Cl^-	• TCVN 6194:1996; • TCVN 6494-1:2011; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • SMEWW 4500.Cl^-:2012 • US EPA method 300.0;
13.	As	• TCVN 6626:2000; • TCVN 6665:2011; • ISO 15586: 2003; • SMEWW 3113B:2012; • SMEWW 3114B:2012; • SMEWW 3125B:2012, • US EPA method 200.8
14.	Cd	• TCVN 6197:2008; • TCVN 6193:1996; • TCVN 6665:2011; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3125B:2012; • US EPA method 200.8
15.	Pb	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586: 2003; • SMEWW 3113B:2012; • SMEWW 3125B:2012; • US EPA method 239.2; • US EPA method 200.8
16.	Cr (VI)	• TCVN 6658:2000; • SMEWW 3500-Cr.B:2012; • US EPA method 7198; • US EPA method 218.4
17.	Cr (III)	• SMEWW 3500-Cr.B:2012
18.	Total Cr	• TCVN 6222:2008; • TCVN 6665:2011;

		• ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 218.1; • US EPA method 218.2
19.	Cu	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
20.	F^-	• TCVN 6494-1:2011; • SMEWW 4500-F^-.B&C:2012; • SMEWW 4500-F^-.B&D:2012; • SMEWW 4110B:2012; • SMEWW 4110C:2012; • US EPA method 300.0
21.	Zn	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
22.	Mn	• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120B:2012; • SMEWW 3125B:2012;

		• US EPA method 200.7; • US EPA method 200.8; • US EPA method 243.1
23.	Ni	• TCVN 6193:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7; • US EPA method 200.8
24.	Total phenols	• TCVN 6216:1996; • TCVN 7874:2008; • TCVN 6199-1:1995; • ISO 14402:1999; • SMEWW 5530C:2012
25.	Fe	• TCVN 6177:1996; • TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3500-Fe.B.2012; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120:2012; • US EPA method 200.7
26.	S^{2-}	• TCVN 6637:2000; • TCVN 6659:2000; • SMEWW 4500 S^{2-}.B&D:2012
27.	CN^-	• TCVN 6181:1996; • TCVN 7723:2007; • ISO 14403-2:2012 • SMEWW 4500-CN-C&E:2012
28.	Sn	• TCVN 6665:2011; • ISO 15586:2003; • SMEWW 3111B:2012; • SMEWW 3113B:2012; • SMEWW 3120B:2012; • SMEWW 3125B:2012; • US EPA method 200.7;

		• US EPA method 200.8
29.	Hg	• TCVN 7724:2007; • TCVN 7877:2008; • SMEWW 3112B:2012; • US EPA method 7470A; • US EPA method 200.8
30.	Phosphorous organic pesticides	• US EPA method 8141B; • US EPA method 8270D
31.	Chlorinated organic pesticides	• TCVN 7876:2008; • TCVN 9241:2012; • SMEWW 6630B:2012; • US EPA method 8081A; • US EPA method 8270D
32.	Polychlorinated biphenyls (PCB)	• TCVN 7876:2008; • TCVN 9241:2012; • SMEWW 6630C:2012; • US EPA method 1668B; • US EPA method 8082A; • US EPA method 8270D.
33.	Total dioxin/furan (PCDD/PCDF)	• US EPA method 1613B
34.	Dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method 1668B
35.	Animal and plant oil and grease	• MEWW 5520B&F:2012; • SMEWW 5520D&F:2012; • US EPA method 1664
36.	Total mineral oil and grease	• SMEWW 5520B&F:2012; • SMEWW 5520C&F:2012; • SMEWW 5520D&F:2012; • US EPA method 1664
37.	Total radioactivity α	• TCVN 6053:1995; • SMEWW 7110B:2012
38.	Total radioactivity β	• TCVN 6219:2011; • SMEWW 7110B:2012
39.	Coliform	• TCVN 6187-1:2009; • TCVN 6187-2:1996; • TCVN 8775:2011; • SMEWW 9221B:2012; • SMEWW 9222B:2012
40.	Salmonella	• TCVN 9717:2013;

		• SMEWW 9260B:2012
41.	Shigella	• SMEWW 9260E:2012
42.	Vibrio cholerae	• SMEWW 9260H:2012
43.	Adsorbable organically bound halogens (AOX)	• TCVN 6493:2008
44.	Surfactants	• TCVN 6622-2-2000; • TCVN 6336-1998; • TCVN 6622-1:2009; • SMEWW 5540C:2012; • US EPA method 425.1

Article 27. Environmental monitoring data processing

The environmental monitoring data shall be processed in accordance with Article 8, Chapter II of this Circular.

Section 7. EXHAUST GAS MONITORING

Article 28. Monitoring locations

The monitoring locations and number of monitoring points shall be determined according to US EPA method 1 or US EPA method 1A, specified in the Appendix 01 enclosed herewith.

Article 29. Monitoring parameters

1. The exhaust gas monitoring parameters include: velocity and flow, dry molecular weight, moisture content, O_2, temperature, pressure, CO_2, particulate matters (PM), PM_{10}, SO_2, NO_x (NO and NO_2), smoke unit, CO, H_2SO_4, cacbonyl sulfide (COS), CS_2, Pb, total Fluoride (F^-), organic matters; dioxins/furans (PCDD/PCDF), dioxin-like polychlorinated biphenyls (dl-PCB); total gaseous nonmethane organics (TGNMO), H_2S, HBr, Cl_2, Br_2, HF, HCl, NH_3; metals including antimony (Sb), As, Ba, Be, Cd, Cr, Co, Cu, Mn, Ni, Se, Ag, Tali (Tl) and Zn, Hg, and polycyclic aromatic hydrocarbons (PAHs).

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment, production types and size, features of exhaust sources and competent authorities' requirements.

2. Parameters mandatory for field monitoring include temperature, velocity, flow, moisture content, dry molecular weight, exhaust gas pressure. Technical regulations on parameters mandatory for field measurement are specified in the Appendixes 02, 03 and 04 enclosed herewith.

3. For the parameters including SO_2, NO_x (NO and NO_2), CO and O_2, apart from field sampling and laboratory analysis, field measurement may be carried out if all requirements specified in the Appendix 06 enclosed herewith are met.

Article 30. Monitoring time and number of monitoring samples

1. Monitoring time: samples are taken when the facility's production activities reach at least 50% of the design capacity. During sampling, such facility must operate stably.

2. Minimum number of samples monitored at a time: 03.

Article 31. Monitoring methods

1. Field monitoring: methods shall be selected in accordance with the applicable national technical regulations or Table 17 below.

Table 17

No.	Parameters	Code of method

1.	Velocity and flow	• US EPA method 2; • ISO 10780
2.	Dry molecular weight	• US EPA method 3
3.	Moisture content	• US EPA method 4
4.	O_2	• Use of direct measuring equipment
5.	Temperature	• Use of direct measuring equipment
6.	Pressure	• Use of direct measuring equipment
7.	CO_2	• Use of direct measuring equipment
8.	Particulate matters (PM)	• US EPA method 5; • US EPA method 17; • TCVN 5977:2005; • ISO 10155; • AS 4323.2:1995; • JIS Z 8808:2013
9.	SO_2	• US EPA method 6; • US EPA method 8; • US EPA method 8A; • TCVN 6750:2005; • TCVN 7246:2003; • JIS K 0103:2011; • Use of direct measuring equipment
10.	NO_x	• US EPA method 7; • TCVN 7172:2002; • TCVN 7245:2003; • JIS K 0104:2011; • Use of direct measuring equipment
11.	H_2SO_4	• US EPA method 8; • US EPA method 8A
12.	Smoke unit	• US EPA method 9
13.	CO	• US EPA method 10; • TCVN 7242:2003; • Use of direct measuring equipment
14.	H_2S	• US EPA method 15; • US EPA method 15A; • JIS K 0108:2010; • IS 11255 (part 4):2006
15.	NH_3	• JIS K 0099:2004
16.	Cacbonyl sulfide (COS)	• US EPA method 15; • US EPA method 15A

17.	CS_2	• US EPA method 15; • US EPA method 15A
18.	Pb	• US EPA method 12; • US EPA method 29; • TCVN 7557-1:2005; • TCVN 7557-3:2005
19.	Total Fluoride (F-)	• US EPA method 13A; • US EPA method 13B
20.	Organic matters	• US EPA method 0030; • US EPA method 0031; • US EP A method 0010
21.	Dioxins, furans (PCDD/PCDF)	• US EPA method 0023A; • TCVN 7556-1:2005; • TCVN 7556-2:2005; • TCVN 7556-3:2005; • BS EN 1948-1:2006
22.	Dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method 0023A; • BS EN 1948-1:2006
23.	Total gaseous nonmethane organics (TGNMO)	• US EPA method 25
24.	HBr	• US EPA method 26; • US EPA method 26A
25.	Cl_2	• US EPA method 26; • US EPA method 26A
26.	Br_2	• US EPA method 26; • US EPA method 26A
27.	HF	• US EPA method 26; • US EPA method 26A; • TCVN 7243:2003
28.	HCl	• US EPA method 26; • US EPA method 26A; • TCVN 7244:2003; • JIS K 0107:2012
29.	Metals including antimony (Sb), As, Ba, Be, Cd, Cr, Co, Cu, Mn, Ni, Se, Ag, TI and Zn	• US EPA method 29; • TCVN 7557:2005
30.	Hg	• US EPA method 29; • US EPA method 101A
31.	Mercury vapor	• US EPA method 30B
32.	PM_{10}	• US EPA method 201;

		• US EPA method 201A
33.	Polycyclic aromatic hydrocarbons (PAHs).	• US EPA method 23; • US EPA method 0010

2. Laboratory analysis

a) Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 18 below.

Table 18

No.	Parameters	Code of method
1.	Particulate matters (PM)	• US EPA method 5; • US EPA method 17; • TCVN 5977:2005; • ISO 10155; • AS 4323.2:1995; • JIS Z 8808:2013
2.	SO_2	• US EPA method 6; • US EPA method 8; • US EPA method 8A; • TCVN 6750:2005; • TCVN 7246:2003; • JIS K 0103:2011
3.	NO_x	• US EPA method 7; • TCVN 7172:2002; • TCVN 7245:2003; • JIS K 0104:2011
4.	H_2SO_4	• US EPA method 8; • US EPA method 8A
5.	Smoke unit	• US EPA method 9
6.	CO	• US EPA method 10; • TCVN 7242:2003
7.	H_2S	• US EPA method 15; • US EPA method 15A; • JIS K 0108:2010; • IS 11255 (part 4):2006
8.	NH_3	• JIS K 0099:2004
9.	Cacbonyl sulfide (COS),	• US EPA method 15; • US EPA method 15A
10.	CS_2	• US EPA method 15; • US EPA method 15A
11.	Pb	• US EPA method 12;

		• US EPA method 29; • TCVN 7557-1:2005; • TCVN 7557-3:2005
12.	Total Fluoride (F^-)	• US EPA method 13A; • US EPA method 13B
13.	Organic matters	• US EPA 0030; • US EPA 0031; • US EPA 0010
14.	Dioxins/furans (PCDD/PCDF)	• US EPA method 23; • BS EN 1948-2:2006; • BS EN 1948-3:2006; • TCVN 7556-2:2005; • TCVN 7556-3:2005
15.	Dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method 1668B; • BS EN 1948-2:2006; • BS EN 1948-3:2006
16.	Total gaseous nonmethane organics (TGNMO)	• US EPAmethod 25
17.	HBr	• US EPAmethod 26; • US EPAmethod 26A
18.	Cl_2	• US EPAmethod 26; • US EPAmethod 26A
19.	Br_2	• US EPAmethod 26; • US EPAmethod 26A
20.	HF	• US EPAmethod 26; • US EPAmethod 26A; • TCVN 7243:2003
21.	HCl	• US EPA method 26; • US EPA method 26A; • TCVN 7244:2003; • JIS K 0107:2012
22.	Metals including antimony (Sb), As, Ba, Be, Cd, Cr, Co, Cu, Mn, Ni, Se, Ag, TI and Zn	• US EPA method 29; • TCVN 7557:2005
23.	P	• US EPA method 29; • TCVN 7557:2005
24.	Hg	• US EPA method 29; • US EPA method 101A
25.	Mercury vapor	• US EPA method 30B;
26.	PM_{10}	• US EPA method 201;

		• US EPA method 201A
27.	Polycyclic aromatic hydrocarbons (PAHs)	• US EPA method 23; • US EPA method 0010

b) Technical regulations on particulate matter (PM) monitoring are specified in the Appendix 05 enclosed herewith.

Article 32. Environmental monitoring data processing

The environmental monitoring data shall be processed in accordance with Article 8, Chapter II of this Circular.

Section 8. SOIL MONITORING

Article 33. Monitoring parameters

The soil monitoring parameters include: temperature, particle size distribution, EC, Cl^-, SO_4^{2-}, PO_4^{3-}, NO_3^-, NH_4^+, total N, total P, total K, organic carbon, As, Cd, Pb, Zn, Hg, total Cr, Cu, chlorinated organic pesticides, phosphorus organic pesticides, total polychlorinated biphenyl (PCB), total dioxin/furan, PCDD/PCDF, dioxin-like polychlorinated biphenyls (dl-PCB).

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities' requirements.

Article 34. Monitoring frequency

1. Regarding total N, total P, total K and organic carbon, the monitoring frequency is at least 01 time every 3 - 5 years.

2. Regarding other parameters, the monitoring frequency is at least once a year at an interval of at least 6 months.

Article 35. Monitoring methods

1. Field sampling: methods shall be selected in accordance with the applicable national technical regulations or Table 19 below.

Table 19

No.	Name of method	Code of method
1	Soil quality - Simplified soil description	• TCVN 6857:2001
2	Soil sampling	• TCVN 4046:1985; • TCVN 7538-2:2005; • TCVN 7538-1:2006; • TCVN 7538-4:2007; • TCVN 7538-5:2007

2. Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 20 below.

Table 20

No.	Parameters	Code of method
1.	Humidity	• TCVN 6648:2000
2.	Particle size distribution	• TCVN 8567:2010
3.	pH	• TCVN 4402:1987; • TCVN 4401:1987; • TCVN 5979:2007

4.	EC	• TCVN 6650:2000
5.	Cl^-	• US EPA method 300.0
6.	SO_4^{2-}	• TCVN 6656:2000; • US EPA method 300.0
7.	PO_4^{3-}	• US EPA method 300.0
8.	NO_3^-	• TCVN 6643:2000; • US EPA method 300.0
9.	NH_4^+	• TCVN 6643:2000
10.	Total N	• TCVN 6645:2000; • TCVN 6643:2000; • TCVN 6498:1999
11.	Total P	• TCVN 8563:2010; • TCVN 6499:1999; • TCVN 8940:2011
12.	Total K	• TCVN 8660:2011
13.	Organic carbon	• TCVN 6642:2000; • TCVN 6644:2000; • TCVN 8941:2011
14.	As	• TCVN 8467: 2010; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7010
15.	Cd	• TCVN 6496:2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
16.	Pb	• TCVN 6496:2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
17.	Zn	• TCVN 6496:2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B;

		• US EPA method 7010
18.	Hg	• TCVN 8882:2011; • US EPA method 200.8; • US EPA method 7471B
19.	Total Cr	• TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
20.	Cu	• TCVN 6496:2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
21.	Chlorinated organic pesticides	• TCVN 8061:2009; • US EPA method 8081B; • US EPA method 8270D
22.	Phosphorous organic pesticides	• US EPA method 8141B; • US EPA method 8270D
23.	Total polychlorinated biphenyl (PCB)	• TCVN 8061:2009; • US EPA method 1668B; • US EPA method 8082A; • US EPA method 8270D
24.	Total dioxins/furans, PCDD/PCDF	• TCVN 10883:2016; • US EPA method 1613B
25.	Dioxin-like polychlorinated biphenyls (dl-PCB)	• US EPA method 1668B

Article 36. Environmental monitoring data processing

The environmental monitoring data shall be processed in accordance with Article 8, Chapter II of this Circular.

Section 9. SEDIMENT QUALITY MONITORING

Article 37. Monitoring parameters

The sediment quality monitoring parameters include: As, Cd, Pb, Zn, Hg, total Cr, Cu, chlorinated organic pesticides, phosphorus organic pesticides, total polychlorinated biphenyl (PCB), total dioxin/furan, (PCDD/PCDF), dioxin-like polychlorinated biphenyls (dl-PCB), polycyclic aromatic hydrocarbons (PAHs).

The monitoring parameters shall be determined according to the monitoring objectives, applicable national technical regulations on environment and competent authorities' requirements.

Article 38. Monitoring frequency

1. The freshwater sediment monitoring frequency: at least twice a year.

2. The salt water sediment monitoring frequency (near-shore and offshore seawater) and brackish water: at least once a year.

Article 39. Monitoring methods

1. Field sampling: methods shall be selected in accordance with the applicable national technical regulations or Table 21 below.

Table 21

No.	Name of method	Code of method
1	Sediment sampling	• TCVN 6663-13:2015; • TCVN 6663-19:2015

2. Preservation and transport of samples: samples taken shall be preserved in accordance with TCVN 6663-15:2004.

3. Laboratory analysis: methods shall be selected in accordance with the equivalent applicable national technical regulations or Table 22 below.

Table 22

No.	Parameters	Code of method
1.	As	• TCVN 8467:2010; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7010
2.	Cd	• TCVN 6496:2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
3.	Pb	• TCVN 6496:2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
4.	Zn	• TCVN 6496: 2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
5.	Hg	• TCVN 8882:2011; • US EPA method 200.8;

		• US EPA method 7471B
6.	Total Cr	• TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
7.	Cu	• TCVN 6496:2009; • TCVN 8246:2009; • US EPA method 200.7; • US EPA method 200.8; • US EPA method 7000B; • US EPA method 7010
8.	Chlorinated organic pesticides	• US EPA method 8081B; • US EPA method 8270D
9.	Phosphorous organic pesticides	• US EPA method 8141B; • US EPA method 8270D
10.	Total polychlorinated biphenyls (PCB)	• US EPA method 1668B; • US EPA method 8270D
11.	Total dioxin/furan (PCDD/PCDF)	• US EPA method 1613B; • TCVN 10883:2016
12.	Dioxin-like polychlorinated biphenyls (dl-PCB)	• USEPA method 1668B
13.	Polycyclic aromatic hydrocarbons (PAHs)	• US EPA method 8100; • US EPA method 8270D

Article 40. Environmental monitoring data processing

The environmental monitoring data shall be processed in accordance with Article 8, Chapter II of this Circular.

Chapter III

QUALITY ASSURANCE AND QUALITY CONTROL IN PERIODIC ENVIRONMENTAL MONITORING

Section 1. QUALITY ASSURANCE IN DESIGN OF ENVIRONMENTAL MONITORING PROGRAM

Article 41. Quality assurance in determination of objectives of environmental monitoring program

The objectives shall be determined according to applicable policies and law on applicable environmental protection, information that needs to be obtained and regulatory authorities' requests.

Article 42. Basic requirements applied to environmental monitoring program

1. Strategy, master plan and plan for environmental management and protection must be conformed to.

2. Scientificness, modernity and feasibility must be ensured.

3. All regulations on design of environmental monitoring program must be complied with.

4. The monitoring objectives must be fulfilled; monitoring time, frequency, components and parameters are reasonable and optimal.

5. Regulations on procedures and measures applied to each environmental parameter and components that need to be monitored must be complied with.

6. Environmental monitoring programs shall be regularly reviewed, adjusted and added.

7. After an environmental monitoring program is completely designed, it must be approved or obtain the written consent of a competent authority or the monitoring program management authority.

Article 43. Designing environmental monitoring program

1. Determine objectives of the environmental monitoring program.

2. Determine the environmental components that need to be monitored.

3. Make a list of monitoring parameters according to environmental components: field measurement parameters and analytical parameters.

4. Preliminary sampling method: determine sampling lines and points and mark them on the map or diagram; describe geographical locations, coordinates and symbols of monitoring points; preliminarily describe the sources, issues and objects that affect the monitoring area.

5. Carry out a physical survey of the area to be monitored;

6. Detailed sampling method: accurately determine sampling lines and points and create a diagram of the monitoring points, describe geographical locations and coordinates of monitoring points; describe the condition of the affecting sources in the monitoring area; determine borders of the monitoring area and forecast potential impacts or changes in the monitoring area;

7. Determine monitoring frequency and time.

8. Determine field sampling and measurement methods and laboratory analytical methods.

9. Determine sampling procedures, volume of samples to be taken, types of sample containers and preservatives, time for storing samples, types of samples and number of QC samples;

10. Make a list and plan for maintenance, inspection and calibration of field monitoring equipment and environmental analytical equipment, including equipment, instruments and vehicles for occupational safety assurance. The environmental monitoring equipment shall be managed and used as prescribed in Chapter VI of this Circular.

11. Select vehicles to serve sample collection and transport.

12. Prepare quality assurance and quality control (QA/QC) project plan in environmental monitoring. The QAPP shall be prepared as prescribed in the Appendix 07 enclosed herewith.

13. Prepare a plan for arrangement of people carrying out monitoring, specify duties of each of them.

14. Make an estimate of expenses for execution of monitoring program, including expenses for implementation of quality assurance and quality control (QA/QC) project plan in environmental monitoring.

15. Make a list of organizations and individuals involved in the execution of the program and responsibilities of relevant parties.

Section 2. QUALITY ASSURANCE AND QUALITY CONTROL IN FIELD MONITORING

Article 44. Quality assurance in field monitoring

The organization charged with field monitoring must satisfy the following quality assurance requirements:

1. People

a) Duties must be assigned to each person carrying out field monitoring;

b) The person charged with field monitoring must be provided with training suitable for the assigned duties and shall only be assigned to officially carry out field monitoring if he/she satisfies internal criteria.

2. Quality management system: the system must be set up, maintained and upgraded in conformity with operating scope to ensure objectivity and accuracy of test results.

3. Field monitoring document control: the documents under the organization's quality management system must be classified, consolidated, stored, managed and controlled.

4. Carrying out internal assessment of the organization's quality management system: annually, the organization must prepare plans and carry out internal self-assessment of the quality management system. The documents relating to quality management and field monitoring shall be assessed to inspect and ascertain the organization's compliance with requirements of the quality management system. After the assessment, the organization must take measures for fixing the detected errors (if any).

5. Monitoring methods

a) The field monitoring methods must be selected in accordance with regulations specified in Chapter II of this Circular;

b) The method of preserving and transporting samples must conform to the monitoring parameters. The transport of samples must be ensured in terms of quantity and quality; Transport time and temperature of samples during the transport are prescribed in applicable regulations on environmental monitoring of each monitoring parameter;

c) Chemicals, reference samples and reference materials must be fully prepared according to requirements of each monitoring method, stored in appropriate containers with labels specifying name or type of the chemical, reference sample and reference material; name of the manufacturer; concentration; preparation date; person in charge; useful life and other information (if any).

6. Inspection, maintenance and calibration of the environmental analytical equipment: a periodic plan for inspection, maintenance and calibration of the environmental analytical equipment must be prepared as prescribed in Chapter VI of this Circular.

7. Sample management:

a) Samples must be encoded and a sample code (sample symbol) must be attached to such samples during the sample lifetime.

b) Samples must be stored in the container in conformity with each monitoring parameter in order not to affect or change its quality, and must be labeled. The label must specify the monitoring parameter, sample code (code symbol), sampling time, method of preserving the used sample and other information (if any).

8. The field sampling record shall be made and completed after the field sampling.

9. Sample delivery: a sample delivery record, specifying names and signatures of the relevant parties must be available.

10. The field monitoring forms are specified in the Appendix 08 enclosed herewith.

Article 45. Quality control in field monitoring

1. Use of QC sample

a) The trip blank sample, equipment blank sample, field blank sample, field replicate/duplicate sample or other QC samples serving monitoring program or field monitoring quality assurance project plan shall be used. The QC samples to be used must conform to each monitoring parameter and environmental component and satisfy the following requirements:

a.1) The QC sample shall not exceed 10% of total number of real samples to be monitored;

a.2) In case there are between 10 and 30 real samples to be monitored in a monitoring program, only 03 samples shall be used. In case there are less than 10 real samples to be monitored, only 01 sample shall be used.

b) QC acceptance criteria for field monitoring are specified in section I, Appendix 09 enclosed herewith.

2. Use of reference materials: for the field measurement parameters, reference materials (standard solution, reference gases) shall be used to control the quality of field measurement data.

3. For the water monitoring parameters, field replicate/duplicate sample shall be used to evaluate the precision of the measurement data.

4. Participation in proficiency testing

a) The organization charged with field monitoring shall periodically participate in the proficiency testing for monitoring parameters and environmental components, which is organized by the Vietnam Environment Administration and units satisfying the requirements of ISO/IEC 17043:2010;

b) The proficiency testing results shall be assessed. In case the |Zscore| is greater than 2, the organization must take remedial measures for the detected error.

Section 3. QUALITY ASSURANCE AND QUALITY CONTROL IN ENVIRONMENTAL ANALYSIS

Article 46. Quality assurance in environmental analysis

The organization charged with environmental analysis must satisfy the following quality assurance requirements:

1. People

a) Duties must be assigned to each person carrying out environmental analysis;

b) The analyzer must be provided with training suitable for the assigned duties and shall only be assigned to officially carry out the analysis if he/she satisfies internal criteria.

2. Quality management system: the system must be set up, maintained and upgraded in conformity with operating scope to ensure objectivity and accuracy of analytical results.

3. Environmental analysis document control: the documents under the organization’s quality management system must be classified, consolidated, stored, managed and controlled.

4. Carry out internal assessment of the organization’s quality management system: annually, the organization must prepare plans and carry out internal assessment of the quality management system to inspect and ascertain the organization’s compliance with requirements of the quality management system. After the assessment, the organization must take measures for fixing the detected errors (if any).

5. Analytical methods

a) Analytical method selection: the analytical methods shall be selected as prescribed in Chapter II of this Circular. The suitability of the selected methods for the condition of the laboratory must be approved as prescribed in Point b of this Clause;

b) Approval for analytical methods: analytical methods must be approved and a written approval must be granted. The method approval must be included in a report according to the Appendix 13 enclosed herewith and the following characteristic quantitive shall be determined:

b.1) Determine the method detection limit: regulations specified in 40 CFR Part 136, Appendix B of US EPA: *“Definition and Procedure for the Determination of the Method Detection Limit-Revision 1.11”* shall be complied with;

b.2) Evaluate the precision (repeatability (RPD), reproducibility): TCVN 6910:2000 and regulations specified in the Appendix 09 enclosed herewith shall be complied with;

b.3) Determine the accuracy: TCVN 6910:2000 shall be complied with;

b.4) Estimate measurement uncertainty (U): TCVN 9595-3:2013 shall be complied with;

c) Establish a standard operating procedure (SOP): standard operating procedures for the approved analytical methods must be established. A standard operating procedure must contain at least the contents specified in the Appendix 14 enclosed herewith.

6. Checking, inspection, maintenance and calibration of the environmental analytical equipment: a periodic plan for inspection, maintenance and calibration of the environmental analytical equipment must be prepared as prescribed in Chapter VI of this Circular.

7. Environmental conditions within the laboratory: environmental within the laboratory must be controlled so that the analytical results or effectiveness of analyses are not affected.

8. Sample management

a) A sample management procedure must be established in conformity with each analytical parameter;

b) Samples must be encoded and a sample code must be attached to such samples while they are stored at the organization charged with environmental analysis. After being analyzed, samples must be stored and preserved for a period of time according to applicable regulations to be used in case of recheck and reanalysis.

c) Upon receipt, samples must satisfy the conditions for sample preservation according to regulations.

Article 47. Quality control in environmental analysis

1. In-house quality control

a) QC samples, including equipment blank sample, method blank sample, laboratory replicate/duplicate sample, spike sample/ matrix spike, certified reference material, control standard sample, or other QC samples serving the monitoring program or field monitoring quality assurance project plan prepared by the organization shall be used;

b) The minimum number of QC samples necessary for each sample batch must be sufficient to inspect the contamination of instruments, chemicals, reagents, affecting factors and assess the precision and accuracy of analytical results but must not exceed 15% of total number of samples necessary for analysis in a monitoring program;

c) QC acceptance criteria are specified in section II, Appendix 09 enclosed herewith.

2. Participation in the proficiency testing: the proficiency testing shall be carried out as prescribed in Clause 4, Article 45 of this Circular.

Section 4. QUALITY ASSURANCE AND QUALITY CONTROL IN DATA MANAGEMENT AND PREPARATION OF MONITORING RESULT REPORT

Article 48. Environmental monitoring data management

1. All documents and data on field monitoring and environmental analysis must be fully gathered in a truthful and timely manner, and stored and managed according to regulations.

2. The original documents about field monitoring and environmental analysis must be stored and ready to be provided for the competent authority upon request. The original documents include:

a) Field monitoring documents: field sampling record, sample delivery record, note of field measurement data, field replicate/duplicate sample measurement record, original data printed or stored in the memory of the field measuring equipment, calculation results and field monitoring results

b) Environmental analytical documents: analytical record, analytical result report, orginial data printed or stored in the memory of the analytical equipment;

c) Documents about field and laboratory QA and QC: records on sampling and field QC sample results, results of field equipment check with reference materials, results of QC samples used in environmental analysis;

3. The data on field monitoring and environmental analysis must be sufficient and compliant with the documents about field monitoring and environmental analysis, sampling time and site, analytical parameters and time, monitoring methods and equipment, and compliant with measurement data acceptance criteria.

4. The data on field monitoring and environmental analysis must be examined, processed, aggregated and evaluated as prescribed in Article 8 of this Circular. In case errors in field monitoring are found, the data must be re-examined or destroyed and removed, and must not be used for the purposes of preparing monitoring result reports. Documents and data must be retained before they are destroyed or removed.

Article 49. Report on environmental monitoring results

The report on environmental monitoring results shall be prepared as prescribed in the Circular No. 43/2015/TT-BTNMT dated September 29, 2015 of the Ministry of Natural Resources and Environment on state of the environment report, set of environmental indicators and management of environmental monitoring data.

Chapter IV

BASIC REQUIREMENTS AND TECHNICAL SPECIFICATIONS OF AUTOMATIC AND CONTINUOUS WASTEWATER AND EXHAUST GAS MONITORING SYSTEMS

Section 1. AUTOMATIC AND CONTINUOUS WASTEWATER MONITORING SYSTEM

Article 50. General requirements for automatic and continuous wastewater monitoring system

The automatic and continuous wastewater monitoring system (hereinafter referred to as “system” in this section) is installed to monitor wastewater monitoring parameters according to applicable regulations on environmental protection and must satisfy the following requirements:

1. The system includes:

a) Automatic and continuous monitoring equipment: 01 or multiple pieces of equipment that may measure, analyze and give wastewater monitoring data in an automatic and continuous manner. The appropriate method of installing monitoring equipment shall be determined according to the monitoring parameters and measurement and analysis principle of the monitoring equipment. To be specific:

a.1) Direct method (Figure 1): monitoring equipment (pH, temperature and TDS/EC probes, etc.) is installed directly in the wastewater holding tank behind the treatment system. The probes must be at least 10 cm from the surface of the tank and at least 15 cm from the bottom;

a.2) Indirect method (Figure 2): treated wastewater shall be pumped into the station, then sample containers and automatic analytical equipment (if any). The pH, temperature and TDS/EC probes are soaked directly in the sample containers inside the station;

b) The equipment for gathering, storing and transferring data: such equipment shall be used to gather, store and transfer automatic and continuous monitoring data of the system to the environment authority. The gathering, storage and transfer of data are specified in Chapter V of this Circular;

c) Standard solution: standard solution shall be used to check and calibrate the monitoring equipment of the system;

d) Automatic sampling equipment: automatic sampling equipment shall be used to take and store sample when one of the monitoring parameters exceeds the allowable standard or at the request of a competent authority;

dd) Camera: camera shall be used to provide online images of the location of monitoring equipment and outlet of the wastewater treatment system, before the wastewater is discharged into the receiving bodies;

e) Infrastructure, including:

e.1) Station: the station shall be used to contain the monitoring equipment of the system. Depending on the installation position, the station may be built in various forms but environmental safety must be ensured and the equipment installed inside the station must remain stable. The location of the station must satisfy the following requirements:

e.1.1) Little shaking and vibration;

e.1.2) Little effect of dust and corrosive gases;

e.1.3) Stable power source. The power source and power backup equipment must ensure the continuous operation of the system and switchgears and overcurrent and overvoltage protection devices must be available; voltage stabilizer with proper capacity must be available to ensure stable operation of the system, uninterruptible power supply (UPS) must be available to will keep the system running for at least 30 minutes after a power failure;

e.1.4) Ensuring convenient installation and maintenance and safety of human and equipment;

e.1.5) Being near the monitoring locations, satisfying the regulation specified in subpoint e.2.3, Clause 1 of this Article.

e.2) Sampling pumps and pipes (if any)

e.2.1) Sampling pumps: 02 alternating sampling pumps and a control system, which operate alternatively, must be available to ensure that water is continuously pumped into the holding tank or measuring and analytical equipment. Air bubbles must not be created in the pipe and holding tank. The pump body and chamber must be made of stainless steel or material that does not alter the quality of the water sample;

e.2.2) Pipes: pipes must be made of durable material that does not affect the quality of the water sample and is resistant to microbiological contamination. There must be two pipes laid in parallel to facilitate the pipe cleaning and periodic maintenance;

e.2.3) In the cases where indirect method is used to install measuring equipment, piping between the monitoring location and the holding tank must be as short as possible (20 m at the maximum) and the diameter (027 at the minimum) must be large enough for the pipe not to be blocked;

e.3) Fire alarm system, smoke detector, direct lightning and surge protection devices;

e.4) Other auxiliary equipment: depending on methods of measurement and analysis, and physical condition at the monitoring location, the auxiliary equipment (not mandatory) may include:

e.4.1) Sewer grates (used in case the equipment for direct monitoring of wastewater samples is installed): sewer grates shall be used to prevent rubbish and dirt from sticking to the probes, affecting the results. Sewer grates shall be made of stainless steel and resistant to corrosion;

e.4.2) Sample container: sample container shall be used to contain the wastewater samples to be monitored and probes. The container shall be made of stainless steel or material that does not affect wastewater and facilitates maintenance. Its volume must be compliant with the requirements of installation of monitoring equipment (15 liters at the minimum) and it must be designed to ensure continuous flow of water, minimize the deposition of water samples in the holding tank, thereby ensuring the accuracy and integrity of water samples;

e.4.3) Wastewater container: wastewater container shall be used to contain analyzed wastewater and standard solutions after use. The wastewater container must be made of chemical-resistant material to prevent leaks. The waste must be stored in a separate area and warning sign must be put up. The waste shall be managed and treated according to applicable regulations on management of waste and discarded materials.

e.5) Temperature and humidity meter must be installed inside the station.

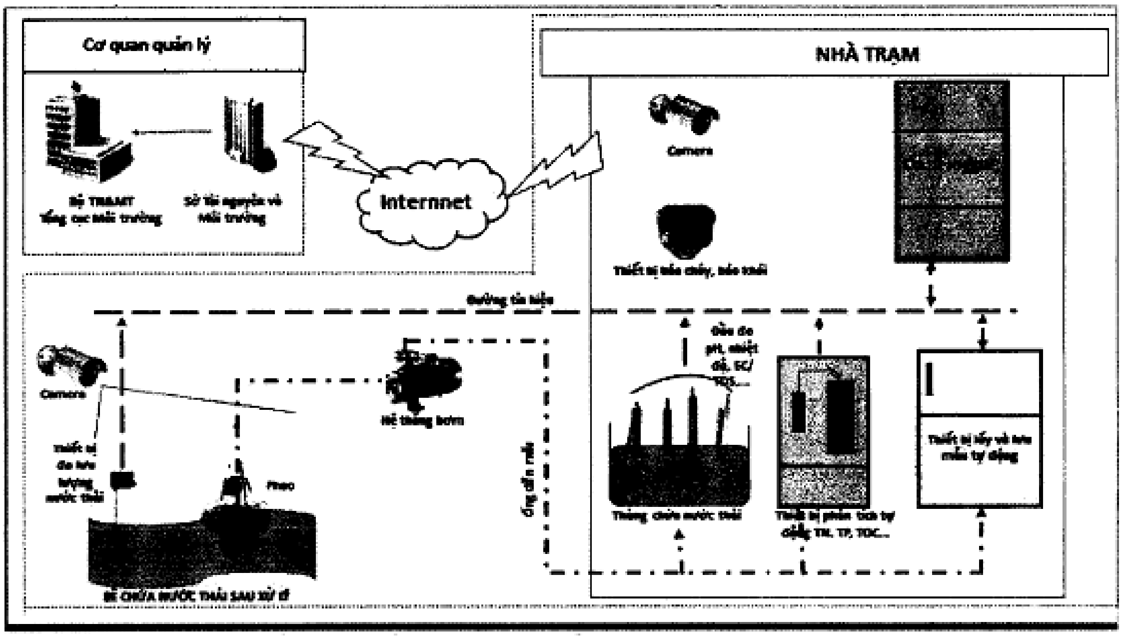


Figure 1: Automatic and continuous wastewater monitoring system (direct method: flow, pH, temperature and TDS/EC probes, etc.)

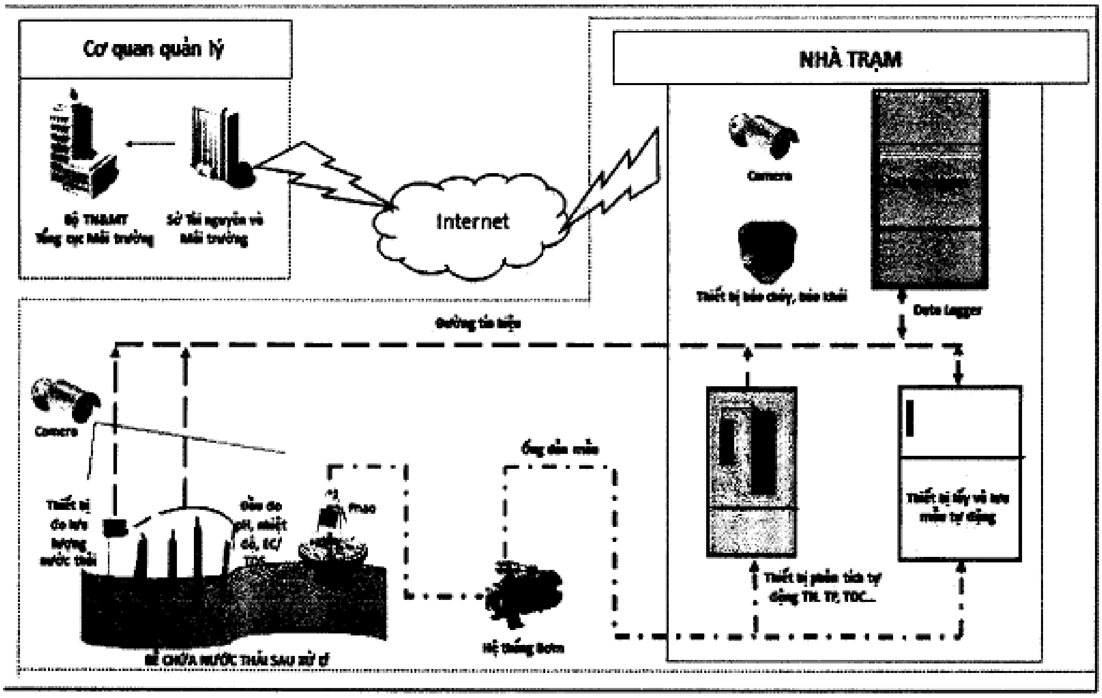


Figure 2: Automatic and continuous wastewater monitoring system (indirect method)

2. Monitoring location: the monitoring location must be representative of the waste source to be monitored and must be behind the wastewater treatment system before the wastewater is discharged into the receiving bodies.

3. Inspection, calibration, testing and periodic checking of automatic and continuous wastewater monitoring equipment

a) Equipment must be inspected, calibrated and tested in accordance with applicable regulations of the laws on measurement and product and goods quality;

b) Equipment must be periodically checked with reference materials upon the manufacturer’s recommendation and checked at least once a month by the system operator;

c) The maintenance, repair and replacement of components and accessories must be planned by the system operator and specified in the standard operating procedure (SOP).

4. Operating time: The system must operate continuously. During maintenance, inspection, calibration or replacement of components and accessories, repair or replacement of measuring and analytical equipment, wastewater must not be discharged into the environment.

5. Before the system is officially put into operation, the system operator must submit relevant documents to the Department of Natural Resources and Environment, including:

a) Information about the system investor and operator: name and address;

b) Installation time (starting and ending time), and time and result of system quality control in accordance with regulations specified in Clause 2, Article 52 of this Circular;

c) Drawing and description of the system; list of monitoring parameters and methods of installing monitoring equipment (direct or indirect method); descriptive information and images, diagram and map of the monitoring locations;

d) List and technical specifications of measuring and analytical equipment; manufacturers and equipment models; certificate and inspection and calibration result reports; monitoring data gathering and storage system; static IP address (data transfer protocol) attached to the system.

Article 51. Requirements for technical specifications and functions of automatic and continuous wastewater monitoring system

1. Automatic and continuous monitoring equipment

a) Technical specifications of automatic and continuous monitoring equipment of the system must satisfy the requirements specified in Table 23 below.

Table 23

No.	Monitoring parameters	Measurement unit	Accuracy (% of reading)	Resolution	Response time
1	Flow	m^3/h	± 5%	-	≤ 5 minutes
2	Temperature	°C	± 0.5%	0.1	≤ 5 seconds
3	Color	Pt-Co	± 5%	-	≤ 5 seconds
4	pH	-	± 0.2 pH	0.1	≤ 5 seconds
5	TSS	mg/L	± 5%	0.1	≤10 seconds
6	COD	mg/L	± 5%	0.5	≤ 15 minutes
7	BOD	mg/L	± 5%	0.5	≤ 15 minutes
8	$N\text{-}NH_4^+$	mg/L	± 5 %	0.2	≤ 30 minutes
10	Total p	mg/L	± 3 %	0.1	≤ 30 minutes
11	Total N	mg/L	± 3%	0.1	≤ 30 minutes
12	TOC	mg/L	± 2%	0.1	≤ 30 minutes
13	Hg	mg/L	± 0.01%	0.001	≤ 30 minutes
14	Fe	mg/L	± 2%	0.1	≤ 30 minutes
15	Total Cr	mg/L	± 0.1%	0.1	≤ 30 minutes
16	Cd	mg/L	± 0.01%	0.1	≤ 30 minutes
17	Clorua	mg/L	± 2%	0.1	≤ 30 minutes
18	Total phenols	mg/L	± 2%	0.1	≤ 40 minutes
19	Total cyanide	mg/L	± 2%	0.1	≤ 30 minutes

Note: “-” unspecified.

b) The monitoring equipment must be able to measure the value that is 3-5 times the limits according to applicable national technical regulation on environment;

c) It is recommended to use synchronious monitoring equipment that is certified by international organizations, including United States Environmental Protection Agency (US EPA), Environment Agency's Monitoring Certification Scheme (mCERTs), German Technical Inspection Association (Technischer Überwachungsverein, TÜV), Republic of Korea's Ministry of Environment (KMOE), Japan's Ministry of Environment (JMOE);

d) The monitoring equipment can automatically store and export monitoring data and status of the measuring equipment (including the following status: measuring, calibrating and error).

2. Reference materials

a) The reference material used for periodic inspection must be within the period of its natural shelf life, have a minimum accuracy of ± 5% (± 0.1 pH for pH) and traceable to standards in accordance with regulations of the law on measurement.

b) The reference material must meet at least 3 concentrations in the measurement range equivalent to each parameter specified in Table 23, except for temperature and flow.

3. Automatic sampling and sample storage equipment

An automatic sampling and sample storage equipment must have the following functions:

a) Automatically take samples (periodic, unscheduled or over time) and store samples in the storage cabinet at 4 ± 2°C;

b) Receive control signals from competent authorities to serve automatic remote sampling.

4. Camera

a) In case of direct method: 01 camera shall be installed at the outlet of the wastewater treatment system;

b) In case of indirect method: 01 camera shall be installed inside the station and outside the station, at the outlet of the wastewater treatment system;

c) The camera must be compliant with the following technical requirements: IP 65 standard, video resolution: full HD 1080p (15fps); ability to rotate (vertically and horizontally); night vision of up to 20m; ability to record images at pre-determined time and make a scheduled recording.

Article 52. Assurance and control of quality of automatic and continuous wastewater monitoring system

1. Assurance of quality of the system

a) Management and operation staff: there must be sufficient staff expert in the system in order to perform the task of managing, maintaining and operating the system;

b) The system operator must periodically participate in the reference material measurement and analysis programs annually organized by the Vietnam Environment Administration.

c) The system management documents must be retained by the system operator and are ready to be presented at the request of the competent authority. The system management documents include:

c.1) List of monitoring parameters;

c.2) List and technical specifications of measuring and analytical equipment; equipment test report by the manufacturer;

c.3) User guide;

c.4) Drawing and description of the system;

c.5) Standard operating procedure (SOP): A SOP must include contents relating to start-up and operating procedures; procedures for daily system testing; frequency and procedures for testing equipment with standard solution; procedures for mixing chemicals, reference materials and creating calibration curve of the analytical equipment (if any); frequency and procedures for maintaining monitoring equipment; frequency of inspection and calibration of equipment; frequency of replacement of accessories and consumables upon the manufacturer's recommendations; procedures for rectifying errors; data back-up procedures; procedures for examining and reporting data, regulations on safety during system operation and procedures for storage, management and treatment of waste that arises;

c.6) Standby equipment, materials and accessories;

c.7) Equipment maintenance, inspection and calibration logbook;

c.8) Manual for some common errors and how to troubleshoot the problems during management and operation of the system;

c.9) Logbook for monitoring and inspection of daily operations of the system;

c.10) Certificate and report on inspection and calibration of the system's monitoring equipment;

c.11) Proof of participation in standard solution measurement and analysis programs organized by the Vietnam Environment Administration;

c.12) Record on testing of relative accuracy of the system;

2. The quality of the system must be controlled before the system is officially put into operation and controlled once a year by a third party to ensure independence and objectivity. The following procedures shall be completed:

a) Inspect monitoring location: regulation specified in Clause 2, Article 50 shall be complied with;

b) Inspect the gathering, storage and transfer of automatic and continuous data of the system;

c) Inspect components, technical specifications and other functions of the system;

d) Evaluate the relative accuracy of the system, including:

d.1) Carry out reference monitoring

d.1.1) Reference monitoring is the use of periodic monitoring methods specified in Section 6, Chapter II of this Circular or methods accepted by US EPA as the equivalent methods to refer and compare the achieved results and monitoring results of the system;

d.1.2) Reference monitoring of each parameter shall be carried out;

d.1.3) At least 6 samples shall be used as reference for every parameter to be monitored.

d.2) The control monitoring data shall be calculated and evaluated using relative accuracy (RA). To be specific:

d.2.1) Calculation shall be made as prescribed in the Appendix 10 enclosed herewith;

d.2.2) In case RA is within the allowable limit specified in Table 24 below, the monitoring data of the system is accepted for use;

Table 24

No.	**Parameters**	**Limit of RA (%)**
1	pH	≤ 20
2	TSS	≤ 30
3	COD	≤ 20
4	BOD	≤ 30
5	$N\text{-}NH_4^+$	≤ 20

6	Total P	≤ 20
7	Total N	≤ 20
8	TOC	≤ 20
9	Hg	≤ 20
10	Fe	≤20
11	Total Cr	≤ 20
12	Cd	≤ 20
13	Clorua	≤ 20
14	Total phenols	≤ 20
15	Total cyanide	≤ 20

d.2.3) In case RA exceeds the limits specified in Table 24, the system operator must find causes and take remedial actions. The reference monitoring must be carried out again to calculate RA until RA satisfies the requirements specified in subpoint d.2.2 of this Article, then the monitoring data of the system is accepted for use.

dd) QC information shall be made into the record on testing of technical specifications, functions and RA of the system, which is specified in the Appendix 11 enclosed herewith.

Section 2. AUTOMATIC AND CONTINUOUS EXHAUST GAS MONITORING SYSTEM

Article 53. General requirements for automatic and continuous exhaust gas monitoring system

The automatic and continuous exhaust gas monitoring system (hereinaftered referred to as “system” in this section) is installed to monitor exhaust gas monitoring parameters according to applicable regulations on environmental protection and must satisfy the following requirements:

1. The system includes:

a) Automatic and continuous monitoring equipment: 01 or multiple pieces of equipment that may measure, analyze and give exhaust gas monitoring data in an automatic and continuous manner. According to the monitoring parameters, and measurement and analysis principle of the monitoring equipment to determine an appropriate method of installing monitoring equipment. To be specific:

a.1) In-situ method (Figure 3): the monitoring equipment is mounted directly on the stack hull to measure parameters and the sample-carrying duct shall not be used;

a.2) Extractive method (Figure 4): the exhaust gas sample is extracted from the stack hull through the probe and is taken to the monitoring equipment through the sample-carrying duct;

b) The equipment for gathering, storing and transferring data: such equipment shall be used to gather, store and transfer automatic and continuous monitoring data of the system to the environment authority. The gathering, storage and transfer of data are specified in Chapter V of this Circular;

c) Standard gas cylinder: separate or mixed gas cylinder shall be used to provide reference gases for the checking and calibration of the monitoring equipment of the system;

d) Camera: it is highly recommended to install camera to provide online images of locations of monitoring equipment of the system;

dd) Infrastructure, including:

dd.1) Station: station shall be used to contain monitoring equipment of the system. Depending on the installation position, the station may be installed or built in various forms but environmental safety must be ensured and the equipment installed inside the station must remain stable.

dd.2) The power source and power backup equipment must ensure the continuous operation of the system. In addition, switchgears and overcurrent and overvoltage protection devices must be available; voltage stabilizer and uninterruptible power supply (UPS) with capacity in conformity with equipment system must be available;

dd.3) Fire alarm system, smoke detector, direct lightning and surge protection devices.

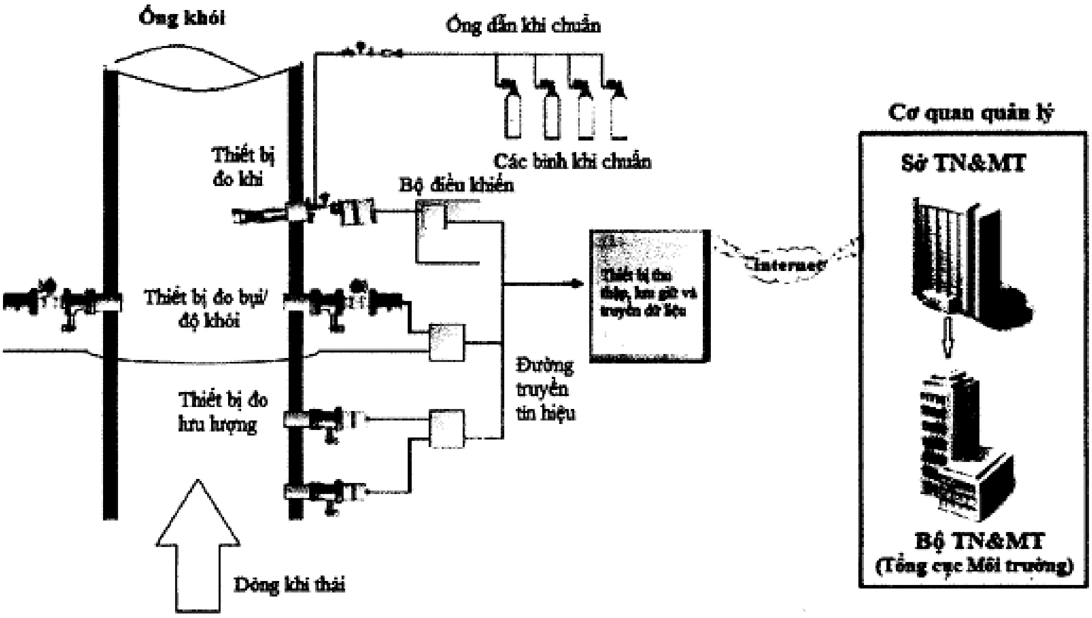


Figure 3: Automatic and continuous exhaust gas monitoring system (direct method)

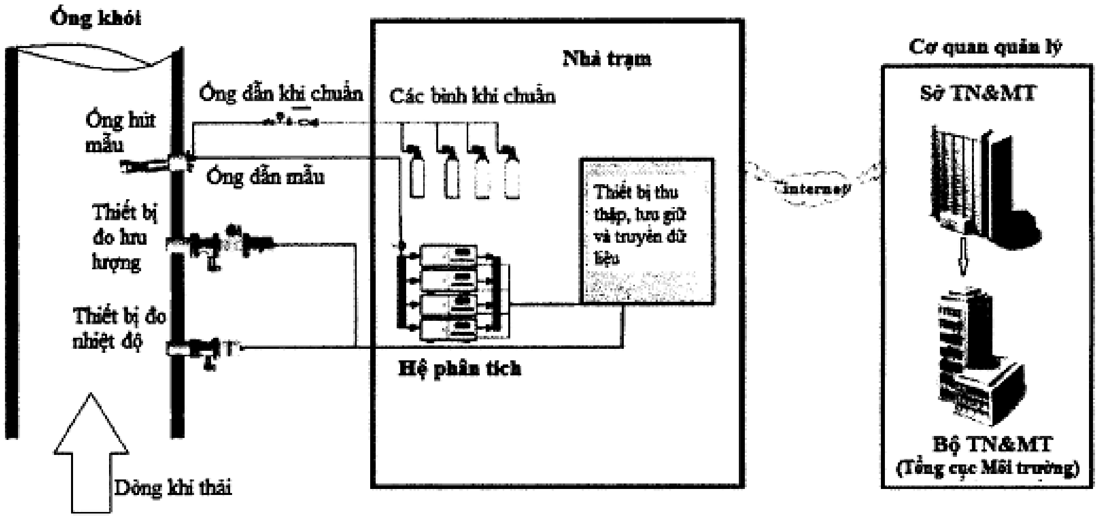


Figure 4: Automatic and continuous exhaust gas monitoring system (indirect method)

2. Location of monitoring holes

a) The determination of location of optimal monitoring hole (mandatory for particulate pollutants): regulations on determination of the location of the sampling port, which are specified in Clause 1, Section III, Appendix 01 enclosed herewith shall be complied with.

b) For the gaseous pollutants: in case the stack fails to satisfy the conditions for determining location of optimal monitoring hole, the monitoring holes must not be located at the mouth of the stack, the place where the stack is contracted or dilated, near exhaust fan or air ejector fan; it is best to place them near the place where the gas flow moves stably.

3. Inspection, calibration, testing and periodic checking of monitoring equipment

a) Automatic and continuous monitoring quipment must be inspected, calibrated and tested in accordance with applicable regulations of the laws on measurement and product and goods quality;

b) Monitoring equipment must be periodically checked with reference gases upon the manufacturer's recommendation and inspected at least twice a week by the system operator. During the measurement of reference gases, entire pump system and monitoring equipment must be in the same mode as the measurement and analysis of exhaust gas flow.

c) The reference gas used for periodic check is specified in Clause 2, Article 54 of this Circular.

4. Operating time: The system must operate continuously, except for the cases where the maintenance, inspection, calibration, repair or replacement of equipment, components and accessories has been included in the plan and standard operating procedure by the system operator.

5. Before the system is offcially put into operation, the system operator must submit relevant documents to the Department of Natural Resources and Environment, including:

a) Information about the system investor and operator: name and address, type of production, production line, design capacity;

b) Installation time (starting and ending time), and time and result of system quality control in accordance with regulations specified in Clause 2, Article 55 of this Circular;

c) Drawing and description of the system; list of monitoring parameters and methods of installing monitoring equipment (in-situ or extractive method); information about the stack (height, diameter), location, images of the monitoring hole on the stack;

d) List and technical specifications of monitoring equipment and probe; manufacturers and equipment models; certificate and inspection and calibration result reports; monitoring data gathering and storage system; name of the system and static IP address attached to the system.

Article 54. Requirements for technical specifications and functions of automatic and continuous exhaust gas monitoring system

1. Automatic and continuous monitoring equipment

a) The technical specifications of automatic and continuous monitoring equipment of the system must satisfy the requirements specified in Table 25 below.

Table 25

No.	**Parameters**	**Measurement unit**	**Accuracy (% of reading)**	**Resolution**	**Response time** (second)
1.	Temperature	°C	± 5%	-	≤ 120
2.	NO	mg/Nm^3	± 5%	1 mg/m^3	≤ 200
3.	NO_2	mg/Nm^3	± 5%	1 mg/m^3	≤ 300
4.	CO	mg/Nm^3	± 5%	1 mg/m^3	≤ 200
5.	SO_2	mg/Nm^3	± 5%	1 mg/m^3	≤ 200
6.	O_2	%V	± 0.5%	0.1 %V	≤ 200
7.	Smoke unit	%	± 5%	0.1 %	≤ 30
8.	H_2S	mg/Nm^3	± 5%	0.1 mg/m^3	≤ 300
9.	NH_3	mg/Nm^3	± 5%	0.1 mg/m^3	≤ 300
10.	Hg vapor	mg/Nm^3	± 5%	0.1 mg/m^3	≤ 900
11.	Particulate matters (PM)	mg/Nm^3	± 10%	0.1 mg/m3	≤ 60

Note: "-" unspecified

b) The monitoring equipment must be able to measure the value that is 3-5 times the limits according to applicable national technical regulation on environment and national technical regulations equivalent to each type of production;

c) For the parameters: exhaust gas velocity, dust, smoke unit and flow, in-situ method shall be used;

d) For the parameters that require extractive method, the system must satisfy the following requirements:

d.1) Probe: probe must be made of stainless steel and placed perpendicular to the stack wall. The probe must be 1 m long or 30% of the diameter of the stack (or the diameter is equivalent to a rectangular stack);

d.2) Sample-carrying duct from the monitoring hole to the monitoring equipment must not be contracted, dilated or folded at an angle of less than 90 degrees;

d.3) The exhaust gas passing through the probe must be heated to remove moisture before entering the measuring and analytical equipment;

dd) It is recommended to use synchronious monitoring equipment that is certified by international organizations, including United States Environmental Protection Agency (US EPA), Environment Agency's Monitoring Certification Scheme (mCERTs), German Technical Inspection Association (Technischer Überwachungsverein, TÜV), Republic of Korea's Ministry of Environment (KMOE);

e) The monitoring equipment can automatically store and export monitoring data and status of the measuring equipment (including the following status: measuring, calibrating and error).

2. Reference gas

a) The reference gas must be taken to the exhaust gas flow and then probe (see Figure 3 and Figure 4. Automatic and continuous exhaust gas monitoring system);

b) The reference gas must be within the period of its natural shelf life, have a minimum accuracy of ± 5% and traceable to standards in accordance with regulations of the law on measurement;

c) The concentration of reference gas must meet at least 30%-70% of the measurement range of each equipment equivalent to each parameter specified in Table 25, except for exhaust gas, smoke unit, particulate matters (PM) and flow.

Article 55. Assurance and control of quality of automatic and continuous exhaust gas monitoring system

1. Assurance of quality of the system

a) Management and operation staff: there must be sufficient staff expert in the system in order to perform the task of managing, maintaining and operating the system;

b) The system management documents must be retained by the system operator and are ready to be presented at the request of the competent authority. The system management documents include:

b.1) List of monitoring parameters;

b.2) List and technical specifications of monitoring equipment of the system;

b.3) User guide;

b.4) Drawing and description of the system;

b.5) Standard operating procedure (SOP): A SOP must include contents relating to start-up and operating procedures; procedures for daily system testing; frequency and procedures for testing probe and testing with reference gas (twice a week); frequency and procedures for maintaining monitoring equipment; frequency of inspection and calibration of equipment; frequency of replacement of accessories and consumables upon the manufacturer’s recommendations; procedures for rectifying errors; data back-up procedures; procedures for examining and reporting data, regulations on safety during system operation and procedures for storage, management and treatment of waste that arises;

b.6) Standby equipment, materials and accessories;

b.7) Equipment maintenance, inspection and calibration logbook;

b.8) Manual for some common errors and how to troubleshoot the problems during management and operation of the system;

b.9) Logbook for monitoring and inspection of daily operations of the system;

b.10) Certificate and report on inspection and calibration of the monitoring equipment of the system;

b.11) Record on testing of relative accuracy of the system;

2. The quality of the system must be controlled before the system is officially put into operation and controlled once a year by a third party to ensure independence and objectivitiy. The following procedures shall be completed:

a) Test monitoring hole: regulation specified in Clause 2, Article 53 shall be complied with;

b) Test probe: regulation specified in subpoint d.1, Clause 1, Article 54 shall be complied with;

c) Check sample carrying duct: reference gas shall be used to check sample carrying duct as prescribed in subpoint d.2, Clause 1, Article 54. During the measurement of reference gases, entire pump system and monitoring equipment must still operate in the same mode as the measurement and analysis of exhaust gas flow. To be specific:

c.1) Measuring time for testing with reference gas is at least 20 minutes for every measurement;

c.2) In case the reference gas measurement data deviates by ≤ 5% from the reference gas concentration, the sample carrying duct meets the prescribed requirements. After the check, information shall be stored.

d) Check the pollution parameter monitoring equipment's functions of measuring and convert the results into mg/Nm^3.

dd) Check the gathering, storage and transfer of automatic continuous data of the system.

e) Check components and other functions of the system.

g) Evaluate the relative accuracy of the system, including:

g.1) Carry out reference monitoring

g.1.1) Reference monitoring is the use of periodic monitoring method specified in Section 7, Chapter II of this Circular or methods accepted by US EPA as the equivalent methods to refer and compare the achieved results and monitoring results of the system;

g.1.2) Reference monitoring of each parameter shall be carried out;

g.1.3) At least 06 samples shall be used for reference for every parameter to be monitored;

g.1.4) While the reference monitoring is being carried out, the facility's capacity must reach at least 50% of the design capacity;

g.2) The reference monitoring data shall be evaluated using relative accuracy (RA). To be specific:

g.2.1) Reference monitoring data shall be calculated. Reference monitoring data of the system and reference monitoring method shall be used to calculate: difference, standard deviation, confidence coefficient and relative accuracy of each equipment and parameter according to the Appendix 10 enclosed herewith. The calculation result must be made into the record on checking of technical specifications, functions and RA of the system, which is specified in the Appendix 12 enclosed herewith;

g.2.2) In case RA is ≤ 20%, the monitoring data of the system is accepted for use;

g.2.3) In case RA is > 20%, the system operator must find causes and take remedial actions.

After taking remedial actions, the reference monitoring must be carried out again to calculate RA until it satisfies the requirements specified in point g.2.2 of this Article, then the monitoring data of the system is accepted for use.

h) QC information shall be made into the record on checking of technical specifications, functions and RA of the system, which is specified in the Appendix 12 enclosed herewith.

Chapter V

REQUIREMENTS FOR RECEIPT, TRANSFER AND MANAGEMENT OF DATA OF AUTOMATIC AND CONTINUOUS ENVIRONMENTAL MONITORING SYSTEM

Article 56. Requirements for data logger

The data logger (see Figure 5) must satisfy the following requirements:

1. Receipt, storage and management of data

a) The system must be directly connected to measuring and analytical equipment, data controler, and automatic sampling system (if any) and must not be connected through other equipment;

b) The output signal of the system must be digital;

c) Data must be stored for at least 30 consecutive days. Stored data must include: measurement parameters, results, unit and time, status of the measuring equipment (measuring, calibrating and error);

d) Data must be displayed and extracted using the data logger.

2. Data transfer

a) Data must be transferred using FTP to FTP server with the FTP account and address provided by the Department of Natural Resources and Environment. Internet connection speed must be at least 3MB/s;

b) Every file must be transferred in real time but no later than 5 minutes after data is gathered from the data logger. Data must be transferred to the Department of Natural Resources and Environment by using the static IP address already reported to the Department of Natural Resources and Environment;

c) Real time must be synchronized with Vietnam Time Zone (GMT+ 7);

d) In case the data transfer is interrupted, after the recovery, the system must automatically transfer the interrupted data. In case the data transfer is interrupted for more than 12 hours, the organization charged with environmental monitoring must send a written response and email about causes and remedial measures for the interruption to the Department of Natural Resources and Environment;

dd) Receipt of control signals for remote automatic sampling (if any) and gathering of data upon request are allowed.

3. File format and content

a) Data is formatted in a *.txt file;

b) A file must include: measurement parameters, results, unit and time, status of the measuring equipment (measuring, calibrating and error). Structure, content and name of the file are specified in the Appendix 15 enclosed herewith.

4. Data security and integrity

a) After the automatic and continuous environmental monitoring station is officially put into operation, an account and password are required to control access to the system. Such account and password shall be established and managed by the Department of Natural Resources and Environment;

b) The facility must ensure and take responsibility for data security and integrity, FTP server account and static IP address through which data is transferred.

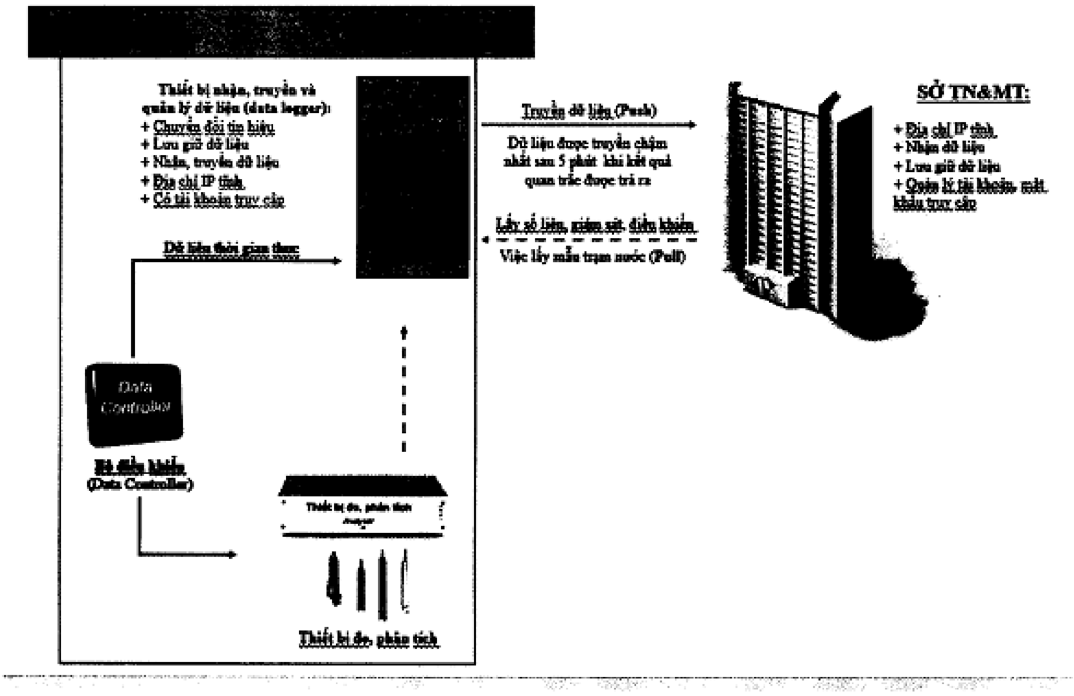


Figure 5: Receipt and transfer of data from the data logger to the Department of Natural Resources and Environment

Article 57. Requirements for data logging system operated at the Departments of Natural Resources and Environment

The data logging system operated at the Department of Natural Resources and Environment (see Figure 6) must satisfy the following requirements:

1. Regarding receipt, storage and management of data from the data logger

a) There must be at least 01 server with the following minimum configuration: 2.5 GHz processor; 32 GB internal memory; 2 TB hard drive;

b) Internet connection speed must be at least 3MB/s;

c) Static IP address must be available and reported to the Ministry of Natural Resources and Environment;

d) There must be at least 02 screens (40 inches at the minimum) to serve display and monitoring of automatic and continuous real-time monitoring data.

dd) FTP server account must be provided for the facility to transfer data;

e) The data received at the Department of Natural Resources and Environment must be verified according to the static IP address and FTP account already granted to the facility;

g) The Department of Natural Resources and Environment shall create and manage account and password for access to the data logging system operated at the automatic and continuous environmental monitoring station.

2. Requirements for data management

a) A database must be established to store data obtained from automatic and continuous environmental monitoring stations in the province in order to manage the following information: name of station, measurement results, unit and time, and status of the measuring equipment (measuring, calibrating and error);

b) A software satisfying the following basic functions must be designed: extraction of data in the form of tables or graphs; data management and display (name of the station, measurement parameters, results, unit and time, status of the measuring equipment, and measurement results in excess of the limits specified in QCVN); transfer of data to the Ministry of Natural Resources and Environment; data calculation, comparison and editing (calculation of maximum, minimum and mean values, comparison of results with QCVN); online monitoring and warning (measurement results in excess of the limit values specified in QCVN, data transfer interruption); system administration (creation of accounts with various levels of privileges). The software must be controlled so that it can obtain data and take samples from the automatic and continuous environmental monitoring station.

3. Requirements for transfer of data to the Ministry of Natural Resources and Environment (through the Vietnam Environment Administration)

a) The transferred data is formatted in a *.txt file;

b) Data must be transferred using FTP to FTP server with the FTP account and address provided by the Vietnam Environment Administration;

c) Data must be automatically transferred using the static IP address already reported to the Ministry of Natural Resources and Environment at 1 hour interval;

d) The data transferred is hourly average values (at 1:00, 2:00, 3:00... 24:00) of the parameters;

dd) The file on hourly average values must include the following information: measurement parameters, results, unit and time, status of the measuring equipment (measuring, calibrating and error), structure, content, regulation on name of the file on hourly average values, which are specified in the Appendix 15 enclosed herewith;

e) Real time must be synchronized with Vietnam Time Zone (GMT+ 7);

g) In case the data transfer is interrupted, after the recovery, the system must automatically transfer the interrupted data. In case the data transfer is interrupted for more than 12 hours, the Department of Natural Resources and Environment must send a written response and email about causes, remedial measures for the interruption to the Ministry of Natural Resources and Environment (through the Vietnam Environment Administration);

h) The Department of Natural Resources and Environment must ensure and take responsibility for data security and integrity, FTP server account and static IP address of the facility.

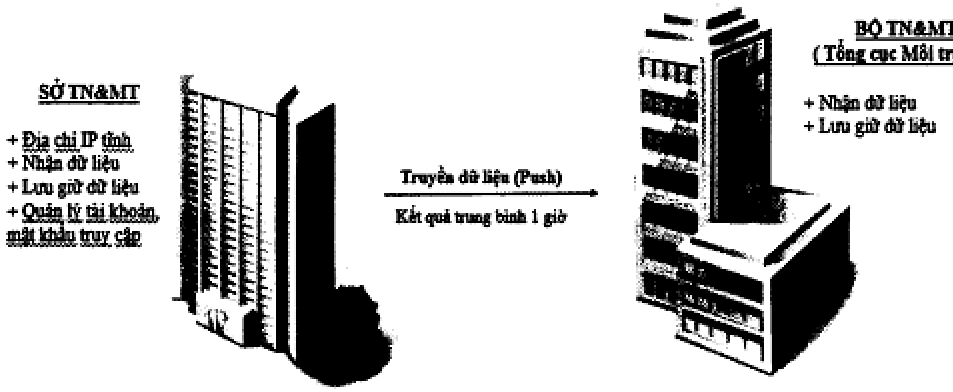


Figure 6: Receipt and transfer of data from the Department of Natural Resources and Environment to the Ministry of Natural Resources and Environment

Article 58. Requirements for the system for receipt and management of automatic and continuous environmental monitoring data operated the Vietnam Environment Administration and Ministry of Natural Resources and Environment

The data receipt and management system operated at the Vietnam Environment Administration and Ministry of Natural Resources and Environment must satisfy the following requirements:

1. Regarding receipt and storage of data

a) There must be at least 03 servers with the following minimum configuration: 2.5 GHz processor; 64 GB internal memory; 20 TB hard drive;

b) Internet connection speed must be at least 10MB/s and a static IP address is available;

c) There must be at least 08 screens (40 inches at the minimum) to serve display and monitoring of automatic and continuous real-time monitoring data.

d) FTP account must be provided for the Department of Natural Resources and Environment to transfer data;

2. Requirements for data management

a) A database must be established to store data obtained from automatic and continuous environmental monitoring stations in order to manage the following information: name of station, measurement results, unit and time, and status of the measuring equipment (measuring, calibrating and error);

b) A software satisfying the following basic functions must be designed: extraction of data in the form of tables or graphs; data management and display (name of the station, measurement parameters, results, unit and time, status of the measuring equipment (measuring, calibrating and error); data calculation, comparison and editing (calculation of maximum, minimum and mean values, comparison of results with QCVN); online monitoring and warning (measurement results in excess of the limit values specified in QCVN, data transfer interruption); system administration (creation of accounts with various levels of privileges).

3. Requirements for receipt of data from the Department of Natural Resources and Environment: the obtained data must be verified according to the static IP address of the Department of Natural Resources and Environment and FTP account already granted to the Department of Natural Resources and Environment.

Chapter VI

MANAGEMENT AND USE OF ENVIRONMENTAL MONITORING EQUIPMENT

Article 59. Use of environmental monitoring equipment

1. Environmental monitoring equipment shall only be used when metrological control measures are taken as prescribed in Article 61 of this Circular.

2. Environmental monitoring data must be used in accordance with manufacturer’s user guide, procedures for using equipment, and technical measurement requirements specified in Vietnam’s metrological documents.

3. Before use, environmental monitoring equipment must be inspected (external inspection, technical inspection and accuracy inspection). In case the equipment fails to satisfy measurement requirements, stop using it, make a record and include it in the management documents.

Article 60. Maintenance, repair and replacement of environmental monitoring equipment

The plan for periodic maintenance, repair and replacement of environmental monitoring equipment must be prepared and implemented in accordance with manufacturer’s instructions and procedures for using equipment.

Article 61. Metrological control and quality of environmental monitoring equipment

1. Environmental monitoring equipment must be under metrological control (inspection, calibration and testing) in accordance with applicable regulations of the law on measurement.

2. Before being put into operation, the environmental monitoring equipment must undergo quality inspection and satisfy technical standards and regulations in accordance with applicable regulations of the law on measurement.

Article 62. Environmental monitoring equipment management document

1. The organization charged with environmental monitoring shall prepare monitoring equipment management documents.

2. Environmental monitoring equipment management documents include:

a) Regarding automatic and continuous wastewater and exhaust gas monitoring equipment: the documents are specified in Point c, Clause 1, Article 52 and Point b, Clause 1, Article 55.

b) Regarding the remaining equipment: the environmental monitoring equipment management documents include:

b.1) List and technical specifications of monitoring equipment; manufacturer's user guide;

b.2) Standard operating procedures and inspection procedures;

b.3) Equipment delivery logbook;

b.4) Logbook for maintenance, repair and replacement of components and accessories;

b.5) Documents about metrological control of monitoring equipment;

b.6) Certificate and report on inspection, calibration and testing.

3. Environmental monitoring equipment management documents shall be retained at the organization charged with monitoring equipment and ready to be presented at the request of the competent authority.

Chapter VII

IMPLEMENTATION CLAUSE

Article 63. Implementation

1. The Vietnam Environment Administration shall provide guidance, inspect and supervise the implementation of this Circular.

2. Ministers, heads of ministerial agencies, heads of Governmental agencies, Presidents of the People's Committees at all levels and relevant organizations are responsible for the implementation of this Circular.

Article 64. Effect

1. This Circular comes into force from October 15, 2017.

2. The following Circulars shall cease to have effect from the effective date of this Cicular:

a) The Circular No. 28/2011/TT-BTNMT dated August 01, 2011 of the Ministry of Natural Resources and Environment on technical procedures for ambient air and noise monitoring;

b) The Circular No. 29/2011/TT-BTNMT dated August 01, 2011 of the Ministry of Natural Resources and Environment on technical procedures for inland surface water monitoring;

c) The Circular No. 30/2011/TT-BTNMT dated August 01, 2011 of the Ministry of Natural Resources and Environment on technical procedures for groundwater monitoring;

d) The Circular No. 30/2011/TT-BTNMT dated August 01, 2011 of the Ministry of Natural Resources and Environment on technical procedures for seawater monitoring (including sea-bed sediments and marine creatures);

dd) The Circular No. 32/2011/TT-BTNMT dated August 01, 2011 of the Ministry of Natural Resources and Environment on technical procedures for rainwater quality monitoring;

e) The Circular No. 33/2011/TT-BTNMT dated August 01, 2011 of the Ministry of Natural Resources and Environment on technical procedures for soil monitoring;

g) The Circular No. 21/2012/TT-BTNMT dated December 19, 2012 of the Ministry of Natural Resources and Environment on quality assurance and quality control in environmental monitoring;

h) The Circular No. 40/2015/TT-BTNMT dated August 17, 2015 of the Ministry of Natural Resources and Environment on technical procedures for exhaust gas monitoring;

3. The regulations on status of measuring equipment specified in Chapter IV and Chapter V of this Circular come into force from February 01, 2018.

4. The organizations issued with the certificate of eligibility for environmental monitoring

shall continue to use the methods certified by the Ministry of Natural Resources and Environment until this certificate expires.

5. Difficulties that arise during the implementation of this Circular should be reported to the Ministry of Natural Resources and Environment (through the Vietnam Environment Administration)./.

PP. MINISTER
DEPUTY MINISTER

Vo Tuan Nhan

APPENDIX 01

DETERMINATION OF LOCATIONS AND NUMBER OF EXHAUST GAS MONITORING POINTS *(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)*

I. GENERAL PROVISIONS

1. This Appendix provides guidance for summary of US EPA method 1, which is designed to aid in the determination of locations and number of exhaust gas monitoring points.

2. This method cannot be used when:

a) the flow is cyclonic or swirling;

b) a stack is smaller than 0.3 meter in diameter;

c) the measurement site is less than two stack or duct diameters downstream or less than a half

3. For the stacks that are smaller than 0.3 meter in diameter, locations and number of monitoring points shall be determined according to US EPA method 1 A.

4. Particulate matters must not be sampled and velocity of exhaust gas must not be measured at the midpoint (or center) of the cross section of the stack.

II. Equipment and supplies

1. Tape measures, logbooks, heat resistant pens.

2. Differential pressure gauges, inclined manometers, U-tube manometers.

III. Procedures

Locations of sampling ports and number of traverse points shall depend on determination of velocity of exhaust gas, gaseous pollutants or particulate matters.

1. Determining sampling ports

a) Principle: sampling ports must be located on the cross-sectional area of the straight stack;

b) Method of determination: sampling ports shall be located on the stake by determining distance A, distance B, inside diameter D. B must be ≥ 2D and A must be ≥ 0.5D. In the ideal case, a sampling port must satisfy the conditions: B = 8D and A = 2D (Figure 7);

A, B and D are illustrated in Firgure 7:

- Distance A: duct diameters that measurement site is from upstream to flow disturbance;
- Distance A: duct diameters that measurement site is from downstream to flow disturbance;
- D: inside diameter of the stack at the sampling location (for rectangular stacks, inside diameter D is calculated using the equation: D = 4 x (cross-sectional area/circumference)).

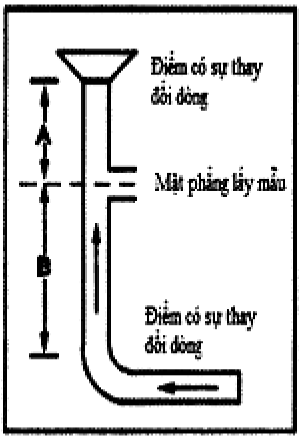


Figure 7: Location of sampling port

2. Requirements applied to a sampling port: a sampling port must have a diameter of from 90 mm to 110 mm;

a) For circular stakes: there must be at least 02 sampling ports that shall be perpendicular to each other;

b) For rectangular stakes: length-to-width ratio and number of sampling ports located on the stake shall be take into consideration to select the appropriate number of sampling ports perpendicular to each other;

c) For the stakes with large inside diameter, more sampling ports shall be located symmetrically to reduce the length of the probe liner.

3. Determining the number of traverse points

a) The traverse point is located within the stake cross section at the sampling ports. The cross-section of the stack is divided into a number of equal areas in two directions perpendicular to each other.

b) Method of determining the number of traverse points within the stake cross section: based on the ratio between distance A and inside diameter D (A/D) or ratio between distance B and inside diameter D (B/D), the number of traverse points shall be determined in the two following cases:

b.1) Case 1 - Velocity (non-particulate) traverses: Figure 8 shall be used to determine the minimum number of traverse points;

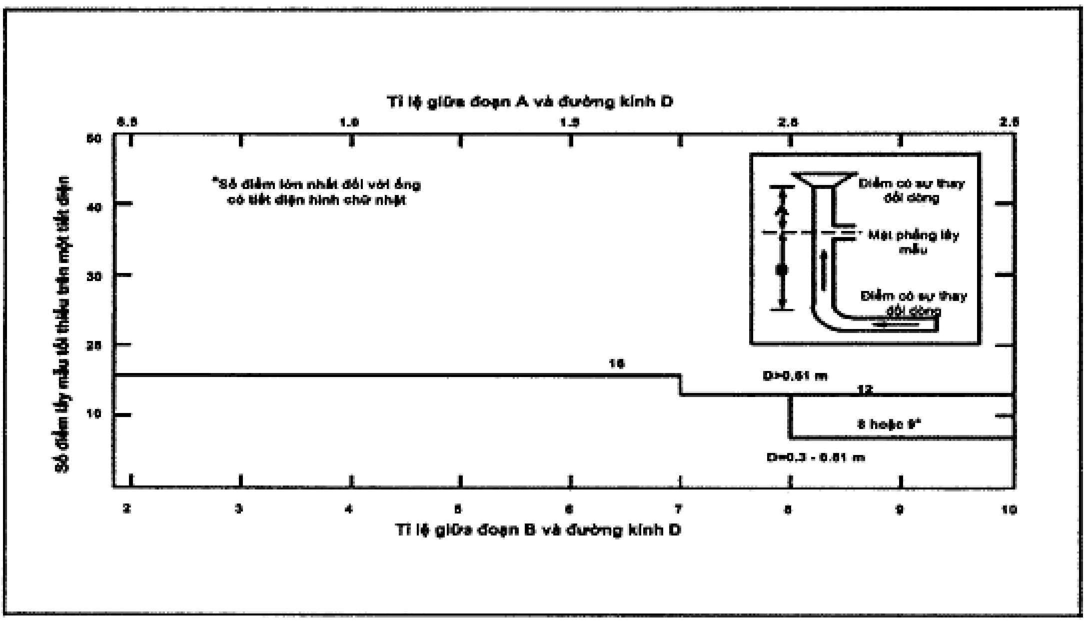


Figure 8: Minimum number of traverse points for velocity (nonparticulate) traverses

b.1.1) For circular stacks: the sampling plane shall be divided into concentric circles, traverse points shall be evenly divided on two right-angle diameters. The distance from the traverse point to the inside wall of the stack is determined in Table 26.

Table 26: Distance from traverse point to the inside wall of the circular stack
(percent of inside diameter of stack (%D))

Traverse point number on a diameter	Number of traverse points on a diameter											
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**
1	14.6	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8				96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10					97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.3
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.8	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												99.9

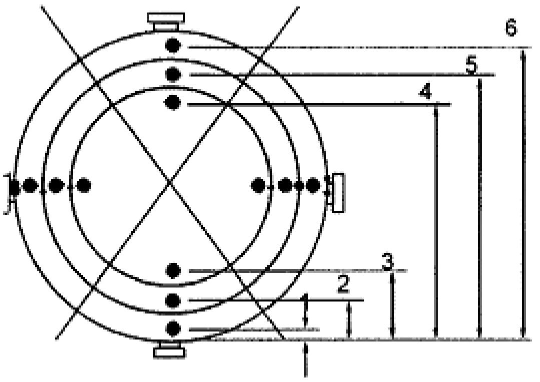


Figure 9: Distribution of 12 traverse points in circular stack

b.1.2) For rectangular stakes: the number of traverse points is specified in Table 27. After determining the number of traverse points, the stake cross section into equal areas, with traverse points at centroid of each area.

Table 27: Cross-section layout for rectangular stacks

Number of traverse points layout	Matrix
9	3 x 3
12	4 x 3
16	4 x 4
20	5 x 4
25	5 x 5
30	6 x 5
36	6 x 6
42	7 x 6
49	7 x 7

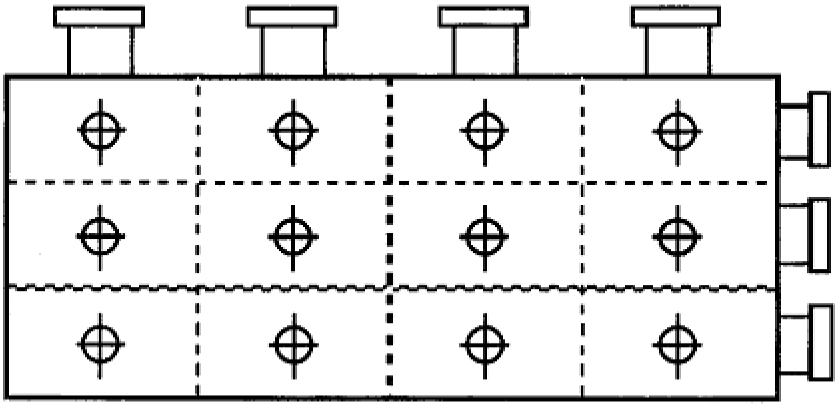


Figure 10: Distribution of 12 traverse points in rectangular stack

b.2) Case 2 - Particulate traverses: Figure 11 shall be used to determine the minimum number of traverse points.

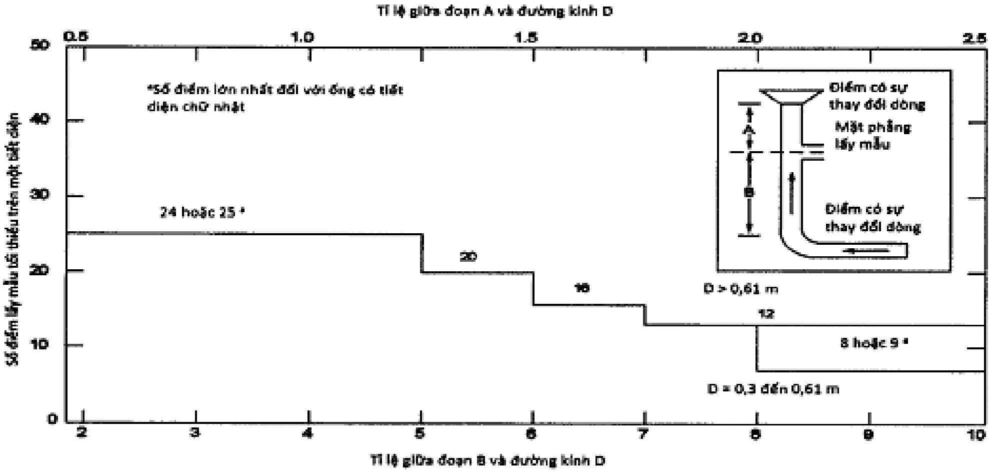


Figure 11: Minimum number of traverse points for particulate traverses

b.2.1) When the sampling location satisfies the ideal case (located between 8D and 2D), the number of traverse points shall be:

- twelve, for circular or rectangular stacks with diameters greater than 0.61 m;
- eight, for rectangular stacks with diameters between 0.30 and 0.61 m.

b.2.2) To ensure the stability of the gas flow in the stack, the nearest traverse point from the stack wall in horizontal direction must ensure a certain distance:

- The minimum distance shall be 2.5 cm for stacks with diameters equal to or greater than 0.61 m;
- The minimum distance shall be 1.3 cm for stacks with diameters greater than 0.61 m.

4. Determining gas flow at a traverse point: it must be determined before measurement is carried out. Determination method: connect an S-type Pitot tube to the manometer, position the Pitot head in the direction perpendicular to the stack cross-sectional plane, check the pressure gauges. If the differential pressure gauge displays value, the system is sealed. Rotate the pitot tube up to ±90° yaw angle. If the differential pressure gauge displays value, at this location, the gas flow is cyclonic, the sampling conditions at that location is indeterminate and other locations need to be determined.

5. The determination of traverse points shall be made into a record using the Form 1 provided in this Appendix.

Form 1

NAME OF THE AUTHORITY (CHARGED WITH ENVIRONMENTAL MONITORING):

…………………………………………………………………………………….

Telephone: …………….. /Fax: ………./E-mail: ………/Address: ………

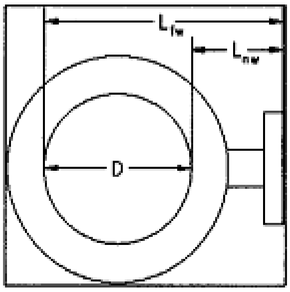
TRAVERSE POINT DETERMINATION RECORD

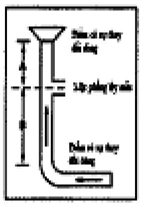
Facility: ……………………………………………………………… Date: ……………………...

Address: .... Sample collector: …………….

Sampling location: ………………………………………………………………………………….

Distance from the outer edge of the sampling port to the far wall inside the stake (L_{fw}) (m)	
Distance from the outer edge of the sampling port to the near wall inside the stake (or wall thickness) (L_{nw}) (m)	
Inside diameter of the stake $D = L_{fw} - L_{nw}$ (> 0.3m) (m)	
Stake cross section $A_s = \pi D^2/4$	
Distance $B \geq 2D$ (m)	
Ratio B/D	
Number of traverse points determined according to B/D	
Distance $A \geq 0.5D$ (m)	
Ratio A/D	
Number of traverse points determined according to A/D	





Traverse points	% D (% inside diameter of stake)	Distance from inside wall of stake to traverse point	Distance from outer edge of sampling port to traverse point
1			
2			
3			
4			
5			
…			

		…., …., *date….*
Representative of the facility	**Head of monitoring group**	**Prepared by**
(Signature and full name)	*(Signature and full name)*	*(Signature and full name)*

APPENDIX 02

DETERMINATION OF EXHAUST GAS VELOCITY AND FLOW

(S-TYPE PITOT TUBE)

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

1. GENERAL PROVISIONS

1. This Appendix provides guidance for summary of sampling method of US EPA method 2, which is designed to determine average velocity and flow of exhaust gases.

2. This method is not applicable in the cases specified in point b, Clause 1, Appendix 01 enclosed herewith.

II. Methodology

The average gas velocity in a stake is determined from the gas density and from the mean value of the differential pressure.

III. Equipment and supplies

1. S-type pitot tube or standard pitot tubes (L-type).

2. Differential pressure gauges, inclined manometers, U-tube manometers or differential pressure meters.

3. Thermometer (usually thermocouple);

4. Equipment for determining gas dry molecular weight.

IV. Procedures

1. Install equipment and supplies

Equipment and supplies shall be installed as shown in Figure 12.

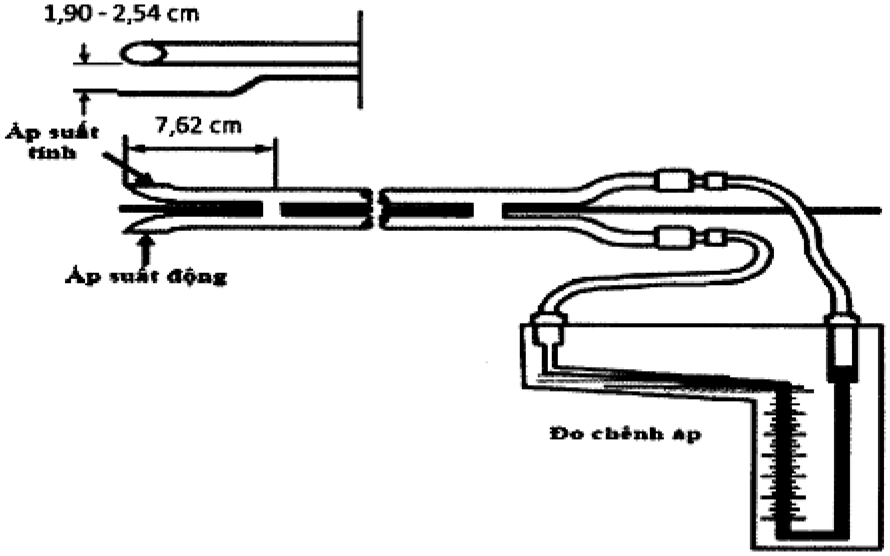


Figure 12: Type-S pitot tube manometer assembly.

2. Leak-check the equipment

A leak-check of the pitot shall be conducted as follows: blow through the pitot impact opening until at least 7.6 cm H_2O, then, close off the impact opening. The pressure shall remain stable for at least 15 seconds. Do the same for the static pressure side, except using suction to obtain the minimum of 7.6 cm H_2O.

3. Inspect the nanometer: Because the zero of the manometer may drift due to vibrations and temperature changes, make periodic checks at least once per hour.

4. Measure the temperature, static and dynamic pressure in the stake: measurement shall be carried out at all traverse points specified in Appendix 01 enclosed herewith. All data shall be recorded.

5. Measure the atmospheric pressure: measurement shall be carried out at the sampling location and all data shall be recorded.

6. Determine the stack gas dry molecular weight.

For combustion processes or processes that emit essentially CO_2, O_2, CO, and N_2, use the method specified in Appendix 03 enclosed herewith.

7. Determine moisture content: determination of moisture content is specified in the Appendix 04 enclosed herewith.

8. Determine the cross-sectional area of the stack or duct at the sampling location. Physically measure the inside diameter of the stack at the sampling location.

V. Calculations and data analysis

1. Average stack gas velocity

$$v_s = K_p C_p \sqrt{p_{avg}} \sqrt{\frac{T_{s(abs)}}{P_s M_s}} \qquad \textit{(2.1)}$$

2. Average dry gas flow rate

$$Q_s = 3.600 v_s A_s \qquad (2.2)$$

$$Q_{std} = 3.600(1 - B_{ws}) v_s A \frac{T_{std}}{T_{s(avg)}} \frac{P_s}{P_{std}}$$

Where:

A_s: Cross-sectional area of stack, m2

B_{ws}: Water vapor in the gas stream, proportion by volume (calculated according to the Appendix 04 enclosed herewith)

C_p: Pitot tube coefficient, dimensionless (S-type pitot tube = 0.84, L-type standard pitot tube L = 1.0)

K_p: Velocity equation constant, $K_p = 34.97 \frac{m}{s}\left[\frac{(g/mol)(mmHg)}{(0K)(mmH_2O)}\right]^{1/2}$

M_s: Molecular weight of stack gas, wet basis, g/mol

P_s: Absolute stack pressure, mm Hg

P_{std}: Standard absolute pressure, 760 mm Hg

Q_{std}: Dry volumetric stack gas flow rate corrected to standard conditions, Nm^3/h

t_s: stack temperature °C

T_s: absolute temperature, °K, $T_s = 273 + t_s$

T_{std}: Standard absolute temperature, 298°K

v_s: Average stack gas velocity, m/s

P_{avg}: average stack gas pressure, mmH$_2$O

Form 2

NAME OF THE AUTHORITY (CHARGED WITH ENVIRONMENTAL MONITORING):

……………………………………………………………………………………

Telephone: …………….. /Fax: ………./E-mail: ………/Address: ………

DIFFERENTIAL PRESSURE DETERMINATION RECORD

Facility: ………………………………………………………… Date: ……………………...

Address:……………………………………………………….Sample collector: ……………

Sampling location: ………………………………………………………………………………

Pitot tube dimensions	
Pitot tube coefficient (C_p)	
Atmospheric pressure	
Stack static pressure (Pg), mmH$_2$O	
Pitot tube check-leak	
Differential pressure (mmH$_2$O)	
Differential pressure remaining stable for 15 seconds (Pass/Fail)	
Pitot tube operating conditions (Pass/Fail)	

Starting time:	Ending time:	
Point	Δp mmH$_2$O	Stack temperature, °C
1.		
2.		
3.		
4.		
5		
6.		
7.		
8.		
9.		
10.		

11.		
12.		
Average $(\Delta p)^{1/2}_{avg} = \frac{1}{n}\sum \Delta p^{1/2}$		

…place..., date….

Respresentative of the facility	**Head of monitoring group**	**Prepared by**
(Signature and full name)	*(Signature and full name)*	*(Signature and full name)*

APPENDIX 03

DETERMINATION OF DRY MOLECULAR WEIGHT

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

I. GENERAL PROVISIONS

This Appendix provides guidance for summary of US EPA method 3 for the determination of oxygen (O_2), carbon dioxide (CO_2), carbon monoxide (CO), and nitrogen (N_2) and dry molecular weight of a sample gas.

II. Methodology

Measure O_2, CO_2 and CO and use stoichiometric calculations to determine dry molecular weight.

III. Equipment and supplies

1. Probe: Stainless steel or borosilicate glass tubing equipped with an in-stack or out-of-stack filter to remove particulate matter. A plug of glass wool is satisfactory for this purpose.

2. Pump or a one-way squeeze bulb.

3. Condenser.

4. Valve.

5. Pump: the pump must be leak free to transport sample gas to the flexible bag Install a small surge tank between the pump and rate meter to eliminate the pulsation effect of the diaphragm pump on the rate meter.

6. Rate meter: A rotameter, or equivalent, capable of measuring flow rate to ±2 percent of the selected flow rate. A flow rate range of 500 to 1000 ml/min is suggested.

7. Flexible bag: Any leak-free plastic (e.g., Tedlar, Mylar, Teflon) or plastic-coated aluminum bag, having a capacity consistent with the selected flow rate and duration of the test run.

Leak-check the flexible bag: connect it to a water manometer, and pressurize the bag to 5 to 10 cm H_2O. Any displacement in the water manometer indicates a leak.

8. Pressure Gauge.

9. Vacuum Gauge: a mercury manometer of at least 760 mm Hg.

IV. Sample collection

1. Single point, grab sampling procedure

a) The sampling point in the duct shall either be at the centroid of the cross section or at a point no closer to the walls than 1.0 m.

b) At least 28 liters of sample gas shall be collected;

c) Equipment shall be installed as shown in Figure 13;

d) Place the probe in the stack, with the tip of the probe positioned at the sampling point. Use the one-way squeeze bulb to transport gas into the bag or sample analyzer to determine O_2, CO_2 and CO concentrations.

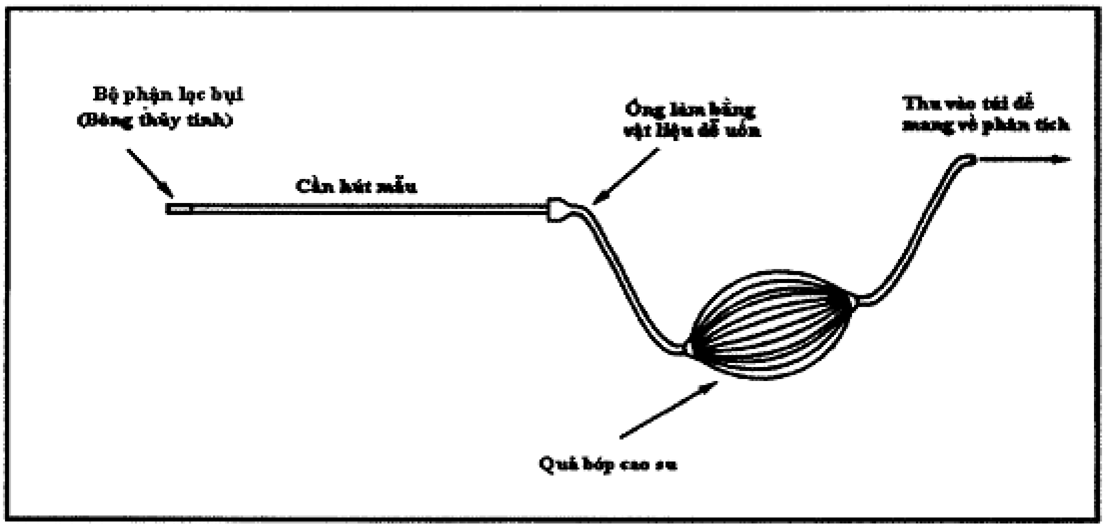


Figure 13: Grab-sampling train

2. Single point, grab sampling procedure

a) Similar to the single point, grab sampling procedure specified in Clause 1, equipment shall be installed as shown in Figure 14;

b) Sample collection: sample at a constant rate (±10 percent). The sample must be collected during sampling.

c) Within 8 hours after the sample is taken, analyze it for percent CO_2 and percent O_2.

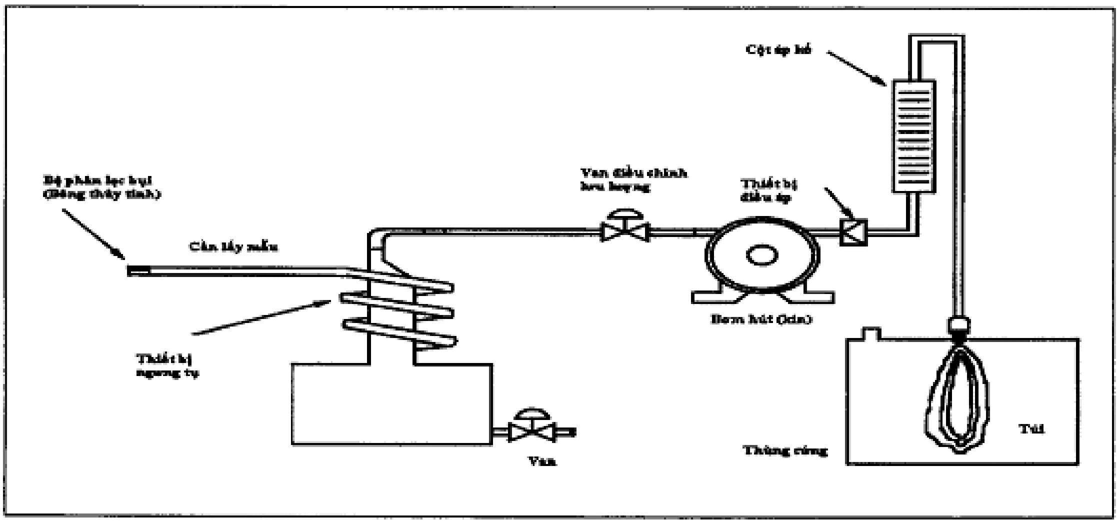


Figure 14: Integrated gas-sampling train

3. Multi-point, integrated sampling procedure

a) Samples are collected at the traverse points specified in the Appendix 01 enclosed herewith.

b) A minimum of 8 traverse points shall be used for circular stacks having diameters less than 0.61 m, a minimum of 9 shall be used for rectangular stacks having equivalent diameters less than 0.61 m, and a minimum of 12 traverse points shall be used for all other cases. Sampling data shall be presented in Table 28.

Table 28: Sampling rate data

Time	Tranverse point	Q (liter/min)	% standard deviation
Average			

% standard deviation = $[(Q - Q_{avg}) / Q_{avg}] \times 100\%$ (must be $< \pm 10\%$)

V. Calculations and data analysis

1. Dry molecular weight.

$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$

Where:

M_d: Dry molecular weight, g/g-mol

$\%CO_2$: Percent CO2 by volume, dry basis

$\%O_2$: Percent O_2 by volume, dry basis

%CO: Percent CO by volume, dry basis

$\%N_2$: Percent N_2 by volume, dry basis

N_2 and CO shall be determined as follows:

$$\%N_2 + \%\ CO = 100 - \%CO_2 - \%O_2$$

However, because of very low CO concentration (around ppm), it can be neglected during the calculation. The dry molecular weight of the stack gas shall be calculated using the equation:

$$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(100 - \%CO_2 - \%O_2) \qquad (3.1)$$

2. <}0{>Fuel factor (F_o)

$$F_o = (20.9 - \%O_2)/(\%CO_2) \qquad (3.2)$$

Where:

$\%O_2$: Percent O_2 by volume, dry basis

$\%CO_2$: Percent CO_2 by volume, dry basis

If CO is present in quantities measurable by this method, adjust the O_2 and CO_2 values before performing the calculation for F_o as follows:

$\%CO_2$ (adjust) = $\%CO_2 + \%CO$

% O_2 (adjust) = $\%O_2 - 0,5\ \%CO$

Compare the calculated F_o factor with fuel factor F_o. The calculated F_o values beyond the acceptable range specified in Table 29 should be investigated before accepting the measurement results.

Table 29. Fuel factor of some fuel type

No.	Fuel type	F_o range
1	Coal	
	Anthracite and lignite	1.016 - 1.130
	Bituminous	1.083 - 1.230
2	Oil	

	Distillate	1.260 - 1.413
	Residual	1.210 - 1.370
3	Gas	
	Natural	1.600 - 1.838
	Propane	1.434 - 1.586
	Butane	1.405 - 1.553
4	Wood	1.000 - 1.120
5	Wood bark	1.003 - 1.130

APPENDIX 04

DETERMINATION OF MOISTURE CONTENT IN STACK GASES

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

I. General requirement

This Appendix provides guidance for summary of US EPA method 4, which is designed to determine moisture content in stack gases.

II. Methodology

A gas sample is extracted at a constant rate from the source. Moisture is removed from the sample stream and determined either volumetrically or gravimetrically.

III. Equipment and supplies

1. Probe liner: Stainless steel or glass tubing, sufficiently heated to prevent water condensation

2. Barometer and graduated cylinder.

3. Impinger system: 4 glass impingers.

4. Cooling system: ice bath container, crushed ice, and water.

5. Valve.

6. Pump: Leak-free, diaphragm type.

7. Volume meter.

8. Rate meter: Rotameter, to measure the flow range from 0 to 3 liters/min.
9. Vacuum gauge: at least 760 mm Hg.

III. Procedures

1. Install moisture content measurement system includes impingers installed as shown in Figure 15 and Figure 16. The first and second impingers contain water, the third is left empty and the fourth is filled with silica gel to dry the sample gas and to protect the meter and pump.

2. Turn on the pump and start the sampling traverse.

3. Determine moisture content in the ambient air for 60 minutes at a rate of 2 liters/min.

4. Volume meter: Dry gas meter, sufficiently accurate to measure the sample volume to within 2 percent, and calibrated over the range of flow rates and conditions actually encountered during sampling.

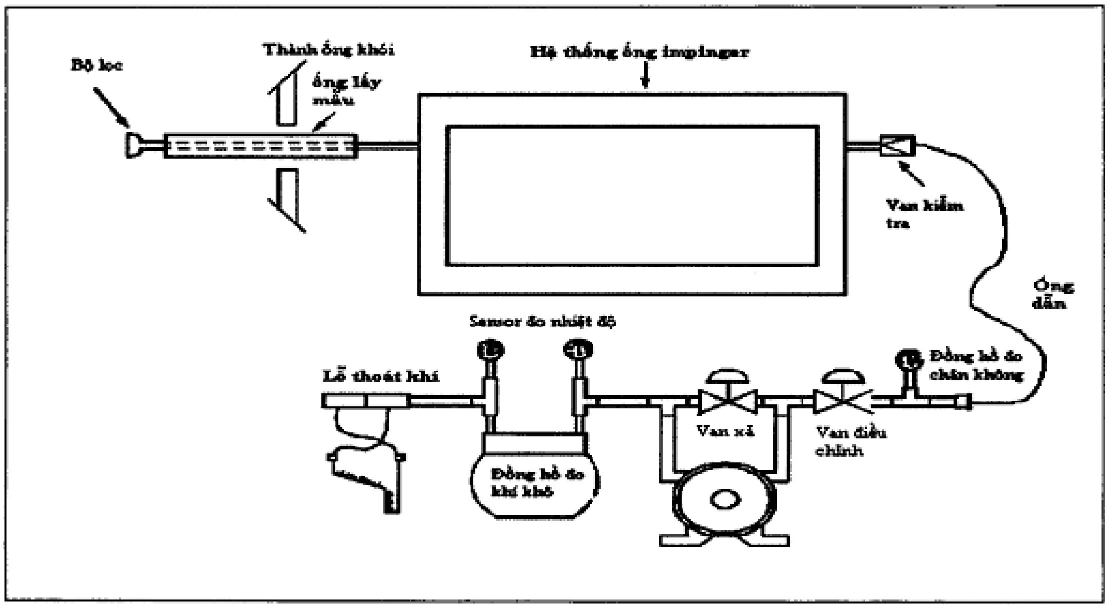


Figure 15: Moisture sampling train-reference method

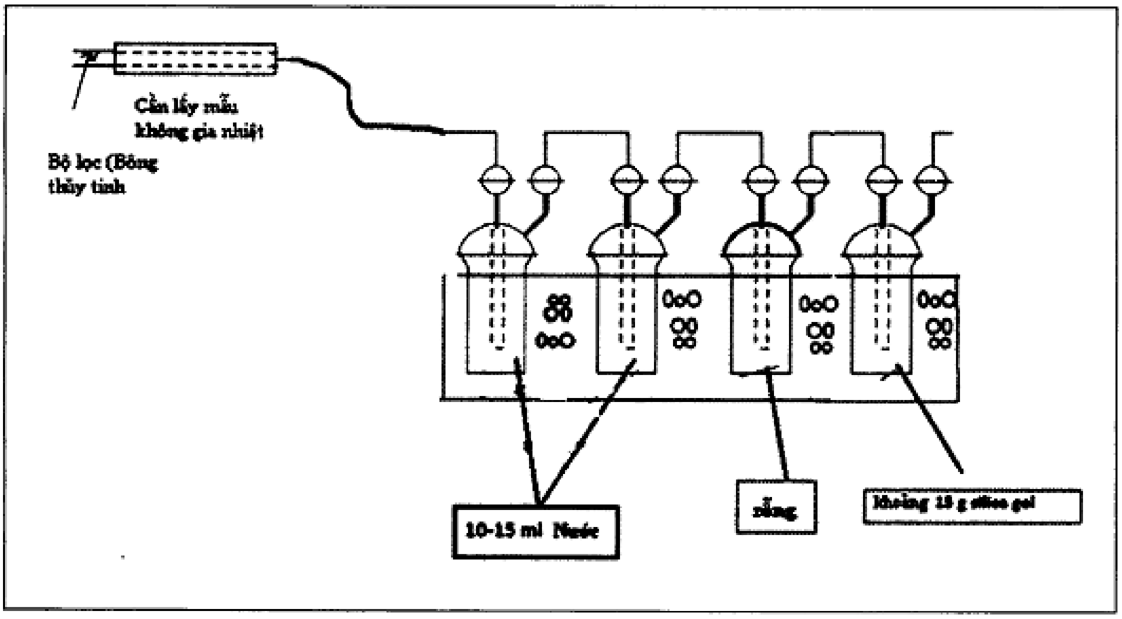


Figure 16. Impinger system

V. Calculations and data analysis

1. Volume of water vapor condensed

$V_{wc(std)} = (V_f - V_i)\ \rho_w R\ T_{std} / (P_{std}\ M_w)$ (4.1)

$= K_1\ (V_f - V_i)$

Where: $K_1 = 0.001356\ m^3/mL$

2. Volume of water vapor collected in silica gel

$V_{wsg(std)} = (W_f - W_i)\ R\ T_{std} / (P_{std}\ M_w)$ (4.2)

$= K_3\ (W_f - W_i)$

Where: $K3 = 0.001358\ m^3/g$

3. Dry gas volume

$$V_{m(std)} = V_m Y \frac{T_{std}\left(P_{bar} + \dfrac{H}{13.6}\right)}{T_m P_{std}} = K_1 V_m Y \frac{P_{bar} + \dfrac{H}{13.6}}{T_m} \qquad (4.3)$$

4. Moisture content

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}} \quad (4.4)$$

Where:

B_{Ws}: Proportion of water vapor, by volume, in the gas stream

M_w: Molecular weight of water, 18.0 g/g.mol

P_m: Absolute pressure (for this method, same as barometric pressure) at the dry gas meter, mm Hg

P_{std}: Standard absolute pressure, 760 mm Hg

R: Ideal gas constant, 0.06236 (mm Hg)(m3)/(g-mole)(°K)

T_m: Absolute temperature at meter

T_{std}: Standard absolute temperature, 293°K

V_f: Final volume of condenser water, ml.

V_i: Initial volume, if any, of condenser water, ml.

V_m: Dry gas volume measured by dry gas meter, m^3

$V_{wc(std)}$: Volume of water vapor condensed, corrected to standard conditions, Nm^3

: Volume of water vapor collected in silica gel, corrected to standard conditions, , $m^3_{<\}68\{>}$

$V_{wsg(std)}$: Volume of water vapor collected in silica gel, corrected to standard conditions, m^3

W_f: Final weight of silica gel or silica gel plus impinger, g

W_i: Initial weight of silica gel or silica gel plus impinger, g

Y: Dry gas meter calibration factor

ΔVm: = Incremental dry gas volume measured by dry gas meter at each traverse point, m^3

ρ_w: Density of water, 0.9982 g/ml

Average differential pressure measured by gauge at each port, mm H_2O

Form 3

NAME OF THE AUTHORITY (CHARGED WITH ENVIRONMENTAL MONITORING):

………………………………………………………………………………………..

Telephone: … … …/ Fax: …………./E-mail:………… /Address: … … … …

MOISTURE CONTENT DETERMINATION RECORD

DịAddress:…………………………………………………………Sample collector: ……………

Sampling location: ………………………………………………………………………………

1. Moisture content

Impinger	Capacity	Initial weight (g)	Final weight (g)	Moisture weight (g)
Impinger 1	H_2O (...mL)			(1)
Impinger 2	H_2O (....mL)			(2)
Impinger 3	Empty			(3)

Impinger 4	Silica gel			(4)
			Total	

$V_f - V_i = (1) + (2) + (3) = \ldots\ldots\ldots\ldots\ldots\ldots\ldots$ $W_f - W_i = (4) = \ldots\ldots\ldots\ldots\ldots\ldots\ldots$

$V_{wc(std)} = 0.001356\ (V_f - V_i) = \ldots\ldots\ldots\ldots\ldots$ $V_{wsg(std)} = 0.001358\ (W_f - W_i) = \ldots\ldots\ldots\ldots$

2. Sampling procedures

Starting time		
Ending time		
Flow rate	Liter/minute	
Time	minute	
Calibration coefficients T° and P		
Total collected sample	L	
$V_{m(std)}$	Nm^3	

3. Calculation of moisture content

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{ws(std)} + V_{wsg(std)} + V_{m(std)}}$$

$$B_{ws} = \frac{(\ )+(\ )}{(\ )+(\ )+(\ )} \times 100\% = \qquad \%$$

…place..., date….

Respresentative of the facility
(Signature and full name)

Head of monitoring group
(Signature and full name)

Prepared by
(Signature and full name)

APPENDIX 05

DETERMINATION OF PARTICULATE MATTER EMISSIONS

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

I. GENERAL PROVISIONS

1. This Appendix provides guidance for summary of US EPA method 5, which is designed to determine particulate matter (PM) emissions.

2. This method is not applicable in the cases specified in Clause 2, Section I, Apppendix 01 enclosed herewith.

3. During sampling run, it is required to maintain an isokinetic sampling rate (I) in the range of $90\% \leq I \leq 110\%$.

II. Methodology

The samples collected at sampling locations must satisfy the requirements for collecting isokinetic sample from stake. Particulate matters are retained on the filter and determined gravimetrically after the removal of moisture.

III. Equipment and supplies

1. Probe nozzle: the probe nozzle must be made of smooth material, preserved in a specialized container to ensure the probe nozzle diameter is not affected during transport. Typical nozzle sizes range from 0.32 to 1.27 cm inside diameter (ID).

2. Probe liner: Borosilicate or quartz glass tubing with a heating system capable of maintaining a probe gas temperature during sampling of 120 ±14°C. Either borosilicate or quartz glass probe liners may be used for stack temperatures up to about 480°C. Quartz glass liners shall be used for temperatures between 480 and 900°C.

3. Pitot Tube: type S, as described in the Appendix 02 enclosed herewith. The pitot tube shall be attached to the probe as shown in Figure 17 to allow constant monitoring of the stack gas velocity.

4. Differential pressure gauge: manometer.

5. Filter holder: Borosilicate glass and a silicone rubber gasket. Stainless steel, Teflon or Viton frit filter support may be used to ensure a good seal during sampling.

6. Filter heating system: capable of maintaining at 120 ± 14°C during sampling.

7. Filter temperature sensor.

8. Condenser: Four impingers connected in series with leak-free ground glass fittings or any similar leak-free noncontaminating fittings. The first and second impingers shall contain known quantities of water, the third shall be empty, and the fourth shall contain a known weight of silica gel, or equivalent desiccant.

9. Metering system: Vacuum gauge, leak-free pump, calibrated temperature sensors capable of measuring temperatures up to ±3°C, dry gas meter (DGM) capable of measuring volume to within 2% (Figure 17).

10. Barometer: capable of measuring atmospheric pressure to within 2.5 mm Hg.

11. Equipment cleaning supplies: the supplies include brushes that shall be properly sized and shaped, at least as long as the probe and constructed of stainless steel, Teflon, or similarly inert material.

12. Acetone wash bottle: polyethylene wash bottles are recommended. That acetone must not be stored in polyethylene bottles for longer than a month.

13. Petri dishes.

14. 250mL graduated cylinder.

15. Field balance with a minimum accuracy of 0.001g.

16. Air-tight plastic storage containers and funnels.

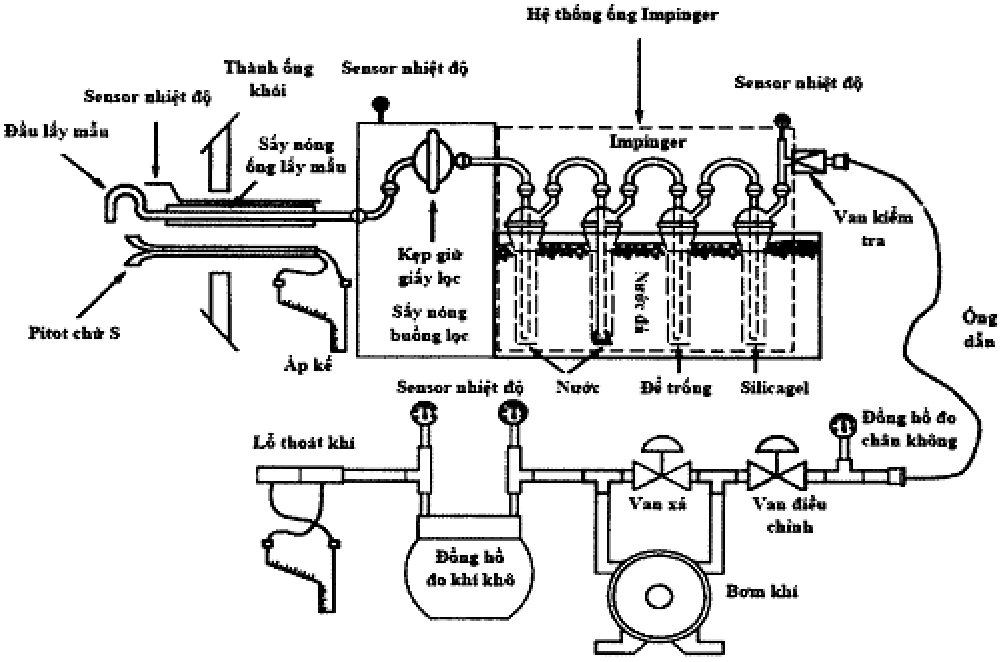


Figure 17: Particulate sampling train

IV. Chemicals, materials

1. Filter: use filter made of stainless steel or inert material to store particular matters during sampling. According to the monitoring parameter, select filters made of appropriate materials such as glass, quartz and cellulose.

2. Silica gel: pore diameter of 1.19 - 3.36 mm. Other materials with equivalent or higher adsorption capacity may be used.

3. Ice water.

4. Pure acetone, ≤ 0.001% residue, in polyethylene bottle.

V. Preparation

1. Pretest preparation

a) Place 200 to 300 g of silica gel in each impinger. Weigh each impinge and record this weight.

b) Check filters visually against light for irregularities, flaws, or pinhole leaks. Label filters of the proper diameter on the back side near the edge or label the shipping containers (glass or polyethylene petri dishes) and keep each filter in its identified container;

c) Desiccate the filters and weigh each filter to a constant weight. The maximum difference between weighings shall not exceed 0.5 mg. Record results to the nearest 0.1 mg. During each weighing, the period for which the filter is exposed to the laboratory atmosphere shall be less than 2 minutes;

d) Determine the sampling location, number of traverse points, stack pressure, temperature, dynamic pressure and moisture content using the methods specified in Appendixes 01, 02, 03 and 04 enclosed herewith. Besides, it is recommended that a leak check of the pitot lines be performed and isokinetic sampling rate settings be made;

dd) Select a suitable nozzle size based on the range of velocity heads;

e) Select a suitable probe liner and probe length such that all traverse points specified in the Appendix 01 enclosed herewith can be sampled.

2. Preparation of sampling train

a) Place 100 ml of water in each of the first two impingers, leave the third impinger empty, and place approximately 200 to 300 g of silica gel in the fourth impinger. The weight of the silica gel plus impinger may be determined to the nearest 0.5 g;

b) Use a tweezer or clean disposable surgical gloves, place the filter in the filter holder. Check the filter for tears after assembly is completed;

c) Mark the probe with heat resistant ink or tape to denote the proper distance into the stack or duct for each traverse point;

d) Set up the train as shown in Figure 17 ensuring that the connections are leak-tight according to the method specified in the Appendix 02 enclosed herewith;

dd) Place crushed ice and water around the impingers.

e) After the sampling train has been assembled, turn on the filter and probe heating systems. Allow time for the temperatures to stabilize. If a Viton A O-ring is used in assembling the probe nozzle to the probe liner, leak-check the train at the sampling location and at approximately 380 mm Hg vacuum.

VI. Sample collection

1. During the sampling run, maintain an isokinetic sampling rate (within 10 percent of true isokinetic) and a sample gas temperature through the filter of 120 ± 14°C;

2. Clean the portholes prior to the test run to minimize the chance of collecting deposited material. Before sampling, check sampling equipment. Position the nozzle at the first traverse point with the tip pointing directly into the gas stream. Start the pump and adjust the flow to

isokinetic conditions (calculation of percent isokinetic, within the range of 90% ≤ I ≤ 110%);

3. All traverse points calculated according to the Appendix 01 enclosed herewith shall be sampled.

4. At the end of the sampling period, remove the probe from the stack. Allow the probe to be cool and start sampling. Before disassembling equipment, use a foil to seal the probe to avoid sample losses or contamination. Remove dust on the outside of the probe and surrounding parts. Remove the filter from the filter holder, and place it in a container or paraffin-coated petri dish. Each sample shall be individually labeled;

5. Clean the inside parts of equipment (probe, probe liner, filter holder, etc.) with acetone and cleaning brushes. Transfer washed liquids to weighing cups. Such liquids shall be stored and each sample shall be individually labeled.

VII. Preservation and transport of samples

Filters and liquids collected after washing parts of measuring equipment shall be transported to a laboratory for weighing under the same condition.

VIII. Calculations

1. Dry gas volume: Correct the sample volume measured by the dry gas meter to standard conditions (25°C, 760 mm Hg).

$$V_{m(std)} = V_m Y \frac{T_{std}\left(P_{bar} + \frac{H}{13.6}\right)}{T_m P_{std}} = K_1 V_m Y \frac{P_{bar} + \frac{H}{13.6}}{T_m} \qquad (5.1)$$

2. Acetone blank concentration

$$C_a = \frac{m_a}{V_a \Delta_a} \qquad (5.2)$$

3. Acetone wash blank

$$W_a = C_a V_{aw} \Delta_a \qquad (5.3)$$

4. Total particulate weight: on the filter and in acetone used for washing equipment:

$$C_S = \frac{K_3 m_n}{V_{m(std)}} \qquad (5.4)$$

5. Isokinetic variation

- Calculation from raw data

$$I = \frac{100 T_S \left[K_4 V_{lc} + \frac{V_m Y}{T_m}\left(P_{bar} + \frac{H}{13.6}\right)\right]}{60\ 2\ \upsilon_s P_s A_n} \qquad (5.5)$$

- Calculation from intermediate values

$$I = \frac{T_S V_{m(std)} P_{std} 100}{T_{std} \upsilon_S 2\ A_n P_S 60 (1 - B_{ws})} = K_5 \frac{T_S V_{m(std)}}{P_S \upsilon_S A_n 2 (1 - B_{ws})} \qquad (5.6)$$

- Acceptable results: If 90% ≤ I ≤ 110%, the results are acceptable.

Where:

A_n: Cross-sectional area of nozzle, m^2

B_{ws}: Water vapor in the gas stream, proportion by volume

C_a: Acetone blank residue concentration, mg/mg

C_s: Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions (g/Nm^3)

I: Percent of isokinetic sampling

m_a: Mass of residue of acetone after evaporation, mg

m_n: Total amount of particulate matter collected, mg

P_{bar}: Barometric pressure at the traverse point, mm Hg (in. Hg)

P_s: Absolute stack gas pressure, mm Hg

P_{std}: Standard absolute pressure, 25°C, 760 mm Hg

R: Ideal gas constant, 0.06236 [(mm Hg)(m3)/(g-mole)(°K)]

T_m: Absolute average DGM temperature, °K

T_{std}: Standard absolute temperature, 25°C+273 = 298°K

V_a: Volume of acetone blank, ml

V_{aw}: Volume of acetone used in wash, ml

V_{lc}: Total volume of liquid collected in impingers and silica gel, ml

V_m: Volume of gas sample as measured by dry gas meter, m^3

$V_{m(std)}$: Volume of gas sample measured by the dry gas meter, corrected to standard conditions, m^3

$V_{w(std)}$: Volume of water vapor in the gas sample, corrected to standard conditions, m^3

V_s: Stack gas velocity, calculated according to the Appendix 02 enclosed herewith, Equation (2.4), m/s

W_a: Weight of residue in acetone wash, mg

Y: Dry gas meter calibration factor

Δ_a: Density of acetone, mg/ml

Δ_w: = Density of water, 0.9982 g/ml

$K_1 = 0.3858$ °K/mm Hg$K_3 = 0.001$ g/mg

$K_4 = 0.003454$ [(mm Hg) (m^3)] /[(mL) (°K)]

$K_5 = 4.320$

APPENDIX 06

TECHNICAL REQUIREMENTS AND PROCEDURES FOR MEASURING GASEOUS POLLUTANTS IN EXHAUST GASES WITH DIRECT MEASURING EQUIPMENT

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

I. GENERAL PROVISIONS

This Appendix provides for technical requirements and procedures for measuring the parameters including NO_x (NO and NO_2), SO_2, CO, O_2 in exhaust gases with direct measuring equipment.

II. Technical requirements for direct measuring equipment

1. Equipment technical requirements

a) The equipment for direct measurement of gaseous pollutants in exhaust gases must satisfy the requirements for technical specifications specified in Table 30.

Table 30: Technical requirements for direct measuring equipment

No.	Parameters	Accuracy	Resolution	Response time
1.	NO	± 5% of reading	1 ppm	<30s

2.	NO_2	± 5% of reading	0.1 ppm	<40s
3.	SO_2	± 5% of reading	1 ppm	<30s
4.	CO	± 5% of reading	1 ppm	<40s
5.	O_2	± 0,3% of measurement range	0.1 %V	<60s

b) It is recommended to use the measuring equipment that is certified by one of the following international organizations: United States Environmental Protection Agency (US EPA), Environment Agency's Monitoring Certification Scheme (mCERTs), German Technical Inspection Association (Technischer Überwachungsverein, TÜV), Republic of Korea's Ministry of Environment (KMOE) and Japan's Ministry of Environment (JMOE);

2. Equipment inspection and check

a) Equipment inspection and check shall be carried out as prescribed in Chapter VI of this Circular;

b) Field check of equipment with reference gases: before measuring concentration of gaseous pollutants in exhaust gases, field zero gas check and span gas check shall be carried out at least once per monitoring date;

c) All documents relating to procedures for field check with reference gas must be retained. The documents include field record and logbook, original data printed or stored in the memory of the equipment in terms of all values, used certificates of reference gases, and are ready to be presented at the request of the competent authority;

d) The reference gas to be used must be within the period of its natural shelf life, have a minimum accuracy of ± 5% and traceable to standards in accordance with regulations of the law on measurement. The reference gas to be used may be a single or mixed one.

III. Measuring location

1. Gas measuring location shall be the particulate sampling location specified in the Appendix 01 enclosed herewith.

2. In case of measurement of gaseous pollutants without particulate sampling, the gas measuring location must not be at the mouth of the stake and it is best to choose the place where the gas flow moves stably.

IV. Field measuring procedures

1. Field check of equipment

a) Check probes: all probes of equipment must be cleaned in accordance with the manufacturer’s instructions. They must be clean and dry before use;

b) Check battery;

c) Start measuring equipment.

2. Field check of equipment with reference gas

a) Zero check: zero check shall be carried out using self-zero check method or using zero gas. The zero check value must be less than the resolution of the equipment corresponding to each parameter. In case the zero check value is not greater than the resolution of the equipment, repeatable checks shall be carried out until prescribed requirements are met;

b) Gas span check: a check shall be carried out on the reference gas concentrations within 10%-50% of the value of entire measurement range of equipment with respect to SO_2, NO_x (NO and NO_2); for CO, the reference gas concentration used for check equals ± 50% of the allowable ranges specified in the equivalent national technical regulations on environment. Exhaust gas measurement shall only be carried out the difference between reference gas measurement data displays on the equipment and reference gas concentration used for check does not exceed 20%. In case the difference is greater than 20%, repeatable gas span checks shall be carried out until prescribed requirements are met.

3. Field measurement

a) After starting the measuring equipment, allow time for values to display stably, then start reading and recording measurement values;

b) At each monitoring location, at least 3 measurements (3 samples) shall be carried out at a time;

c) The minimum time for each measurement (1 sample) is 15 minutes with a measured value reading and recording frequency of 3 minutes per value.

V. Calculations upon use of direct measuring equipment

1. According to applicable regulations on measurement units and standards specified in equivalent national technical regulations on environment, measurement units shall be converted into mg/m^3 according to equivalent standards. In case the data is reported as ppm and the concentration standards are corrected to 25°C and 760 mm Hg, pollutant concentrations shall be calculated using the following equation:

CO: ppm x 1.14 = mg/Nm^3

SO_2: ppm x 2.62 = mg/Nm^3

NO_2: ppm x 1.88 = mg/Nm^3

NO: ppm x 1.23 = mg/Nm^3

2. In case the applicable national technical regulations on environment specify reference oxygen concentration, the monitoring data shall be calculated using the following equation:

$$C_{std} = C_m \left(\frac{20.9\% - \%O_{2(std)}}{20.9\% - \%O_{2(m)}} \right)$$

Where:

C_{std}: pollutant concentration at a reference oxygen concentration, mg/Nm^3

C_m: pollutant concentration at measured oxygen concentration, mg/Nm^3

$\%O_{2(std)}$: allowable reference oxygen concentration (according to regulations of law)

$\%O_{2(m)}$: oxygen concentration measured at the monitoring location

VI. Environmental monitoring result report

1. A field record shall be made according to the Form 4 provided in this Appendix.

Form 4

NAME OF THE AUTHORITY (CHARGED WITH ENVIRONMENTAL MONITORING):

……………………………………………………………………………………..

Telephone: … … …/ Fax: …………/E-mail:………… /Address: … … … …

RECORD ON EXHAUST GAS MONITORING WITH DIRECT MEASURING EQUIPMENT

Facility:……………………………………………………….Date:………………
…

Address:……………………………………………………Sample collector:
…………

Sampling location:
…………………………………………………………………………………

Date		Equipment information (name, manufacturer, model)	
Name of facility		Equipment model	
City		Issued date of calibration certificate	
Type of production (specify production line where samples are taken)		**Parameters of measuring equipment** O_2 ☐ CO ☐ SO_2 ☐ NO_2 ☐ NO ☐ Other parameters: ______________	
Stake		Person in charge	
Leaks: Yes ☐ No ☐		Data recording frequency: ………………………………	
Adjustments after data recording Yes ☐ No ☐		Dehumidification system: Yes ☐ No ☐	

Check with reference gas

I. Reference gas	Concentration: Accuracy:			Expiry date: Manufacturer:	
II. Check with reference gas	O_2 (%)	CO (ppm ☐ mg/m^3 ☐)	NO (ppm ☐ mg/m^3 ☐)	NO_2 (ppm ☐ mg/m^3 ☐)	SO_2 (ppm ☐ mg/m^3 ☐)
1. Zero point					
- Set value					
- Measured value					
2. Span point					
- Set value					
- Measured value					
3. Reference gas measurement					
- Zero point					
- Span point					

Measurement results					
Time	O_2 (%)	CO (ppm ☐ mg/m^3 ☐)	NO (ppm ☐ mg/m^3 ☐)	NO_2 (ppm ☐ mg/m^3 ☐)	SO_2 (ppm ☐ mg/m^3 ☐)

…place..., date….

Respresentative of the facility
(Signature and full name)

Head of monitoring group
(Signature and full name)

Prepared by
(Signature and full name)

APPENDIX 07

GUIDANCE ON DEVELOPMENT OF QUALITY ASSURANCE PROJECT PLAN

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

I. Steps

1. Determining the goals and objectives of the monitoring program.

2. Determine the right kind of data to collect:

a) Determine the goals of using data (environmental assessment, environmental quality control, supplement regulatory authority data, or serving as a basis for issuance of decisions on environment, etc.);

b) Design programs that meet the needs of monitoring data users: officials, local or state planning authorities, etc.;

c) Strike a balance between data quality and available resources.

3. Collect background information to design monitoring programs:

a) Carry out a physical survey of the area where the monitoring will be carried out;

b) Collect information about the monitoring programs already operated in the area where the monitoring will be carried out;

c) Collect available data for reference for design of monitoring programs.

4. Refine the monitoring program goals: based on collected information and available information and data, refine and reevaluate the original monitoring program goals and objectives.

5. Design monitoring program:

a) A monitoring program shall be designed in accordance with the requirements and steps specified in Article 43 of this Circular;

b) The following notes shall be taken of when determining data quality objectives:

b.1) Data quality objectives are the quantitative and qualitative statements describing the degree of the data’s acceptability or utility to the data user(s). Data quality objectives specify the quality of the data needed in order to meet the monitoring program's goals;

b.2) Data quality objectives must determine one or some of the following indicators: accuracy or precision.

6. Develop an implementation plan including preparation for the monitoring program.

7. Draft standard operating procedures (SOPs): SOPs are the details on all the methods and can serve as the program handbook that helps monitors to carry out monitoring in an easy manner. Where possible, adapt the procedures from existing methods and modify them as needed to fit the project objectives.

8. Solicit feedback on your draft SOPs and QAPP.

9. Revise the AQPP based on the comments about the draft plan:

a) Specify existing methods and quality control procedures in the plan;

b) Modify the procedures to meet requirements;

c) Submit it to the competent authority for formal approval.

10. Once the QAPP is approved, begin the monitoring program by following the procedures described in the QAPP to train staff, conduct sampling, analyze samples, compile results, and develop any reports

11. Evaluate and refine monitoring program over time and reflect any changes in the QAPP:

a) Program evaluation should occur during the course of the program;

b) If any changes are made in the QAPP, report them to the QA official and always be prepared for formal audits or QC inquiries from data users during the course of the project.

II. Basic contents of QAPP

1. Basic contents of a QAPP are as follows:

a) Monitoring data users;

b) The monitoring program’s goals, objectives and issues;

c) Decisions and policies that may be issued by using monitoring data;

d) Issues that may arise and actions that may be taken to minimize effects of these issues;

dd) Data quality objectives;

e) Methods, time and place for executing the monitoring program;

g) Analytical methods, assessment and reports.

2. The QAPP shall be formulated and approved before starting your monitoring program.

3. The contents of the QAPP depend on the monitoring program's objectives, scale and methods of using data.

APPENDIX 09

QUALITY CONTROL ACCEPTANCE CRITERIA AND REMEDIAL MEASURES

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

I. Quality control acceptance criteria in field monitoring

Field QC samples shall be determined according to the following regulation:

1. Field replicate/duplicate sample

For two replicates, precision is assessed according to assessment of RPD that is calculated as follows:

$$RPD = \frac{|LD1 - LD2|}{[(LD1 + LD2)/2]} \times 100\,(\%)$$

Where:

RPD: relative percent difference;

LD1: measured value of the first duplicate;

LD2: measured value of the second duplicate.

RPD shall be established by the environmental monitoring organization and shall not exceed 30% but ensure the precision according to the method applied.

2. For the field replicate/duplicate sample: assess the precision of the field replicate/duplicate sample according to assessment of RPD that is calculated using the equation provided in Clause 1 of this Section, where LD1 is measured value of the first duplicated, LD2 is measured value of the second duplicate. RPD shall be established by environmental monitoring organization and shall not exceed 15%.

3. Field blank sample, trip blank sample and equipment blank sample

Value of field blank sample is acceptable if it is < MDL (method detection limit)

4. Field QC with reference material

a) For the exhaust gas monitoring equipment: regulations specified in the Appendix 06 enclosed herewith shall be complied with;

b) For the water monitoring equipment (inland surface water, groundwater, rainwater, seawater and wastewater): the allowable error is in the range of ±5% of reading (for pH meter, the allowable error is in the range of ± 0.05 pH in case of 0.01 pH interval scale and ± 0.2 pH in case of 0.1 pH interval scale).

5. In case the QC results is not compliant with regulations specified in Clauses 1, 2, 3 and 4 of this Section, find causes and take remedial and preventive measures.

II. Quality control acceptance criteria in environmental analysis

Environmental analysis must prepare QC documents to ensure the confidence of the analytical results. QC sample analytical results shall only be considered satisfactory if the criteria are established for comparison and acceptable error is determined at the request of the organization or monitoring program or according to laboratory statistical QC charts.

After each sample batch, the organization shall analyze one of the following control samples: method blank sample (to control the possibility of contamination of chemicals, tools and equipment), control standard sample, spike sample/ matrix spike (to assess the accuracy of analytical results), replicate/duplicate sample (to assess the precision of analytical results) or may analyze certified reference materials.

1. For each sample batch, the method blank sample is the first one to be analyzed. Value of method blank sample is acceptable if it is < MDL (method detection limit).

2. Control standard sample: the control standard sample is assessed through spike sample/ matrix spike percent recovery (%R) on blank sample background:

$$R = \frac{C_f}{C_t} \times 100$$

Where:

R: Percent recovery (%);

C_f: concentration of spike sample/ matrix spike;

C_t: concentration of control standard sample;

(C_f and C_t have the same dimensions)

3. Spike sample/ matrix spike: the control standard sample is assessed through spike sample/ matrix spike percent recovery (%R) on environmental sample background:

$$R = \frac{Cs - C}{S} \times 100$$

Where:

R: Percent recovery (%);

Cs: concentration of spike sample/ matrix spike;

C: sample background concentration;

S: concentration equivalent of analyte added to sample background.

(Cs, C and S have the same dimensions)

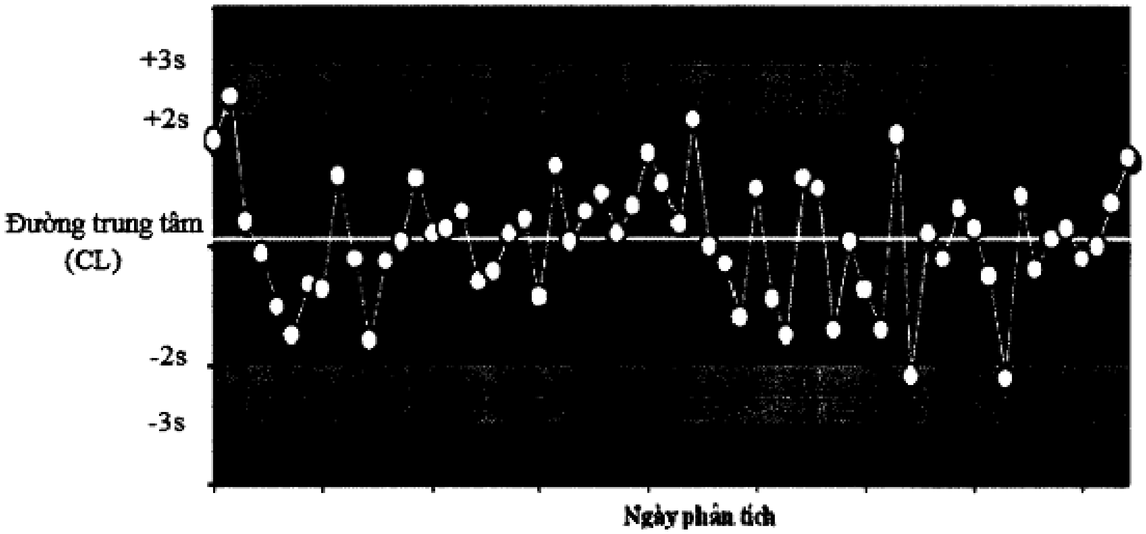
Analytical results of the control standard sample specified in Clause 2 of this Section and spike sample/ matrix spike are acceptable if %R of control standard sample is within the laboratory control range determined according to the results of method approval and meets the requirements for accuracy of the applied method.

4. Replicate sample: for two replicates, assess the precision according to RPD assessment specified in Clause 1, Section I of this Appendix.

4.1) Analytical results are acceptable if RPD of the replicate sample is within the laboratory control range determined according to the results of method approval and meets the requirements for precision of the applied method but shall not exceed 30%.

4.2) In addition to assessing the analytical results of the control samples according to the abovementioned criteria, the organization needs to control the trends and process of the analytical results according to statistical method by designing QC charts.

- Example 1: X-chart



Where:

CL: Central line in the control chart: mean value of the control values or a reference value;

CL ± 2s: warning limits (95% of the data normally distributed should be within these limits);

CL ± 3s: control limits (99,7% of the data normally distributed should be within these limits);

s: Standard deviation calculated according to the data set used for determining the central line.

- Example 2: R-chart

When analyzing laboratory replicate/duplicate samples, % mean difference may be determined ($\overline{R} = D2*\sigma$). In this case, width control chart or range control chart has a central line $\overline{R} = D2*\sigma$, warning limits (WL):

$$WL = \overline{R} + 2\sigma(R) = \overline{R} + 2/3(D4*\overline{R} - \overline{R})$$

and control limits:

$$CL = \overline{R} + 3\sigma(R) = D4*\overline{R}$$

Where:

D_2: coefficient of variation calculated from the standard deviation and range

D_4: coefficient of variation calculated from the mean range and standard deviation

σ: standard deviation

σ(R): standard deviation from range;

Depending on the number of replicates, D2 and D4 are determined according to Table 35 below:

Table 35

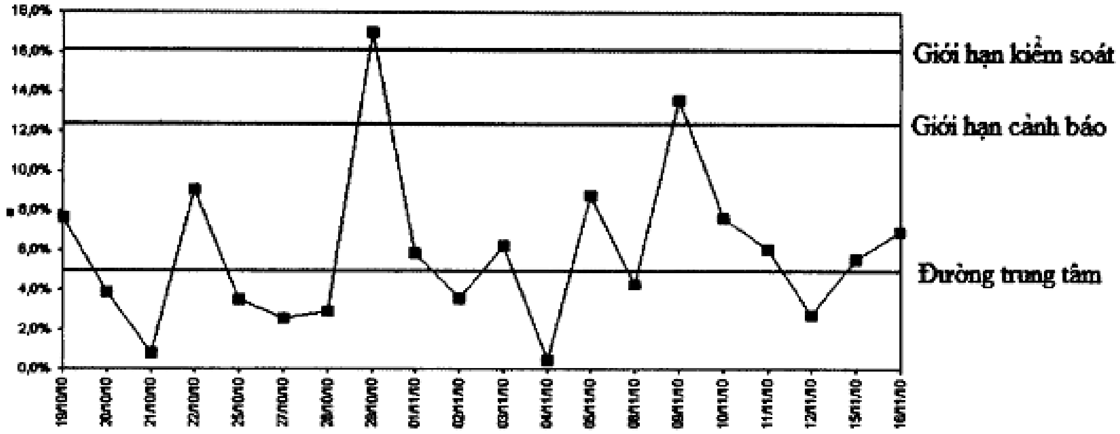
Number of replicates (n)	D2	D4
2	1.128	3.267
3	1.693	2.575
4	2.059	2.282
5	2.326	2.115

Depending on the number of replicates, calculation of central line, warning limits and control limits is determined according to Table 36 below:

Table 36

Number of replicates	Standard deviation (σ)	Central line	Warning limits (WL)	Control limits (CL)
2	Mean range/1.128	1.128*σ	2.833*σ	3.686*σ
3	Mean range/1.693	1.693*σ	3.470*σ	4.538*σ
4	Mean range/2.059	2.059*σ	3.818*σ	4.698*σ
5	Mean range/2.326	2.326*σ	4.054*σ	4.918*σ

In case of 02 replicates, the R chart is as follows:



Assumptions	Conclusion	Measures
- Case 1: the control value is within the warning limits - Case 2: the control value is between the warning and control limits and the two previous control values were within warning limits	The method is in control	The analytical results can be reported
- Case 1: the control value is outside the control limits - Case 2: the control value is between the warning and control limits and at least one of the two previous control values were also between the warning and control limits	The method is out of control	No analytical results can be reported. All samples analyzed since last control value in control was obtained must be reanalyzed
- Case 1: 7 control values in consecutive order gradually increase or decrease. - Case 2: 10 out of 11 consecutive control values are lying on the same side of the central line.	The method is in control but tends to be out of statistical control if the majority of the control values are within the warning limits	Analytical results can be reported, but important trends should be discovered as early as possible in order to avoid serious problems in the future

APPENDIX 10

CALCULATION OF RELATIVE ACCURACY (RA) OF MONITORING RESULTS OF AUTOMATIC AND CONTINUOUS MONITORING SYSTEM AND REFERENCE MONITORING METHOD

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

1. Difference shall be calculated using the equation (1):

$$|d| = \left| \frac{1}{n_i} \sum_{i=1}^{n} d_i \right| \qquad \text{Equation (1)}$$

Where:

d (difference): difference between the 02 sets of data;

n: total number of reference monitoring runs;

d_i: difference between the results of the system and reference monitoring results from the i-th reference monitoring, $d_i = CEM_i - RM_i$;

CEM_i: monitoring results of the system from the i-th reference monitoring;

RM_i: monitoring results obtained from the reference monitoring method from the i-th reference monitoring.

2. Standard deviation shall be calculated using the equation (2):

$$Stdev = \sqrt{\frac{\sum_{i=1}^{n} (d_i)^2 - \frac{1}{n}\left(\sum_{i=1}^{n} (d_i)\right)^2}{n-1}} \qquad \text{Equation (2)}$$

Where:

Stdev (Standard deviation): standard deviation of the two sets of reference monitoring data;

n: total number of reference monitoring runs;

d_i: difference between the results of the system and reference monitoring results from the i-th reference monitoring, $d_i = CEM_i - RM_i$;

CEM_i: monitoring results of the system from the i-th reference monitoring;

RM_i: monitoring results obtained from the reference monitoring method from the i-th reference monitoring.

3. Confidence coefficient shall be calculated using the equation (3):

$$|cc| = \frac{t_{0.025} \times Stdev}{\sqrt{n}} \qquad \text{Equation (3)}$$

Where:

cc: confidence coefficient,

Stdev (Standard deviation): standard deviation of the two sets of reference monitoring data;

n: total number of reference monitoring runs;

$t_{0.025}$: the coefficient t is corrected for n-1 degrees of freedom as shown in Table 37 below:

n - 1	5	6	7	8	9	10	11	12	13	14
$t_{0.025}$	2.571	2.447	2.365	2.306	2.262	2.228	2.201	2.179	2.160	2.145

➢ **Relative accuracy (RA)** shall be calculated using the equation (4):

$$RA = \left(\frac{|d| + |cc|}{RM} \right) \times 100 \qquad \text{Equation (4)}$$

Where:

RA: Relative accuracy (%);

d: Difference between the two sets of data calculated using the equation (1);

cc: Confidence coefficient calculated using the equation (3);

RM (reference method): mean value of all reference monitoring results.

APPENDIX 13

CONTENTS OF METHOD APPROVAL REPORT

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

The method approval report must contain the following contents:

1. Accuracy

Describe the approaches and methods for determining accuracy. Carry out a detailed analysis and assessment of test information and data to prove the capability of the selected analytical method meets criteria for accuracy.

2. Precision

Analyze and assess replicate or reproducible samples in each sample batch or difference sample batches to assess the effects due to changes of analytical conditions, conditions of equipment and chemicals on the monitoring results. The determination may be carried out by analyzing replicate/duplicate or reproducible samples at least 10 times.

3. Range and linearity

4. Method detection limit

a) Describe the method of determining the analyte concentration from analysis of a sample in a given matrix containing the analyte to ensure that the 99% confidence limit is calculated and the selected analyte has the lowest concentration.

b) The testing and assessment results used for determining medthod detection limit according to the documents of US EPA in 40 CFR Part 136, Appendix B: “Definition and Procedure for the Determination of the Method Detection Limit-Revision 1.11” shall be presented in this report.

5. Limit of quantitative

6. Uncertainty of measurement

7. Testing results

The organizations assessing and approving the value of the method need to include the laboratory test results in the Appendix of the report.

APPENDIX 14

CONTENTS OF STANDARD OPERATING PROCEDURES

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

Each standard operating procedure (SOP) for laboratory analytical methods shall include contents and implementation steps, containing at least:

1. Scope

Information about organization and place where the procedure is applied, analytical parameters, analytes, analytical equipment, characteristics of the method according to the approved values (measurement range, detection limit, etc.).

2. Terms and definitions

3. General introduction of the method

4. Sample collection and preservation

5. Effects

Effects on the analytical process and results. Measures taken to minimize such effects.

6. Equipment and supplies

Equipment and supplies necessary for analysis. Technical specifications of such equipment and supplies.

7. Chemicals and reference materials

Information about the chemicals and reference materials to be used and methods of preparing them.

8. Analytical procedures

9. Analytical data and result calculation

10. Quality control

QC criteria and assessment of analytical results, applicable to laboratory

APPENDIX 15

NAME, STRUCTURE AND CONTENTS OF FILE

(Enclosed with the Circular No. 24/2017/TT-BTNMT dated September 01, 2017 of the Minister of Natural Resources and Environment)

1. Name of the file: ProvinceName_Facilityname_Stationname_Time.txt

Where:

ProvinceName$^{(*)}$: abbreviated name of the province where the automatic and continuous monitoring station is installed, written continuously without separation and accents and specified in Table 38 below.

Table 38

No.	Name of provinces and cities	Symbol	No.	Name of provinces and cities	Symbol
1	An Giang	AG	33	Kon Tum	KT
2	Bac Can	BC	34	Lai Chau	LC
3	Binh Duong	BD	35	Lam Dong	LD
4	Binh Dinh	BD	36	Lang Son	LS
5	Bac Giang	BG	37	Lao Cai	LCa
6	Bac Lieu	BL	38	Long An	LA
7	Bac Ninh	BN	39	Nam Dinh	ND
8	Binh Phuoc	BP	40	Nghe An	NA
9	Ben Tre	BT	41	Ninh Binh	NB
10	Binh Thuan	BTh	42	Ninh Thuan	NT
11	Ba Ria - Vung Tau	BV	43	Phu Tho	PT
12	Cao Bang	CB	44	Phu Yen	PY
13	Ca Mau	CM	45	Quang Binh	QB
14	Can Tho	CT	46	Quang Nam	QNa
15	Da Nang	DNa	47	Quang Ngai	QNg
16	Dac Lac	DL	48	Quang Ninh	QN
17	Dac Nong	DNo	49	Quang Tri	QT

18	Dien Bien	DB	50	Ho Chi Minh city	HCM
19	Dong Nai	DN	51	Son La	SL
20	Dong Thap	DT	52	Soc Trang	ST
21	Gia Lai	GL	53	Tay Ninh	TN
22	Ha Giang	HG	54	Thai Binh	TB
23	Ha Nam	HNa	55	Thai Nguyen	TNg
24	Ha Noi	HN	56	Thanh Hoa	TH
25	Ha Tinh	HT	57	Thua Thien Hue	TTH
26	Hai Duong	HD	58	Tien Giang	TG
27	Hai Phong	HP	59	Tuyen Quang	TQ
28	Hau Giang	HGi	60	Tra Vinh	TV
29	Hoa Binh	HB	61	Vinh Long	VL
30	Hung Yen	HY	62	Vinh Phuc	VP
31	Kien Giang	KG	63	Yen Bai	YB
32	Khanh Hoa	KH			

FacilityName*: 4-letter abbreviated name of the facility, written continuously without separation and accents.

Stationname(*): 6-letter abbreviated name of the station (name of water station consists of 3 letters "NUO" and 3-letter specific name of the station, name of gas station consists of 3 letters "KHI" and 3-letter specific name of the station), written continuously without separation and accents.

Time: time of monitoring results in **yyyyMMddhhmmss** format.

Where:

yyyy: four-digit year format

MM: two-digit month format

dd: two-digit day format

hh: two-digit hour format

mm: two-digit minute format

ss: two-digit second format

(*): remain unchanged throughout operations of the station

2. Structure and content of file

Measurement parameter 1	Measurement parameter 1	Parameter unit 1	Time	Status of measuring equipment 1
Measurement parameter 2	Monitoring result 2	Parameter unit 2	Time	Status of measuring equipment 2
………..				

Notes:

- Columns are separated by a space aquivalent to a TAB key.

- Measurement parameter is the symbol for parameter of the monitoring station

- Measurement unit is the symbol for measurement unit of the monitoring parameter.

The symbol for measurement parameter and measurement unit is shown in Table 39 below, as an example:

Table 39

No.	Measurement parameters	Symbol	Measurement unit
I	**Regarding automatic and continuous wastewater monitoring station**		
1	Flow	Flow	m^3/h
2	Temperature	Temp	°C
3	Color	Color	Pt-Co
4	pH	pH	-
5	Total suspended solids	TSS	mg/L
6	Chemical oxygen demand	COD	mg/L
7	Biological oxygen demand	BOD	mg/L
8	Ammonia	$N\text{-}NH_4^+$	mg/L
10	Total phosphorous	TP	mg/L
11	Total Nitrogen	TN	mg/L
12	Total organic carbon	TOC	mg/L
13	Mercury	Hg	mg/L
14	Iron	Fe	mg/L
15	Total Chromium	TCr	mg/L
16	Cadmium	Cd	mg/L
17	Chlorine	Cl	mg/L
18	Total phenols	TPh	mg/L
19	Total cyanide	TCN	mg/L
II	**Regarding automatic and continuous exhaust gas monitoring station**		
1	Temperature	Temp	°C
2	Nitrogen monoxide	NO	mg/Nm^3
3	Nitrogen dioxide	NO_2	mg/Nm^3
4	Carbon monoxide	CO	mg/Nm^3
5	Sulfur dioxide	SO_2	mg/Nm^3
6	Oxygen	O_2	%V
7	Smoke unit	Opp	%
8	Hydrogen sulfide	H_2S	mg/Nm^3
9	Ammonia	NH_3	mg/Nm^3
10	Mercury vapor	VHg	mg/Nm^3
11	Particulate Matter	PM	mg/Nm^3
	……..	……..	

- Monitoring result is the results of the parameters obtained from the monitoring station.

- Time format: **yyyyMMddhhmmss**.

- Status of measuring equipment (measuring, calibrating and error) is specified by codes. Each code equivalent to each status of measuring equipment is specified in Table 40 below.

Table 40

Code	Status of measuring equipment
00	measuring
01	calibrating
02	error