PERFORMANCE VALIDATION PROCEDURE FOR DRINKING WATER TREATMENT TECHNOLOGIES

Revised March 2021

Québec

Date	Modifications
2002	Publication of the first edition
2008	General revision
January 2014	General revision (transfer of coordination to the BNQ)
September 2014	Changes to the name of the ministry Removal of the quality limit definition (Chapter 4) Changes to Section 5.3 (Chapter 5) Addition of a paragraph in Case 1 (Appendix 2-B) Addition of a paragraph in Section 2 (Appendix 3-A) Change to Table 2.1 reference in Section 3 (Appendix 3-A) Changes to the title, text and table of Case 1 (Appendix 3-B) Removal of Appendix 4
March 2021	General revision

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EDITORIAL TEAM

The editorial team thanks everyone that collaborated in preparing and writing this publication, as well as the treatment technology manufacturers and distributors who assisted the government in developing a strict and fair validation method.

We also thank the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MDDELCC) and Bureau de normalisation du Québec (BNQ) management and support staff.

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PERFORMANCE VALIDATION PROCEDURE FOR DRINKING WATER TREATMENT TECHNOLOGIES

1. BACKGROUND

Under an agreement between the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC) and the Bureau de normalisation du Québec (BNQ), the government has mandated the BNQ to administer the performance validation procedure for drinking water treatment technologies.

The *Drinking Water and Domestic Wastewater Treatment Technologies – Performance Validation – Administrative Procedure* publication issued by the BNQ, as well as this publication, describe the procedure for submitting a performance validation application; amendments to an existing fact sheet; or the issuance of new fact sheets pertaining to drinking water treatment technologies.

The purpose of issuing technology fact sheets is to facilitate the analysis of files submitted through the infrastructure programs managed by the Ministère des Affaires municipales et de l'Habitation and the authorization by the MELCC of projects that use these treatment technologies.

2. PURPOSE AND FIELD OF APPLICATION

This publication describes the technical approach required by the *Drinking Water and Domestic Wastewater Treatment Technologies – Performance Validation – Administrative Procedure* (BNQ 9922-200) document. The technical and administrative documents describe the steps taken by the BNQ with respect to the performance validation procedure for drinking water treatment technologies.

The procedure applies to any drinking water treatment technology, or its application, that is not described in reference documents that are available on the MELCC website.

Any given treatment technology must meet the following criteria:

- Comply with the Regulation respecting the quality of drinking water (RRQDW) standards or, when targeted parameters are not standardized, with the *Guidelines for Canadian Drinking Water Quality*
- All materials in contact with the water used by the treatment technology must be NSF/ANSI 61 certified or comply with appropriate BNQ standards
- All chemicals used in treatment technologies must be NSF/ANSI 60 certified.

3. REFERENCES

In this document, a dated prescriptive reference means that the given version of the reference applies, whereas a non-dated prescriptive reference means that the latest version of the reference applies.

For the purposes of this publication, the following references (including any amendments, errata, corrigenda, etc.) contain requirements that must be taken into account and are quoted in the appropriate locations in the text:

BNQ (Bureau de normalisation du Québec) [https://www.bnq.qc.ca/en/]

BNQ 9922-200	*Drinking Water and Domestic Wastewater Treatment Technologies – Performance Validation – Administrative Procedure* *(Technologies de traitement en eau potable et en eaux usées d'origine domestique — Validation de la performance — Procédure administrative)*

ETV (Environmental Technology Verification) [https://etvcanada.ca/]

GVP	*Environmental Technology Verification – General Verification Protocol (GVP) – Review of Application and Assessment of Technology*

ISO (International Organization for Standardization)
[https://www.iso.org/home.html]

ISO/CEI 17025	*General requirements for the competence of testing and calibration laboratories*

MELCC (Ministère de l'Environnement et de la Lutte contre les changements climatiques) [www.environnement.gouv.qc.ca]

Design Guide	*Guide de conception des installations de production d'eau potable* (available in French only)
RRQDW	*Regulation respecting the quality of drinking water* (Q-2, r. 40)
Interpretation of the RRQDW	*Guide d'interprétation du Règlement sur la qualité de l'eau potable* (Q-2, r. 40, available in French only)

NSF (NSF International) [https://www.nsf.org/]

NSF/ANSI 60	*Drinking Water Treatment Chemicals — Health Effects*
NSF/ANSI 61	*Drinking Water System Components — Health Effects*

Health Canada [https://www.hc-sc.gc.ca/]

Canadian Recommendations	*Guidelines for Canadian Drinking Water Quality —Technical Documents*

4. DEFINITIONS

For the purposes of this publication, the following term applies:

Treatment technology: a system consisting of one or more pieces of equipment used to process water for human consumption.

For other definitions, refer to the BNQ 9922-200 procedure.

5. TREATMENT TECHNOLOGY PERFORMANCE VALIDATION

Under this validation procedure, the performance of treatment technologies can be classified in a technology fact sheet as *Under Validation (En validation)* or *Validated (Validé)*.

Validation begins with the submission of an official application to the BNQ, as set forth in the BNQ 9922-200 procedure. The validation process is summarized in Table 1.

5.1. *Under Validation* Level

5.1.1 Validation requirements

A technology fact sheet at the *Under Validation* level may be published when pilot test monitoring data demonstrate that the treatment technology has sufficient efficiency for full-scale use to be authorized, but longer term verification is still required. The use of this level of treatment technology must be authorized by the MELCC before being implemented. The formulaire de demande d'autorisation (available in French only) is available on the MELCC website.

Pilot test monitoring is described in Appendix 2. Monitoring must be conducted by a third party and analyses carried out by a laboratory that is accredited by the Centre d'expertise en analyse environnementale du Québec (CEAEQ). If the pilot test took place outside Quebec, analysis of the samples taken during the course of the pilot tests must have been conducted by an accredited laboratory that complies with the ISO/CEI 17025 international standard and subscribes to the International Laboratory Accreditation Cooperation's (ILAC) Mutual Recognition Agreement (MRA).

If monitoring required herein or that was submitted to and accepted by the BNQ cannot be met during the tests, the applicant must contact the BNQ as quickly as possible to receive its agreement for any required changes, failing which the file could be rejected when submitted for acquiring or amending a fact sheet.

The RRQDW requirements for standardized parameters or the Guidelines for Canadian Drinking Water Quality for parameters that are not subject to standards are met when the calculated tolerance limits are less than the specified values, based on results of the test method specified in section 5.3.

5.1.2 Application for an *Under Validation* technology fact sheet

In order for the performance of a treatment technology to be validated for given conditions (flow, flow variations, nature of raw waters, etc.) in a technology fact sheet at the *Under Validation* level, the applicant must submit the following documents to the BNQ as supporting documentation:

- The engineering report per Appendix 1 herein, including information pertaining to log removal credits and the selected integrity measurement method, if this acknowledgement is requested by the applicant, per Appendix 2-B;

- The pilot test report per Appendix 2-A and Appendix 2-B, if applicable;
- An independent third-party declaration;
- Supporting documents as listed in the BNQ 9922-200 procedure.

5.2. *Validated* Level

5.2.1 Validation requirements

A technology fact sheet at the *Validated* level may be published when a treatment technology presents monitoring data from an actual installation that demonstrates sufficient treatment efficiency and operational reliability for it to be authorized with no restrictions.

The requested monitoring is described in Appendix 3. Monitoring must be conducted by a third party and the analyses carried out by a laboratory that is accredited by the Centre d'expertise en analyse environnementale du Québec (CEAEQ). If the validation monitoring took place outside Quebec, analysis of the samples taken during the course of monitoring must have been conducted by an accredited laboratory per the ISO/CEI 17025 international standard and that is a subscriber to the International Laboratory Accreditation Cooperation's (ILAC) Mutual Recognition Agreement (MRA).

If the monitoring required herein or that was submitted to and accepted by the BNQ cannot be accomplished during the tests, the applicant must contact the BNQ as quickly as possible to obtain agreement for any required changes, failing which the file could be rejected when it is submitted for acquiring or amending a fact sheet.

The RRQDW requirements or the *Guidelines for Canadian Drinking Water Quality* for parameters that are not standardized must be met during the monitoring period.

5.2.2 Application for a *Validated* technology fact sheet

In order for the performance of a treatment technology to be validated for given conditions (flow, flow variations, nature of raw waters, etc.) in a technology fact sheet at the *Validated* level, the applicant must submit the following to the BNQ as supporting documentation:

- The engineering report per Appendix 1 herein, including information pertaining to the integrity measurement method, if this acknowledgement is requested by the applicant, per Appendix 3-B;
- The full-scale installation test report per Appendix 3-A and Appendix 3-B, if applicable;
- An independent third-party declaration;
- Supporting documents listed in the BNQ 9922-200 procedure.

TABLE 1 – SUMMARY OF APPLICATION LIMITS ASSOCIATED WITH VALIDATION LEVELS

Validation level	NO VALIDATION	UNDER VALIDATION	VALIDATED
Goal of the tests	Obtain a technology fact sheet for the *Under Validation* level. Check the performance of a pilot unit for a period of at least 13 weeks(1). Note: The treatment technology cannot be used to produce water for human consumption.	Obtain a technology fact sheet for the *Validated* level. Check the performance and operational reliability of an actual installation during a period of at least 52 weeks. Produce drinking water for human consumption.	Produce drinking water for human consumption.
Discharge of sludge and process water	Sewer network or authorized treatment system	Sewer network or according to stipulations in chapter 14 of the Design Guide	Sewer network or according to stipulations in chapter 14 of the Design Guide
Performance evaluation criteria	Pilot scale tests with performance monitoring, meeting the criteria set out in Appendix 2. As set out in the BNQ 9922-200 procedure, the BNQ may analyze the test protocol prepared by the applicant prior to its implementation.	Full-scale tests with performance monitoring, meeting the criteria set out in Appendix 3. As set out in the BNQ 9922-200 procedure, the BNQ may analyze the test protocol prepared by the applicant prior to its implementation.	
Documents to be prepared by the applicant following the performance tests	Engineering report (Appendix 1) Test report written by a third party, presenting the results of the pilot test (Appendix 2) or Test report showing that the treatment technology has already been successfully implemented elsewhere for a period of at least 13 weeks (Appendix 2)(1) Supporting documents requested in the BNQ 9922-200 procedure.	Engineering report (Appendix 1) Test report written by a third party, presenting the results of the validation tests (Appendix 3) or Test report showing that the treatment technology has already been successfully implemented elsewhere for a period of at least 52 weeks (Appendix 3)(1) Supporting documents requested in the BNQ 9922-200 procedure.	
Document produced by the BNQ	Comments on the test protocol, if requested Publication of an *Under Validation* technology fact sheet, if applicable	Comments on the test protocol, if requested Publication of a *Validated* technology fact sheet, if applicable	
MELCC authorization for the project	Not necessary, but compliance with all laws and regulations in effect is required.	Necessary Formulaire de demande d'autorisation pour réaliser un projet assujetti à l'article 22 de la Loi sur la qualité de l'environnement	Necessary Formulaire de demande d'autorisation pour réaliser un projet assujetti à l'article 22 de la Loi sur la qualité de l'environnement

(1) In the special case where the treatment technology has already been validated elsewhere in equivalent implementation conditions, a pilot test is not required. However, the applicant must provide all documentation requested for the review of its file. Moreover, treatability tests may be necessary in order to confirm performance or optimize design parameters.

5.3. Calculation of expected maximum limits for produced water

BACKGROUND

According to a generally recognized and accepted principle, justification of performance presented in the engineering report must be based on a statistical analysis of the test results, allowing for an adequate level of confidence with respect to regulatory requirements.

STATISTICAL APPROACH PROMOTED BY CANADA'S ETV PROGRAM

Just like the United States Environmental Protection Agency's (USEPA) Environmental Technology Verification (ETV) Program, Canada's Environmental Technology Verification Program (ETV), in its general protocol, requires that submitted files are supported by a statistical analysis of the results shown.

The applicant may refer to *Environmental Technology Verification — General Verification Protocol (GVP) — Review of Application and Assessment of Technology* (also available in French as *Vérification des technologies environnementales – Protocole de vérification générique (PVG) – Examen de la demande et évaluation de la technologie*) and its appendices, which are available on the ETV Canada website at [http://etvcanada.ca/home/protocols-and-procedures/].

As such, an applicant wishing to obtain an ETV Canada Technology Fact Sheet is encouraged to become familiar with the General Verification Protocol mentioned above.

REQUIREMENT FOR A STATISTICAL APPROACH THAT IS ADAPTED TO REGULATORY REQUIREMENTS APPLICABLE IN QUEBEC

To receive acknowledgement of the tests and performance monitoring in a technology fact sheet, a statistical approach with criteria adapted to the RRQDW requirements applicable in Quebec is required.

In this perspective, the applicant should refer to the RRQDW and the Interpretation of the RRQDW, which are both available on the MELCC website.

5.3.1 Presentation of data on raw water parameters

Presentation of all raw water parameters that were measured on the technology fact sheet is not required.

In order to report raw water conditions on the technology fact sheet that are representative of conditions during the 13-week pilot tests or a 52-week full scale validation, it is useful to retain a number of the more significant parameters.

With respect to the treatment technologies used for surface water (clarification, granular filtration, membranes, etc.), the values to be presented for raw water parameters are as follows:

i) Critical raw water parameters

Turbidity:
- value based on the 95th percentile of observed values
- maximum of observed values

TOC[1]:
- value based on the 90th percentile of observed values
- maximum of observed values

Other:
- value based on the 90th percentile of observed values and the maximum value for any other parameter deemed essential to ensure desired equipment performance

ii) Other measured raw water parameters

The following list is not exhaustive and can be adjusted according to the procedures that were assessed.

True colour: - value based on the 90th percentile of observed values

Temperature: - range of observed values

pH: - range of observed values

Total alkalinity: - range of observed values

Iron: - range of observed values

Manganese: - range of observed values

UV absorbance: - range of observed values

SUVA[2]: - range of observed values

With respect to the treatment processes used for groundwater, the values to present for raw water parameters will depend on the targeted performance. As such, raw water data will be required for each parameter for which a treatment performance acknowledgement is requested.

[1] Total organic carbon
[2] Specific UV Absorbance

i) Critical raw water parameters

Parameter: - value based on the 90th percentile of observed values and the maximum value for any other parameter deemed essential to ensure desired equipment performance

ii) Other raw water parameters measured

Parameter: - value based on the 90th percentile of observed values and the maximum value for any other parameter deemed relevant

The same applies to treatment technologies for which log removal credits are requested, regardless of whether they are used for surface water or groundwater.

5.3.2 Presentation of data on treated water parameters

For treated water results, it is necessary to demonstrate, using an adapted statistical method, that the regulatory requirements developed in the RRQDW have been satisfied.

As such, the applicant shall demonstrate, in a distinct manner for the following parameter groups and by limiting itself to the targeted parameters treated by the equipment, that the results obtained meet the RRQDW requirements, considering the specifications provided by the Interpretation of the RRQDW, as follows:

i) Microbiological parameters

The results presented must allow for the achieved elimination rate to be noted for each of the targeted microorganisms. To ascertain which parameter and achievable elimination rates to present, the applicant should refer to Appendix 2-B of this procedure and to volume 1, chapter 10 of the Design Guide.

ii) Inorganic substance parameters

The results presented must demonstrate that RRQDW standards will be met at all times. Section 2, Appendix 1 of the RRQDW lists maximum inorganic substance concentrations for treated water.

If the parameter targeted by the treatment is not part of an RRQDW standard, the results presented must demonstrate that the generally allowed threshold for this parameter (*Guidelines for Canadian Drinking Water Quality*, World Health Organization, etc.) will be met at all times.

iii) Organic substance parameters

The results presented must demonstrate that RRQDW standards will be met at all times. Section 3, Appendix 1 of the RRQDW lists maximum organic substance concentrations for treated water.

If the parameter targeted by the treatment is not part of an RRQDW standard, the results presented must demonstrate that the generally allowed threshold for this parameter (*Guidelines for Canadian Drinking Water Quality*, World Health Organization, etc.) will be met at all times.

Chlorination by-products

For trihalomethanes (THM) and haloacetic acids (HAA), note 3 at the bottom of Table 3, Appendix 1 of the RRQDW requires that the average of the maximum values obtained for four consecutive quarters be calculated. As such, the results presented for chlorination by-products will be based on the average of four consecutive values instead of the maximum obtained value.

iv) Radioactive substance parameters

The results presented must demonstrate that RRQDW standards will be met at all times. Section 4, Appendix 1 of the RRQDW lists maximum radioactive substance concentrations for treated water.

If the parameter targeted by the treatment is not part of an RRQDW standard, the results presented must demonstrate that the generally allowed threshold for this parameter (*Guidelines for Canadian Drinking Water Quality*, World Health Organization, etc.) will be met at all times.

v) Turbidity parameters

The results presented must demonstrate that RRQDW standards will be met at all times. Section 5, of Appendix 1 of the RRQDW lists the values for the following processes:

- the threshold value for a period of 30 days;

- the threshold value that must be met at all times.

5.3.3 Application to amend critical raw water quality parameters

Applications to amend an existing fact sheet with respect to a critical raw water parameter may be filed with the BNQ. Applications must include a technical note signed by an engineer making a critical judgment on the treatment technology applicability conditions, and must be supported by results of pilot testing extending over at least two weeks with all equipment functioning adequately on the basis of the design criteria shown in the fact sheet, including planned normal washing sequences during the period in question.

5.3.4 Statistical analysis of obtained results

For all parameters shown in the previous sections, a statistical method must be used in order to demonstrate that the obtained results will allow requirements to be met. The statistical analysis of the results must demonstrate that the performance allegation has a statistical significance of 95%.

For the purposes of the statistical analysis, the applicant will use the criteria set forth in chapter 5 of the *Environmental Technology Verification - General Verification Protocol (GVP) - Review of Application and Assessment of Technology* and its Appendices, which are available on ETV Canada's website [http://etvcanada.ca/en/home/protocols-and-procedures/].

APPENDIX 1

ENGINEERING REPORT

APPENDIX 1: ENGINEERING REPORT

PREAMBLE

The applicant is required to submit an engineering report with its request for an *Under Validation* or *Validated* level technology fact sheet.

This Appendix describes the engineering report content that is to be submitted to the BNQ for validation.

ENGINEERING REPORT CONTENT

The applicant's engineering report must be prepared and signed by an engineer who is either a member of a Québec professional corporation or a like association in the jurisdiction where they practise. The engineer may work for the applicant or be an independent contractor.

The engineering report must be divided into four chapters containing the following items, at a minimum:

CHAPTER 1 – MANUFACTURER'S CONTACT INFORMATION

- Enter the name of the treatment technology referenced in the report.
- Enter the manufacturer's name and contact information and, if possible, the name, telephone and fax numbers and email address of a contact person.
- If applicable, enter the name and contact information of the distributor and the name, telephone and fax numbers and email address of a contact person.

CHAPITER 2 – DESCRIPTION OF THE TREATMENT TECHNOLOGY

- Enter the name and, if applicable, the brand and model number.
- Explain the working principle of the equipment.
- Describe the treatment chain.
- Describe each component of the treatment technology and its function.
- If applicable, describe the specifications for the pretreatment stages.
- Provide a flow scheme that illustrates the equipment covered by the report.

CHAPITER 3 – TECHNICAL SPECIFICATIONS AND DESIGN CRITERIA

Description of the treatment technology

- Detail the proposed design criteria, including the flow range within which the treatment technology and/or each of the models are usable, the redundancy equipment, emergency measures, continuous monitoring and alarms, etc.
- If the dimensions of the treatment units are based on a kinetic or other mathematical model, provide the model and the values of the coefficients that were used.
- As need be, provide the scaling rules used for the components and the prescribed design and operational limits.

- Detail the range of concentrations of all parameters deemed critical for the proper functioning of the treatment technology within the intended application.
- State any other constraints on the use of the treatment technology, such as excessive turbidity, presence of high concentrations organic matter, etc.
- If the treatment technology necessitates a pretreatment stage, provide its specifications or references as set out in the Design Guide or section of another appropriate technical manual.
- If applicable, state whether adjustments to the design are warranted, in particular to take account of the lower water temperature in winter and reduced equipment efficiency over time.
- Provide a detailed description of the maintenance steps used for the treatment equipment, such as rinsing, washing, regeneration, etc., as well as the management mode for wastewater, including quantitative estimates.

Description of conducted tests and/or monitoring

- Provide details on the installation where the testing or monitoring was conducted:
  - Location where the treatment technology was tested;
  - Site map and photos of the equipment installation;
  - Specifications of each piece of equipment monitored for its performance and any differences between the monitored installation and the proposed treatment technology or model.
- Provide details on the tests and/or monitoring:
  - Type and mode of feed water used, as well as flow and temperature variations;
  - Operational parameters used during the testing or monitoring;
  - Action taken, such as washing, maintenance, modifications, etc.

Description of obtained results

- Present the raw and treated water quality results observed during the test or monitoring period that provide details on the design criteria.
- Provide the list of subsidiary products that formed during the treatment, including the measured concentrations. If applicable, detail the relationships between raw water quality, product dosages and resulting concentrations of subsidiary products.
- Provide the mass balances and all available results relating to the production and discharge of waste water and sludge.
- Assess whether or not these performance values are expected to continue beyond the test period.
- Assess the potential for sludge accumulation, and progressive clogging of equipment, etc., as well as their impact on system performance and operation.
- Submit a diagrammatic illustration of the performance monitoring results based on design and/or operational parameters to which the variable correlates, stating the confidence intervals and regression tolerance thresholds (see section 5.3).
- When applying for a *Validated* fact sheet, include the list of authorized installations, provides dates of entry into service and, to the extent possible, any results of control monitoring carried out prior to 60 days before the monitored installation validation report was filed (see Appendix 3-A).
- Provide any other information that could be useful in interpreting results.

CHAPTER 4 – USER GUIDE AND OPERATIONAL RECOMMENDATIONS

- Provide a user guide that details operational, inspection and maintenance recommended by the applicant. The user guide should contain, at a minimum, the following:
  - General information;
  - Flow diagram;
  - Equipment description and functionality;
  - Operational details of the equipment:
    - Start-up;
    - Normal conditions, particularly the frequency of recommended intervention if relating to fixed-frequency periodic activities or the criterion spurring action (volume or height of accumulated sludge in a basin, accumulation of water at the surface of a filter, etc.);
    - Assistance in locating malfunctioning of a critical component;
    - Component replacement procedure (turning equipment off, parts to be replaced or checked, etc.).
  - Expected performance;
  - Warranties and limitations (expected useful life of components, warranty expiry date, etc.).
- The engineering report should list all interventions at authorized installations (for example, if specialists were needed, whether the intervention is described in the user guide or operational manual).
- Provide certification by an engineer that recommendations for the utilization, inspection and maintenance as set forth in the user guide meet good practices, aim at maintaining expected performance and are consistent with operational activity during equipment monitoring.

TECHNOLOGY FACT SHEET PROPOSAL

The applicant must present a technology fact sheet proposal prepared on the basis of the preceding chapters in the report.

To ensure uniformity in the proposed technology fact sheet, the format of this proposal shall draw inspiration from typical examples of fact sheets that are available upon request from the BNQ.

The applicant will also be able to refer to already published sheet formats.

APPENDIX 2

PERFORMANCE VALIDATION MONITORING TO SUPPORT AN UNDER VALIDATION LEVEL FACT SHEET (APPENDIX 2-A)

AND

METHODS FOR ESTABLISHING MICROORGANISM LOG REMOVAL CREDITS (APPENDIX 2-B)

APPENDIX 2-A: PERFORMANCE VALIDATION MONITORING TO SUPPORT AN UNDER VALIDATION LEVEL FACT SHEET

1. MONITORING OBJECTIVE

The objective of pilot test monitoring is to demonstrate equipment performance and conditions prevailing when the tests were conducted. Monitoring is supervised by an independent third party who must check the accuracy of the tests and objectively report the results.

2. TEST PROTOCOL

Monitoring can vary per the treatment technology and the water supply source (surface or groundwater). Sampling must be performed when the pilot unit is under stable conditions. A stable condition may be associated with no noteworthy change in performance over time, with constant flow, concentration, and temperature not being necessarily limited to these categories.

The applicant must prepare a test protocol that takes the guidelines of this appendix into account, adapting it as needed on the basis of the treatment technology and its implementation.

The BNQ may be consulted regarding the content of the test protocol as described in the BNQ-9922-200 procedure.

3. DURATION OF PILOT TEST MONITORING

The pilot unit must be operated in the reference conditions during a period of at least 13 uninterrupted weeks where, in the case of surface water, the raw water quality conditions are representative of the variations expected in actual conditions.

4. SUPERVISION BY A THIRD PARTY

The pilot test monitoring must be conducted under the supervision of a competent third party, including at least one engineer who has the necessary knowledge relating to the treatment technology monitoring.

The third party mandate must include supervising sampling and logging, monitoring all operational parameters and prevailing conditions when the samples were taken for laboratory analysis. The following publication may serve as an example when defining sampling tasks:
www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/generalitesC1.pdf.

The third party must write a test report as described in section 9 of this appendix.

5. PILOT UNIT OPERATION

The applicant can ensure the operation of the pilot unit.

6. PARAMETERS AND ANALYSES

6.1 OPERATING PARAMETERS

With respect to pilot test monitoring, the third party must ensure that operating parameter measurements correspond to the operating conditions of the equipment used. Monitoring must ensure that these measurements are documented when the samples are taken for analysis.

Monitoring must also report start and stop times of equipment such as injection pumps, transfer or recirculation pumps, and, if applicable, operating speeds, variator induction percentages or number of discontinuous operating cycles, etc., as well as equipment calibration.

During inspections, the status of systems, indications and registration of measurement equipment or any other instrumentation such as flow meters, temperature sensors, level sensors and alarms, must be recorded.

The operating cycles, automatic programming and operation of control systems must be described. Where required, operating tests and device calibration checks must be carried out.

6.2 SAMPLING PROGRAM AND ANALYSES

Tables 1.1 and 1.2 specify basic parameters for pilot test monitoring. Table 1.1 must be used for surface water and Table 1.2 for groundwater. Additional analyses of particular parameters could also be relevant per local characteristics (for example, analysis of aluminum if alum is used).

Sampling must be done uniformly during the entire testing period, particularly during the first and last weeks.

Special case: monitoring of parameters for a treatment technology that is part of a complete treatment chain

In the event the treatment technology to be evaluated is incorporated into a complete treatment chain, monitoring must also pertain to the operating parameters of the treatment technologies, as well as to intermediate sampling.

6.3 SAMPLING, SAMPLE PRESERVATION AND TRANSPORT

The sampling, preservation, and transport of samples must meet the requirements set forth in the RRQDW for the targeted parameters. If the parameters used are not standardized in accordance with the RRQDW, the third party must ensure that the conditions set by the accredited laboratory are met.

7. EVENT REGISTRY

The third party must prepare a registry of the conditions that prevailed during sampling, the sequence of events and all equipment intervention. In particular, the following must be noted and reported:

- the nature and quantity of products added (chemicals or other additives) and the frequency of the addition of these products during the entire full-scale validation period;
- all noteworthy events (equipment breakdown, repairs, adjustments or minor modifications, unclogging, scarification, replacement of filtering material, etc.);
- the status of all systems, including automatic control systems and instrumentation;
- equipment calibration dates;
- the quantity and characterization of produced wastewater or sludge, if applicable.

8. CHANGES DURING TESTING

No installation treatment technology changes are to be made during the pilot test. If any changes are made, pilot test monitoring must take place for at least 13 subsequent uninterrupted weeks thereafter.

9. PILOT TEST REPORT

The pilot test report must be prepared by the third party and bear the signature of the engineer in charge on a page that explicitly describes the mandate.

The engineer's report must include the following:

- certification that the samples were taken by a qualified individual and that the standards on sampling and sample preservation methods and periods set forth in the RRQDW, or by the accredited lab for unregulated parameters have been complied with;
- presentation of all compiled analytical results (include laboratory analysis certificates, to be shown in an appendix). The calculation of expected maximum limits for water produced must have been based on obtained results (see section 5.3);
- operating conditions before and after sampling;

- nature of added products (coagulants, flocculants, oxidants, etc.) and quantity and frequency of addition of these products during the monitoring period;
- description of all noteworthy events (equipment failure, repairs, adjustments, minor changes or other);
- interpretation of the impact of observed interventions and events during the tests on the obtained results, including the engineer's own readings and comments.

Table 1.1: Parameters and sample frequency
Pilot tests with surface water

PARAMETERS	**RAW WATER**	**TREATED WATER**
	Minimum number of samples	Minimum number of samples
pH (on site)	**13 (1/week)**	**13**
Temperature (on site)	**13**	**13**
Escherichia coli	**13**	**13**
Total coliforms	**13**	**13**
Total organic carbon (see note 1)	**13**	**13**
Dissolved organic carbon (see note 1)	**13**	**6 (1/2 weeks)**
Turbidity	**13**	**13**
UV Absorbance at 254 nm (see note 1)	**13**	**6**
Ammoniacal nitrogen	**3 (start, middle, end)**	**3**
Nitrates and nitrites	**3**	**3**
Chlorine demand (see note 2)	**optional**	**6**
Total Alkalinity	**6**	**6**
Al (for technologies using aluminum salts)	**6**	**6**
Silt Density Index (SDI, see note 3)	**6**	**-**
Trihalomethane formation simulation (SDS-THM, see note 2)	**N/A**	**6**
Haloacetic acid formation simulation (SDS-HAA, see note 2)	**N/A**	**6**

OPTIONAL PARAMETERS (may become necessary depending on raw water quality and the objectives of the treatment technology)	**RAW WATER** Minimum number of samples	**TREATED WATER** Minimum number of samples
Heterotrophic plate count (HPC)	**13**	**13**
Aerobic sporulating bacteria (ASB)	**13**	**13**
Calcium	**6**	**6**
Conductivity	**6**	**6**
True colour (on site)	**13**	**13**
Hardness	**6**	**6**
Iron	**6**	**6**
Manganese	**6**	**6**
Nitrites	**3**	**3**
Dissolved solids	**3**	**3**
Total solids	**3**	**3**

Note 1: These samples allow the specific UV absorbance (SUVA) of raw water to be calculated.

Note 2: 24-hour test with 0.5 ± 0.2 mg/L of free residual chlorine after 24 hours, with a pH of 7.5 and temperature of ± 22°C.

Note 3: This parameter need only be measured for nanofiltration treatment technologies. Sampling must be conducted upstream of the first membrane level, including recirculation if applicable.

Table 1.2: Parameters and sample frequency
Pilot tests with groundwater

PARAMETERS	**RAW WATER**	**TREATED WATER**
	Minimum number of samples	Minimum number of samples
pH (on site)	**13 (1/week)**	**13**
Temperature (on site)	**13**	**13**
Escherichia coli	**13**	**13**
Total coliforms	**13**	**13**
Total organic carbon	**13**	**13**
Turbidity	**13**	**13**
Nitrates and nitrites	**3 (start, middle, end)**	**3**
Chlorine demand (see note 1)	**N/A**	**6 (1/2 weeks)**
Total Alkalinity	**6**	**6**
Hardness	**6**	**6**
Al (for technologies using aluminum salts)	**6**	**6**
Iron	**6**	**6**
Manganese	**6**	**6**
Silt Density Index (SDI, see note 2)	**6**	**-**
Sulphides	**3**	**3**
Trihalomethane formation simulation (SDS-THM, see note 1)	**N/A**	**6**
Haloacetic acid formation simulation (SDS-HAA, see note 1)	**N/A**	**6**

OPTIONAL PARAMETERS (may become necessary depending on raw water quality and the objectives of the treatment technology)	**RAW WATER** Minimum number of samples	**TREATED WATER** Minimum number of samples
True colour (on site)	**13**	**13**
Dissolved oxygen (on site)	**6**	**6**
Nitrites	**3**	**3**
Arsenic	**3**	**3**
Barium	**3**	**3**
Calcium	**6**	**6**
Chlorides	**3**	**3**
Conductivity	**6**	**6**
Fluorides	**3**	**3**
Sulfates	**3**	**3**
Sodium	**3**	**3**
Dissolved solids	**3**	**6**
Total solids	**3**	**3**
Reduction-oxidation potential	**3**	**3**

Note 1: 24-hour test with 0.5 ± 0.2 mg/L of free residual chlorine after 24 hours, with a pH of 7.5 and temperature of ± 22°C.

Note 2: This parameter need only be measured for nanofiltration treatment technologies. Samples must be carried out upstream of the first membrane level, including recirculation if applicable.

APPENDIX 2-B: METHODS FOR ESTABLISHING MICROORGANISM LOG REMOVAL CREDITS

The different accepted methods for establishing microorganism log removal credits are listed in Appendix 2-B.

Two cases are shown below: ultraviolet reactors and other treatment systems.

CASE 1 — ULTRAVIOLET REACTORS

The performance of any ultraviolet irradiation disinfection reactor used in the treatment of water to be used for human consumption must have been validated by a recognized biological dosimetry method. The objective of the validation is to confirm the effective dosage provided by an ultraviolet reactor in different operating conditions, while allowing the sensors to be calibrated based on the effective dosage provided.

Given the fact that there exist several standards, the applicant must provide the test results, stating the validation protocol that was used and the independent organization that supervised the tests. The German (DVGM-W294), Austrian (ONORM M 5873-1) or American (NWRI-AWWARF and NSF 55) validation protocols are currently acceptable references relating to the subject matter. The USEPA (UVGM) could also be used to validate the performance of an ultraviolet reactor.

If the biological dosimetry tests are conducted directly at the location where the reactor is to be installed, the protocol used shall comply with one of the recognized protocols and be approved by the BNQ before the tests are conducted.

In all cases, the applicant shall submit, along with the biological dosimetry report on tests conducted by an independent third party using a recognized protocol, a report signed by an engineer that explicitly presents the proof of every value to be shown in the technology fact sheet for the reactor, with spreadsheets that include the formulas and all relevant notes.

CASE 2 — OTHER TREATMENT SYSTEMS

The maximum credit granted for treatment systems is the lowest among the following two values:

- the lowest removal (log) obtained during tests allowing the removal credits to be established;
- the highest removal (log) verified by the periodic measurement of system integrity.

Protocol for establishing parasite and virus log removal credits

A recognized protocol allowing log removal credits to be granted to treatment systems is the EPA/NSF ETV *Protocol for Equipment Verification Testing for Physical Removal of Microbiological and Particulate Contaminants*.

This protocol promotes the use of reference particles or microorganisms to check the manufacturing and assembly quality of systems with respect to parasite and virus removal. In compliance with this protocol, the following guiding principles apply:

- the **reference** particles used (inert particles, microorganisms or other) are **representative** of the target organisms (parasites or viruses) and are easily **measurable or countable** (for example, by using aerobic sporulating bacteria, MS2 bacteriophage viruses, fluorescent calibrated particles, etc.);
- the **reference particles** used are **sufficient in number** to establish a log removal level of the tested system;
- the **tested system** is **representative of the actual system;** for example, it uses the same type of membranes, operating conditions (membrane flux, water quality before membranes, flow conditions), assembly methods and accessories, housings, etc.

Other approaches to log removal credit may be recognized, on condition that they clearly show achieved disinfection performance.

It is therefore the responsibility of each applicant to establish a protocol and submit it for approval. The protocol **must be accompanied** by an integrity measurement method protocol for the submitted treatment system (see the following section).

Protocol used to recognize an integrity measurement method

By carrying out (continuous or discontinuous) integrity measurement with an acknowledged method (direct or indirect), the protocol aims to ensure that the protozoa and virus log removal credits of the treatment technology under review are maintained. Even though several methods exist in the marketplace for measuring equipment integrity, there is no currently available protocol that allows an integrity measurement method to be associated with the log removal credits granted.

However, the guiding principles that allow for recognizing an integrity measurement method are the following:

- **Direct integrity measurement methods are preferred** over indirect methods (the following table lists a number of methods, as well as their benefits and drawbacks).

INTEGRITY MEASUREMENTS METHODS		
INDIRECT METHODS	**BENEFITS**	**DRAWBACKS**
Permeate turbidity measurement	- Easy to use - Inexpensive	- Less precise than the following two methods
Particle monitoring in the permeate	- More precise than turbidity measurements	- More expensive than turbidity measurements
Particle counting in the permeate	- Very precise	- More costly than the two preceding methods - More complex than turbidity measurements
DIRECT METHODS	**BENEFITS**	**DRAWBACKS**
Maintaining pressure[1]	- Simple - Can easily be automated	- Filtration must be stopped - Must be incorporated into the process
Maintaining vacuum[2, 3]		
Bubble point measurement[1]	- Simple - Determines the size of defects in membranes	- Filtration must be stopped - Manual measurement, one module at a time - Difficult to implement on a large scale
Acoustic detection[1]	- Online control	- Need to control background noise

1. Used mostly for hollow fibre membrane modules.
2. Used mostly for spiral wound membrane modules.
3. Existing standard (most recent version): ASTM D3923, *Standard Practices for Detecting Leaks in Reverse Osmosis and Nanofiltration Devices*.

- The **method used** for the system under review must be **validated at the time** when the parasite and virus **log removal credits** are established.

- The **method used** must be sufficiently precise to detect a **quality variation in the treated water** that would risk having an impact on the log removal credits obtained by the system under review (for example, if the system under review is granted five log removal credits, the integrity measurement method must enable distinguishing between five and four log removal values).

It is therefore the responsibility of each applicant to establish a protocol and submit it for approval. The protocol **must be accompanied by** the parasite and virus removal credit establishment protocol (see preceding section).

APPENDIX 3

PERFORMANCE MONITORING TO SUPPORT A CLASSIFICATION REQUEST FOR THE VALIDATED LEVEL

(APPENDIX 3-A)

AND

COMPLEMENTARY MONITORING REQUIRED IN SPECIFIC SITUATIONS (APPENDIX 3-B)

APPENDIX 3-A: PERFORMANCE MONITORING TO SUPPORT A CLASSIFICATION REQUEST FOR THE VALIDATED LEVEL

1. MONITORING OBJECTIVE

The objective of performance monitoring for an *Under Validation* level installation is to assess whether the treatment technology may be considered as being at the *Validated* level from a performance and operational reliability perspective. Monitoring is supervised by an independent third party who must check the accuracy of the validation and objectively report the obtained results.

2. PROTOCOL FOR PERFORMANCE MONITORING

Monitoring varies on the basis of the treatment technology and water supply source (surface or groundwater). Sampling must be carried out when the installation is in a normal state of activity.

A **sampling protocol** must be prepared by the applicant, taking into account the guidelines of this appendix as well as the guidelines of Appendix 3-B, if applicable, which describe proposed **complementary monitoring** for specific situations. The sampling protocol will be adapted, if needed, on the basis of the treatment technology and its application.

For ultraviolet irradiation disinfection reactors, section 6 (Parameters and analyses) of this appendix is not mandatory. The complementary monitoring required in this case is described in Appendix 3-B, under "CASE 1–OPERATIONAL VALIDATION OF UV REACTORS."

The test monitoring program may be submitted prior to validation as described in the BNQ-9922-200 procedure.

3. DURATION OF VALIDATION MONITORING

The applicant must demonstrate that the proposed treatment technology has reached a sufficient level of mechanical and operational reliability for it to be considered as being at the *Validated* level. The demonstration must be based on the results of validation monitoring conducted over a **period of a minimum of 52 uninterrupted weeks**, on a full-scale installation.

In the event that the treatment technology is used to treat surface water, the equipment must function at its maximum production capacity (design criteria) for a minimum of five consecutive days at four specific times during the 52 weeks of monitoring: winter, spring (targeting the worst raw water conditions), summer and fall (targeting the worst raw water conditions).

Sampling set out in Table 2.1 shall be distributed as follows:

- one sampling per day (i.e. four five-day periods, for a total of 20 samplings) during periods where maximum criteria is expected to be reached, these samplings counting for the month;
- one sampling per month (i.e. eight in total) during the other months.

If monitoring is carried out at an installation that is not located in Quebec, the applicant shall demonstrate that the choice of installation is relevant to the use of the treatment technology in Quebec conditions, and in particular the similarity of raw water quality parameters, cold winter temperatures and overall operational conditions (number of hours of daily operation, operator qualifications, etc.).

4. SUPERVISION BY A THIRD PARTY

Validation monitoring must be conducted under the supervision of a competent third party, i.e. a firm with at least one engineer who has the necessary knowledge relating to the treatment technology being monitored.

The third party mandate must include sampling and logging supervision, operational parameter monitoring and checking the conditions prevailing at the installation when the samples were sent for laboratory analysis. The following may be used as an example for defining sampling-related tasks:
www.ceaeq.gouv.qc.ca/documents/publications/echantillonnage/generalitesC1.pdf.

The third party must write a test report as described in section 9 of this Appendix.

5. FULL-SCALE UNIT OPERATION

During validation monitoring, operation of the unit must normally be the responsibility of the owner of the facility.

The treatment technology applicant cannot be in charge of the operation.

6. PARAMETERS AND ANALYSES

6.1 OPERATING PARAMETERS

Under validation monitoring, the third party must ensure that the measurement of the operating parameters corresponds to the operating conditions of the equipment used and that these measurements are documented when the samples are taken for analysis.

6.2 SAMPLING PROGRAM AND ANALYSES

Tables 2.1 and 2.2 specify basic parameters for validation monitoring. Table 2.1 must be used for surface water and Table 2.2, for groundwater. Additional analyses of particular parameters could also be relevant per local characteristics (for example, analysis of aluminium if alum is used).

Any full-scale installation that undergoes validation monitoring is also subject to mandatory drinking water quality control, in compliance with all regulations in effect.

Sampling must be conducted uniformly over the entire test period, particularly during the first and last weeks of testing.

Special case: monitoring treatment technology parameters that are part of a complete treatment chain

If the treatment technology being monitored is incorporated into a complete treatment chain, monitoring must also pertain to equipment operating parameters and intermediate samplings, whose number and frequency must be specified in the monitoring protocol.

Integrity measurement for membrane filtration processes

In the case of membrane filtration treatment technology with log removal credits, an integrity measurement of the membrane systems must be conducted according to a recognized and approved method.

6.3 SAMPLING, SAMPLE PRESERVATION AND TRANSPORT

Sampling and preservation and transport of samples must meet the requirements described in the RRQDW for the targeted parameters. If the parameters used are not standardized in accordance with the RRQDW, the third party must ensure that the conditions set by the accredited laboratory are followed.

7. EVENT REGISTRY

The third party must prepare a registry of the prevailing conditions during sampling, the sequence of events and the interventions made on the treatment installation and, in particular, note and report the following:

- the nature and quantity of products added (chemicals or other additives) and the frequency of the addition of these products during the entire monitoring period;
- all noteworthy events (equipment breakdown, repairs, adjustments or minor modifications, unclogging, scarification and/or replacement of filtering material, etc.);
- the description of any intervention conducted at the facilities subject to their monitoring and analysis with respect to the design, operation, inspection and maintenance of the treatment technology (if, for example, a specialist intervention

was necessary, specify if the operation sets forth this in the guide to operations, inspection and maintenance provided by the applicant);
- the quantity and characterization, if applicable, of produced wastewater or sludge.

8. CHANGES DURING OPERATIONS

No change to the treatment technology is to be made during performance monitoring. If a change is made, performance monitoring must take place at least 52 weeks after the change.

9. VALIDATION TEST REPORT

The validation test report must be prepared by the third party and bear the signature of the engineer in charge, on a page that explicitly describes the mandate.

The engineer's report must include the following items:

- certification that the samples were taken by a qualified individual and that the standards on sampling and sample preservation methods and periods set forth in the RRQDW, or by the accredited lab for unregulated parameters, have been complied with;
- presentation of all compiled analytical results (included laboratory analysis certificates in an appendix). The calculation of expected maximum limits for produced water must have been performed using the obtained results (see section 5.3);
- operating conditions before and after sampling;
- nature of products added (coagulants, flocculants, oxidants or other) and the quantity and frequency of addition of these products during the monitoring period;
- description of all noteworthy events (equipment failure, repairs, adjustments, minor changes or other);
- interpretation of the impact on obtained results of observed interventions and events during the tests, including the engineer's own readings and comments.

Table 2.1: Parameters and sample frequency
Performance monitoring of surface water treatment

PARAMETERS	**RAW WATER**	**TREATED WATER**
	Minimum number of samples	Minimum number of samples
pH (on site)	**28 (8 months = 1/week 4 months = 5/week)**	**28**
Temperature (on site)	**28**	**28**
Escherichia coli	**28**	**28**
Total coliforms	**28**	**28**
Total organic carbon (see note 1)	**28**	**28**
Turbidity	**28**	**28**
UV Absorbance at 254 nm (see note 1)	**28**	**28**
Ammoniacal nitrogen	**28**	**If required**
Nitrates and nitrites	**12 (1/month combined with more frequent sampling)**	**12 (if present in the raw water)**
Chlorine demand (see note 2)	**N/A**	**12**
Total Alkalinity	**12**	**12**
Al (for technologies using aluminum salts)	**12**	**12**
Silt Density Index (SDI, see note 3)	**12**	**N/A**
Trihalomethane formation simulation (SDS-THM, see note 2)	**N/A**	**12**
Haloacetic acid formation simulation (SDS-HAA, see note 2)	**N/A**	**12**

OPTIONAL PARAMETERS (May become necessary depending on raw water quality and the objectives of the treatment technology)	**RAW WATER** Minimum number of samples	**TREATED WATER** Minimum number of samples
True colour (on site)	**28**	**28**
Nitrites	**12**	**If required**
	12	**6 (1/2 months + 4 weeks x 1 sample)**
Hardness	**12**	**6**
Iron	**28**	**28**
Manganese	**28**	**28**
Dissolved solids	**12**	**12**
Total solids	**12**	**12**
Conductivity	**28**	**28**

Note 1: These samples enable the specific UV absorbance (SUVA) of raw water to be calculated.

Note 2: 24-hour test with 0.5 ± 0.2 mg/L of free residual chlorine after 24 hours, with a pH of 7.5 and temperature of ± 22°C.

Note 3: This parameter need only be measured for nanofiltration treatment technologies. Sampling must be conducted upstream of the first membrane level, including recirculation, if applicable.

Table 2.2: Parameters and sample frequency for a full-scale validation monitoring of groundwater treatment

PARAMETERS	**RAW WATER**	**TREATED WATER**
	Minimum number of samples	Minimum number of samples
pH (on site)	**13 (1/4 weeks)**	**13**
Temperature (on site)	**13**	**13**
Escherichia coli	**26 (1/2 weeks)**	**26**
Total coliforms	**26**	**26**
Total organic carbon	**13**	**13**
Turbidity	**26**	**26**
Nitrates and nitrites	**13**	**13 (if present in the raw water)**
Chlorine demand (see note 1)	**N/A**	**13**
Total Alkalinity	**13**	**13**
Al (for technologies using aluminum salts)	**13**	**13**
Hardness	**26**	**26**
Iron	**26**	**26**
Manganese	**26**	**26**
Silt Density Index (SDI, see note 2)	**13**	**N/A**
Sulphides	**13**	**13**
Trihalomethane formation simulation (SDS-THM, see note 1)	**N/A**	**13**
Haloacetic acid formation simulation (SDS-HAA, see note 1)	**N/A**	**13**

OPTIONAL PARAMETERS (May become necessary depending on the raw water quality and the objectives of the treatment technology)	**RAW WATER** Minimum number of samples	**TREATED WATER** Minimum number of samples
True colour (on site)	**26**	**26**
Dissolved oxygen (on site)	**13**	**13**
Arsenic	**13**	**13**
Barium	**13**	**13**
Calcium	**26**	**26**
Sulphates	**13**	**13**
Sodium	**13**	**13**
Chlorides	**13**	**13**
Fluorides	**13**	**13**
Dissolved solids	**13**	**13**
Total solids	**13**	**13**
Conductivity	**26**	**26**
Reduction-oxidation potential	**26**	**26**

Note 1: 24-hour test with 0.5 ± 0.2 mg/L of free residual chlorine after 24 hours, with a pH of 7.5 and temperature of ± 22°C.

Note 2: This parameter need only be measured for nanofiltration treatment technologies. Sampling must be conducted upstream from the first membrane level, including recirculation, if applicable.

APPENDIX 3-B: COMPLEMENTARY MONITORING REQUIRED IN SPECIFIC SITUATIONS

Appendix 3-B illustrates the complementary monitoring required in certain situations.

CASE 1 —OPERATIONAL VALIDATION OF UV REACTORS

The applicant must provide monitoring data on at least one existing UV system in operation for **a minimum of 52 uninterrupted weeks**. An independent organization must be used to collect the data. The existing facilities may be inside or outside Quebec, as long as water temperature is similar to that of waters in Quebec.

The following table shows the parameters and frequency of measurement required for validating the performance and operational reliability of an ultraviolet irradiation disinfection system.

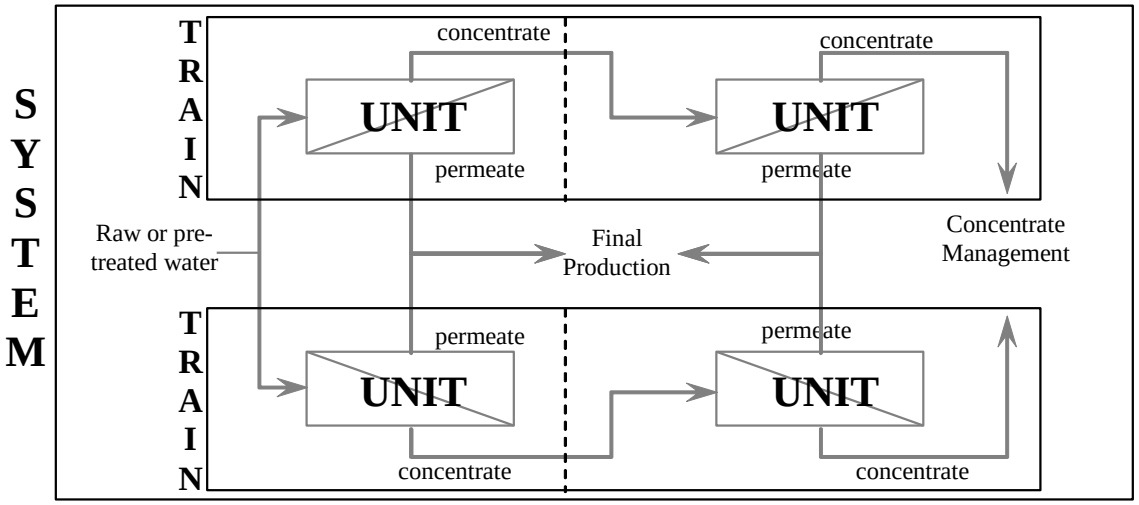
PARAMETERS	**FREQUENCY**
Operating conditions	
Flow	Monthly average
Operational dose for reactor	Ongoing
Temperature	Monthly average (at least one measurement per week)
Cumulative number of starts and stops	One operating year
Number of lamps, sleeves, intensity sensors and ballasts replaced	One operating year
Age of lamps (in hours)	Monthly average of the reactors in operation Total age for each reactor
Cleaning frequency (if applicable)	Number per month
Cumulative power consumed	Monthly value
Alarm monitoring	
List of low dose alarms	One operating year
List of grounding alarms	
List of operating shutdowns	

CASE 2 — PROJECTS INVOLVING MEMBRANES

EQUIPMENT CONTROL AND MONITORING

The terminology used here is the same as in the Design Guide found on the MELCC website. The main terms used in the equipment control and monitoring presentation are repeated and illustrated in Figure 1.

Figure 1 Schematic representation of a membrane treatment installation



Membrane: A very thin layer of matter that enables separation on a microscopic scale.

Module: A method of implementing membranes (spiral wound, tubular, hollow fibres, frame plate, etc.). This is the basic component in membrane treatment systems.

Housing: A container that is usually pressurized, in which one or several modules are found.

Unit: A method of arranging modules in the given space. In a unit, the modules may be in parallel, in series or both (for example, 10 rows in parallel consisting of three modules in series).

Train: An independent group of membrane treatment systems. Each train may contain one single unit or several units with associated pumps.

System: A complete treatment set including pretreatment, trains (one or several in parallel) as well as post-treatment.

EQUIPMENT AND MONITORING

Various pieces of equipment are essential for the efficient operation of treatment systems by membrane filtration, such as isolation valves for each unit and pump (maintenance) or even interconnecting piping between pumps and units (any pump may feed any membrane train). Some parts are also necessary to ensure module integrity measurement and verification.

The following table lists equipment that is necessary to treat technology monitoring in single-membrane treatment installations:

Equipment type	Parameters to follow	Frequency
Sampling	Raw water quality	See Appendix 2 or 3
	Treated water quality	See Appendix 2 or 3
Temperature sensor	Treated water temperature	Ongoing
Pressure sensor	Pressure in the pretreatment entry	Ongoing
	Pressure differential in pretreatment stages	Ongoing
	Pressure at the entry of each unit	Ongoing
	Pressure at the exit of each unit (permeate and concentrate)	Ongoing
Flow meter	Raw water flow (or pretreated) at the entry of each train	Ongoing
	Permeate flow at the exit of each unit	Ongoing
	Concentrate flow at the exit of each unit	Ongoing
Turbidity reader (precise to one hundredth of a NTU[1])	Permeate turbidity of each train	Ongoing
Integrity measurement	Membrane integrity	Requires BNQ approval

[1] Nephelometric Turbidity Unit

The following table lists monitoring parameters that may be used for better module verification and optimization of treatment performance:

Equipment type	Parameters to follow
Sampling	Permeate quality (each unit)[a]
	Concentrate quality (each unit)[a]
	Backwash water quality (each unit)[a]
Head loss measurement	For each pretreatment
	For each membrane unit
Flowmeter	Raw water flow pumped towards plant
Permeability measurement	Initial module permeability (ideally for each module) measured with very clean water[b] in controlled conditions (reference measurement)
	Permeability of each unit during operations
Recovery rate measurement	The overall rate, taking into account internal losses (membrane cleaning, pretreatments, leaks, etc.)
Rinsing-cleaning	Number, frequency, duration and products used in pretreatment rinsing and cleaning
	Pretreatment replacement frequency
	Factor that triggers membrane cleaning
	Number, frequency, duration and products used in membrane rinsing and cleaning

[a] See the list of parameters in appendices 2 and 3.

[b] Very clean water is water with turbidity of less than 0.1 NTU, conductivity of less than 50 µS/cm and total organic carbon content of less than 0.2 mg/L.

ALARMS

Treatment processes by membrane filtration must provide for alarms in the following situations:

- membrane train integrity non-compliance;
- loss of permeability greater than the process control value;
- pretreatment head loss greater than the process control threshold;
- membrane filtration head loss greater than the process control threshold;
- turbidity greater than or equal to 0.1 NTU at a unit permeate;
- pressure at the entry of a train unit greater than the process control threshold;
- system shutdown due to power outage (with a connection to the emergency generator in order to maintain drinking water production);
- flow (raw water, concentrate or permeate) greater than process control threshold.