

**Using Ultraviolet Disinfection as
a Corrective Action for
Registered Public Drinking
Water Supplies**

PROCEDURE

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Introduction

This procedure outlines the acceptable use of ultraviolet (UV) disinfection for registered public drinking water supplies where corrective actions set out in the *Guidelines For Monitoring Public Drinking Water Supplies* have failed to remediate problems related to the presence of total coliform and/or *E. coli*.

Authority

Section 34 of the *Water and Wastewater Facilities and Public Drinking Water Supplies Regulations* requires an owner of a public drinking water supply to:

- Notify the department immediately upon becoming aware of not meeting bacteriological water quality criteria; and
- Take corrective action as set out in the *Guidelines for Monitoring Public Drinking Water Supplies* or as may be required by the Minister or Administrator.

Where corrective actions set out in the *Guidelines* have failed to remediate problems related to the presence of total coliform and/or *E. coli*, the use of UV disinfection according to this procedure may be considered as the corrective action that shall be required by the Minister or an Administrator as per Section 34 of the *Water and Wastewater Facilities and Public Drinking Water Supplies Regulations*.

Exceptions.

This procedure should only be applied to registered public drinking water supplies where a water sample has failed to meet the bacteriological water quality criteria triggering the need for corrective action. It should not be used to require a supply to upgrade its treatment system, UV disinfection or otherwise, if the current system is meeting the bacteriological water quality criteria.

This procedure does not apply to municipal water systems.

Criteria to Use UV for Corrective Action

In order for a UV disinfection system to be considered as a corrective action the following conditions must be met.

- The system must have a maximum flow of 75.7 L/min or 4.5 m³ /hr (20 US gpm).
- Chlorine (or equivalent) must be used as a secondary disinfectant to provide a disinfectant residual if the system has an extensive water distribution system.
- The owner must confirm that water quality results are within the range recommended by the UV disinfection system manufacturer or supplier. In the absence of specific manufacturer or supplier requirements for water quality, the water must meet the parameters outlined in Appendix A.
- Proper pre-treatment must be added to correct water quality problems or address parameters of concern prior to installation of the UV disinfection unit if water quality is not within the range recommended by the UV disinfection system manufacturer or supplier.
- The water must be filtered by a 10 micron or less filter prior to UV disinfection if the water source is surface water or a groundwater source under the direct influence of surface water.
- The UV unit must meet NSF #55 (Class A) certification.
 - The UV dosage must be a minimum of 40 mJ/cm² and this must be confirmed using a UV intensity monitor with alarm configuration.
- The UV system must be placed on a designated electrical circuit.
- The owner of the facility must maintain documentation for lamp age/usage, maintenance and replacement, intensity monitoring, and bacteriological monitoring.
- The owner must have operational practices (procedures and contingencies) in place and provide them to NSEL upon request.
- Measures must be put in place to ensure ongoing disinfection during maintenance of the UV lamps.

Guidance Material

Appendix A may be issued to owners of supplies requiring corrective action to address bacteriological water quality issues.

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APPENDIX A - Using Ultraviolet Disinfection for Drinking Water

Approach

When ultraviolet (UV) disinfection equipment is properly designed, installed, operated and maintained, it will provide reliable disinfection which is effective to inactivate microbial organisms including *E. coli* and total coliform bacteria. Current data also supports that *Cryptosporidium* oocysts and *Giardia* cysts are inactivated by ultraviolet disinfection.

It is important that drinking water system owners utilize a proactive approach to providing clean safe drinking water by accessing and maintaining the best possible source water. Source water protection provides the first line of defense against contamination of the drinking water supply and should always be the priority. System owners should ensure that groundwater wells are: 1) properly constructed; 2) are located in an area where there is minimal potential for contamination; and 3) have appropriate well head protection measures in place. The application of UV disinfection is an effective secondary defense against microbial contamination and may provide adequate treatment should the source water contain microbial organisms, be it from a groundwater well or surface water supply.

For drinking water systems where microbial organisms are present in the water supply, and the organisms are a known health concern, any failure of the UV system will require the system owner to have procedures in place to ensure drinking water safety (e.g. boil water protocol, alternate disinfection capability and/or an alternate source of water supply).

This guidance defines the approach to be used when determining applicability for registered public drinking water systems wishing to incorporate UV disinfection. Requirements are listed within the following three categories and are summarized at the end of the document:

1. UV Application;
2. UV System Design; and
3. Monitoring and Operational Issues.

1. UV Application

The applicability of UV disinfection is dependent upon the source of the water being treated. Water quality is very important to ensure the optimum performance of a UV disinfection system. Some parameters may affect the transmittance of UV light while other parameters may precipitate on the lamp sleeve and block the light. Water quality parameters of concern include: alkalinity, calcium, hardness, iron, manganese, tannins, turbidity and UV transmittance.

If water quality results are not within the range recommended by the UV disinfection system manufacturer/supplier, proper pre-treatment may be required to correct water

quality problems prior to installation. Proper pre-treatment is essential for the UV disinfection system to operate as intended.

In the absence of specific manufacturer or supplier requirements, the water should meet the following parameters:

- Hardness: < 120 mg/L
- Iron: < 0.3 mg/L
- Hydrogen Sulphide: < 0.05 mg/L
- Manganese: < 0.05 mg/L
- Tannins: < 0.1 mg/L
- Total Suspended Solids (TSS): < 5.0 mg/L
- Turbidity: <1.0 NTU
- UV Transmittance: > 75 %

Effective disinfection of adequately filtered influent water or raw water of suitable quality (e.g. low turbidity and high UV transmittance) can be accomplished by the use of UV light. The disinfection process will not be as effective on influent waters of inferior quality and it may be necessary to introduce additional filtration ahead of the disinfection stage.

Some water sources such as surface water supplies and groundwater supplies that are under the influence of surface water supplies should be filtered prior to UV disinfection.

Requirement #1 - UV disinfection systems cannot be used in a system that has an extensive water distribution line unless a secondary disinfection system with chlorine addition is provided to ensure a chlorine residual is maintained to protect water quality in the distribution line.

Requirement #2 - Confirm that water quality results are within the range recommended by the UV disinfection system manufacturer or supplier. If not, proper pre-treatment may be required to correct water quality problems or address parameters of concern prior to installation of a UV disinfection unit.

Requirement #3 - If the raw water source is a surface water supply, or if it is a groundwater supply under the direct influence of surface water (GUDI), the water must be properly filtered prior to UV disinfection to ensure effective light transmittance. Filtration must be sized to provide 10 micron particle removal or less. UV light on its own is not an acceptable substitute for filtration of surface water or GUDI supplies.

Requirement #4 - Nova Scotia Environment and Labour does not recommend specific brands of drinking water devices, but it strongly recommends that consumers use only devices that have been certified as meeting the appropriate NSF drinking water treatment unit standard. NSF standards have been designed to safeguard drinking water by helping to ensure material safety and performance of products that come into contact with drinking water. Where supplementary treatment is necessary to meet the

health-related parameters listed in the *Guidelines for Canadian Drinking Water Quality*, the system owner must have regard to:

- NSF Standards 42 and 53: Drinking Water Treatment Units - Aesthetic and Health Effects
- NSF Standard 44: Cation Exchange Water Softeners
- NSF Standard 58: Reverse Osmosis Drinking Water Treatment Systems
- NSF Standard 62: Drinking Water Distillation Systems

2. UV System Design

Drinking water disinfection and any pre-disinfection requirements are specific to the source water type. This approach reflects the raw water characterization and variability to address the risks associated with the source vulnerability. A particular type and design of UV disinfection system may be considered acceptable if it has been shown to achieve the required level of disinfection.

Requirement #5 - The system must be certified to meet the latest edition of **NSF Standard #55 (Class A)** for any UV application in a drinking water supply. The NSF Standard #55 (Class A) system is designed to provide a minimum dose of 40 mJ/cm² throughout the UV reactor at all times when water is flowing through the disinfection system. These systems are also required to have an intensity monitoring device with alarm settings and indicators to notify when the UV dose drops below the minimum required for effective disinfection.

The light transmission and its effectiveness can be reduced by the age of the lamp, reducing output, or by the blockage of the light transmission caused by fouling of the lamp sleeve by deposition of material such as sediment or hardness in the water. Therefore lamps must be cleaned or replaced as required.

Requirement #6 - The UV unit is to be installed on an electrical circuit specifically designated for the unit to avoid accidental shut-down if wired to a switch used for other electrical fixtures. Whenever possible, the electrical wiring must be configured in a manner that will not allow the water pump to operate if the UV system is not operating or is in an alarm situation, unless it is critical that the water system maintain pressure. In the latter case, water for human consumption must be either boiled, disinfected using an alternate disinfectant or another acceptable solution used.

3. Monitoring and Operational Issues

The following requirements take into consideration the lamp life expectancy, the light transmission and water quality:

Requirement #7 - The following dates must be identified and posted near the UV disinfection unit:

- lamp installation;
- anticipated lamp replacement (based on manufacturer/supplier requirement);
- last lamp inspection and/or cleaning;
- calibration of UV intensity monitor (based on manufacturer/supplier requirement);
and
- last sample taken for bacteriological analysis.

Note: The lamp replacement date must be determined based on the life expectancy of the lamp from the manufacturer/supplier of the equipment.

Requirement #8 - Intensity readings must be taken on a frequency based on requirements from either the manufacturer or the supplier, whichever is more stringent. In the absence of manufacturer or supplier requirements, the readings must be taken on a weekly basis.

Requirement #9 - Owners and operators of UV disinfection systems must have operational practices in place including:

1. procedure for lamp maintenance and replacement;
2. procedures for water sampling;
3. procedure for monitoring the system operation;
4. procedure for disinfecting the water system following system failure, lamp replacement and maintenance involving contact with the water;
5. procedure to investigate and correct low lamp intensity readings (based on manufacturer-identified value);
6. contingency for implementing a boil water advisory or accessing an alternate drinking water supply if UV disinfection system fails (operationally or based on a positive bacteriological sample result);
7. contingency for an electrical failure event;
8. proper disposal of UV lamps, ballasts, quartz sleeves and other UV system related materials.

Requirement #10 - If filtration is used, the owner must have a program for ensuring that the filtration system is working properly and monitoring the system for effective operation. This is to ensure the ability for the UV system to provide effective disinfection.

Requirement #11 - Water must not be bypassed during regular lamp replacement or unit maintenance.

Requirement #12 - In the event of a positive bacteriological sample result corrective action (boil water advisory or alternate supply) must be implemented and the problem rectified.

Summary of Requirements

UV Application

- For systems with an extensive water distribution line, UV disinfection can only be used as a primary disinfectant with chlorine addition as a secondary disinfectant;
- Confirm water quality results;
- Review water chemistry results and determine if pre-treatment is necessary;
- Filter water to 10 micron or less prior to UV disinfection if the source is surface water or GUDI.

UV System Design

- UV unit must meet NSF #55 (Class A) certification;
 - UV dosage - minimum of 40 mJ/cm²;
 - Intensity monitor with alarm configuration;
- Designated electrical circuit.

Monitoring and Operational Issues

- Documentation required for:
 - lamp age/usage, maintenance and replacement;
 - intensity monitoring;
 - bacteriological monitoring;
- Intensity readings to be recorded;
- Operational practices (procedures and contingencies)
- Filtration effectiveness monitored if source is surface water or GUDI;
- Ongoing disinfection during maintenance;
- Regular sampling and bacteriological analysis;
- Corrective action plan.