|  |  |
| --- | --- |
| Minnesota Pollution Control Agency (MPCA), 520 Lafayette Road North, St. Paul, MN 55155-4194 | Ultraviolet Disinfection Process Design Review Checklist  NPDES/SDS Permit Program  National Pollutant Discharge Elimination System (NPDES)/ State Disposal System (SDS)  Doc Type: Plan/Specification Review Summary |

**Purpose:** This checklist is intended for use by design engineers, to assist Minnesota Pollution Control Agency (MPCA) review engineers in the efficient review of planning and design documents. The information requested is the minimum technical data necessary for MPCA staff to review proposed designs and to determine whether there is reasonable assurance that the treatment system, when constructed, will comply with permit conditions, regulations, and criteria of the MPCA.

**Instructions:** The information in this checklist is based on the ***Recommended Standards for Wastewater Facilities published by the Great Lakes Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (Ten State Standards) 2014 Edition,*** other accepted engineering references, and MPCA recommendations. Specific references, other than Ten State Standards, are listed where appropriate. The checklist is organized according to the numbering sequence found in Ten State Standards to allow for ease in locating the entire content and text of the recommendations.

The checklist is designed so that a “**yes**” answer indicates compliance with Ten State Standards et al.

A “**no**” answer indicates a deviation from Ten State Standards et al. Answering “no” to any question will require justification that can be provided at the end of the checklist and possibly supporting information, from wastewater treatment plant operational data, to demonstrate how the intent of the recommendation will be met. Additional information may be requested based on site specific conditions.

Wastewater Treatment Facility information

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Date** (mm/dd/yyyy): | |  | **MPCA Project No:** |  |
| **Title of project:** |  | | | |

Permittee information

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Facility name: | |  | | | | |
| Contact name and title: | | |  | NPDES/SDS Permit No: | MN |  |
| Email: |  | | | Phone number: |  | |

Design Engineer information

|  |  |  |  |
| --- | --- | --- | --- |
| Contact name: |  | Contact phone number: |  |
| Email: |  |  |  |

**Phase:**   Planning Phase  Design Phase

**Ultraviolent Disinfection System:**  New construction  Retrofit: provide existing system type:

**Permit Disinfection Requirements:**  Year-round  Seasonal: provide months:

Ultraviolet (UV) Disinfection Influent Characteristics

|  |  |  |
| --- | --- | --- |
| ADW |  | mgd |
| AWW |  | mgd |
| PHWW |  | mgd |
| BOD5 |  | mg/L |
| TSS |  | mg/L |
| Turbidity |  | NTU |
| UV Transmittance |  | % UVT |

**104. Ultraviolet Disinfection**

| ***104.1 General*** | | **Yes** | **No** |
| --- | --- | --- | --- |
| Is the expected performance of the UV disinfection units for the full operating ranges of flow rates based on experience at similar full scale installations or thoroughly documented prototype testing with representative wastewater? | |  |  |
| Has third-party bioassay validation testing been conducted on the UV system by the equipment manufacturer? (M&E 2014, MOP8 2018) | |  |  |
| UV system manufacturer selected: |  | | |
| UV system model selected: |  | | |

| ***104.2 Lamp Type*** | | | | |
| --- | --- | --- | --- | --- |
| Are the UV disinfection lamps low pressure-low intensity, low pressure-high intensity, medium pressure-high intensity or LED? | | |  |  |
| Type of lamps: |  | | | |
| Is the output spectrum adjustable by using the electronic ballast setting? (MOP8 2018) | | |  |  |
| Output spectrum of lamps: |  | nm (e.g., 200 – 415 nm) | | |
| Output spectrum design setting: |  | nm | | |

| ***104.3 Channel Design and Hydraulics*** | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Can the modular UV disinfection units be removed from the flow in open channel designs? | | | | | | | |  |  |
| Type of design: | | Open channel  In-pipe (enclosed vessel) | | | | | | | |
| Number of UV channels: | |  | | | | | | | |
| Number of UV banks: | |  | | | | | | | |
| Number of UV modules per bank: | |  | | | | | | | |
| Number of UV lamps per module: | |  | | | | | | | |
| Number of spares provided as back-up: | |  | bank(s)  module(s) | | | | | | |
| Lamp configuration: | horizontal  vertical  in-pipe  angled: provide degree of angle: | | | | | |  | | |
| Are at least two banks in series provided in each channel for disinfection reliability and to ensure uninterrupted service during required maintenance? | | | | | | | |  |  |
| Is the rated flow capacity of each UV bank equal to the AWW flow or 50% of PHWW flow, whichever is greater? (M&E 2014) | | | | | | | |  |  |
| Rated flow capacity of each UV bank: | | | |  | mgd | | | | |
| Rated flow capacity of each channel: | | | |  | mgd |  | | | |
| Are the hydraulic properties of the system designed to simulate plug flow conditions without short circuiting under the full operating flow range? | | | | | | | |  |  |
| Flow velocity: | | | |  | ft/sec | | | | |
| Hydraulic loading rate corresponding to desired dose: | | | |  | L/min/lamp |  | | | |
| Is water level control provided to achieve the necessary exposure? | | | | | | | |  |  |
| Type of water level control: | | | |  | | | | | |
| Are provisions made so the upstream process will deliver steady flow for a uniform velocity field in the disinfection reactor so that wastewater will receive an adequate UV dose? (M&E 2014, MOP 8 2018) | | | | | | | |  |  |
| Are provisions taken to maintain a well-mixed steady water level across all lamps? (M&E 2014) | | | | | | | |  |  |

| ***104.4 Transmittance*** | | | | **Yes** | **No** |
| --- | --- | --- | --- | --- | --- |
| Is this process limited to a high quality effluent having at least 65% UV radiation transmittance at 254 nanometers wave length, and BOD5 and TSS concentrations no greater than 30 mg/L at any time? | | | |  |  |
| If the TSS concentration is greater than 30 mg/L, has the lamp spacing been reduced to shorten the UV path length? (MOP8 1998) | | | |  |  |
| Were representative wastewater samples used to evaluate transmittance, taken during typical flows, when there were no upsets, and no irregular constituents, chemicals, and dyes in the wastewater? (M&E 2014) | | | |  |  |
| Sample dates: |  | | | | |
| Flow at WWTP when samples were taken: |  | mgd |  | | |
| Will impacts from the overall project be managed so that there is no change to UV influent water quality conditions? (M&E 2014) | | | |  |  |
| Will wastewater influent be without dyes, UV inhibitors, tannins, metals (ferrous, ferric, manganese) or other constituents that may reduce or prevent UV transmission? (M&E 2014) | | | |  |  |

| ***104.5 Dosage*** | | | | | |
| --- | --- | --- | --- | --- | --- |
| Is the UV dosage based on the design peak hourly flow? The design peak hourly flow is the largest volume of flow to be received during a one hour period expressed as a volume per unit time. | | | |  |  |
| Is the UV reactor designed and validated for the range of potential UVT and flow rate combinations? (M&E 2014) | | | |  |  |
| Are project specific dosage calculations provided from the equipment manufacturer? Attach calculations. | | | |  |  |
| Is the UV dosage not less than 30 mW\*s/cm2 after adjustments for maximum tube fouling, lamp output reduction after 8,760 hours of operation, and other energy absorption losses? (mW\*s/cm² = mJ/cm² = 1000 μW\*s/cm2) | | | |  |  |
| Design dose: |  | mW\*s/cm2 | | | |
| Intensity: |  | mW/cm2 |  | | |
| Has the burn-in period of the UV lamps been accounted for in the design? (NWRI 2012) | | | |  |  |
| Is a correction factor for quartz lamp sleeve fouling accounted for in the design? (M&E 2014) | | | |  |  |
| Quartz sleeve fouling factor: |  | | | | |
| Is a lamp aging factor accounted for in the design? (M&E 2014) | | | |  |  |
| Lamp aging factor: |  | | | | |
| Are UV sensors specified for UV transmittance and UV intensity? (NWRI 2012) | | | |  |  |
| Are ancillary sensors specified for water flow rate and turbidity? (NWRI 2012) | | | |  |  |
| Are spare modules/banks provided if rated flow capacity of each UV bank is equal to AWW flow or 50% of PHWW flow? (M&E 2014) | | | |  |  |

| ***104.6 Operations, Safety and Alarm System*** | | **Yes** | **No** |
| --- | --- | --- | --- |
| Is consideration given to operator safety (electrical hazards and exposure to UV radiation) and tube cleaning frequency? | |  |  |
| Is an alarm system provided to separately indicate lamp failure, low UV intensity and any other cause of UV disinfection unit failure? | |  |  |
| If the system has an in-pipe configuration, are there established procedures for cleaning, maintenance and removal of biofilms? Provide these procedures as an attachment. | |  |  |
| Are lamps removable from the channel? (M&E 2014) | |  |  |
| Is adequate storage space available for lamps during the non-disinfection seasons? | |  |  |
| Has a cleaning method been selected for lamp quartz sleeves? Provide a cleaning plan as an attachment. (M&E 2014) | |  |  |
| Indicate mechanical or chemical-mechanical: |  | | |
| Has process influent alkalinity and hardness been evaluated for potential effects on the cleaning system? (M&E 2014) | |  |  |
| If chemical addition is used for phosphorus removal, are there provisions for managing a potential increase in lamp sleeve fouling? | |  |  |
| List chemical(s): |  | | |
| Is there planned calibration of sensors at regular intervals? (NWRI 2012) | |  |  |
| In an open channel design, are the channels fully covered with slip-resistant, foot traffic rated metal plates? | |  |  |
| Is safety interlock provided that will shut down the UV disinfection system if a module is removed from a reactor and/or the water level falls below the top of the lamps? (MOP8 2018) | |  |  |
| Are all UV disinfection system components provided with ground fault interruption (GFI) circuitry? (NWRI 2012, UVDGM 2006, MOP8 2018) | |  |  |
| Is there an emergency back-up source of power available for use? (NWRI 2012) | |  |  |
| Is there an established contingency plan to prevent the release of mercury into the water stream in the event of lamp breakage? (NWRI 2012) | |  |  |

| ***104.7 Electrical Control*** | | |
| --- | --- | --- |
| Is a programmable logic controller (PLC) provided? |  |  |
| Are multiple PLCs provided as necessary to ensure rapid recovery and minimize the deterioration of effluent quality from the failure of a single controller? |  |  |
| Is an uninterruptable power supply with electrical surge protection provided for each PLC to retain program memory (i.e. process control program, last known set-points and measured process/equipment status, etc) through a power loss? |  |  |
| Is a hard-wired backup for manual override provided in addition to automatic process control? |  |  |
| Do both automatic and manual controls allow independent operation of each UV disinfection unit? |  |  |

|  |
| --- |
| Justification for all questions answered with a “no” and all questions where neither the “yes” or “no” box was checked: |
|  |
| Additional comments: |
|  |

**References**

GLUMRB (2014 Edition) *Recommended Standards for Wastewater Facilities* (Ten State Standards), Health Research, Inc., Health Education Services Division, Albany NY.

Metcalf & Eddy, Inc. (2014) *Wastewater Engineering, Treatment and Resource Recovery*, 5th ed., McGraw-Hill, New York. (M&E 2014)

WEF (2018) *Design of Municipal Wastewater Treatment Plants*, Manual of Practice No. 8, 5th Ed., Water Environment Federation, Alexandria, VA. (MOP8 2018)

NWRI (2012) UV Disinfection Guidelines for Drinking Water and Water Reuse (3rd Ed., w/ WRF, August 2012) (NWRI 2012)

USEPA (2006) UV Disinfection Guidance Manual (UVDGM 2006)

**Acronym definitions**

ADW Average Dry Weather Design Flow

AWW Average Wet Weather Design flow

BOD5  Biochemical Oxygen Demand (5-day)

cm2 square centimeter

ft feet

ft/sec feet per second

gal gallon

gpd gallons per day

L/min/lamp liters per minute per lamp

mg/L milligrams per liter

mgd million gallons per day

LED light emitting diode

mW/cm2 milliwatts per square centimeter

mW\*s/cm2 milliwatt seconds per square centimeter

nm nanometer

NTU Nephelometric Turbidity Unit

PHWW Peak Hourly Wet Weather flow

PLC Programmable Logic Controller

TSS Total Suspended Solids

UPS Uninterruptible Power Supply

UV Ultraviolet

UVT Ultraviolet Transmittance

WWTP Wastewater Treatment Plant