

Reliability for activated sludge and fixed film reactor wastewater treatment facilities

These recommended guidelines address the reliability of the major treatment units for both the activated sludge and fixed film reactor processes and electric power system reliability. The guidelines do not address preliminary treatment units, disinfection, sludge handling, or collection systems. The primary objectives of these guidelines are to ensure that an inventory of biological growth is maintained in the system and to protect the receiving stream.

Any reliability requirements not addressed in this document shall be in accordance with the most recent edition of the *Recommended Standards for Wastewater Facilities*, published by the Great Lakes-Upper Mississippi Board of State and Provincial Public Health and Environmental Managers (Ten States Standards).

Glossary

Fixed film reactor – Refers to any form of treatment where the growth is attached to the media. Examples are trickling filter, packed tower, packed bed reactor, and rotating biological discs.

Stationary media fixed film reactor – Reactor that does not require the media to be physically moved through the wastewater. These include trickling filters, packed towers, and packed bed reactors.

Loading – Refers to that controlling design parameter (e.g., peak instantaneous wet weather flow, average wet weather flow, BOD, etc.) that governs the design of the unit.

Major treatment units – Primary clarifiers, primary fine screens, intermediate clarifiers, final clarifiers, fixed film reactors, and activated sludge basins.

Unit operation – An operation involving a single physical, chemical, or biological process. Examples of unit operations are primary screening, primary clarification, first stage aeration or fixed film reactor, intermediate clarification, second stage fixed film reactor or aeration, and final clarification.

General information

Where duplicate units are not provided, unit bypass structures must be provided so that each unit operation of the facility can be independently removed from service.

Where duplicate units are provided, each unit operation must be designed such that, with the largest unit out of service, the hydraulic capacity of the interconnecting piping will be sufficient to transport the peak instantaneous wet weather flow (as defined in MPCA "Design Flow and Loading Determination Guidelines" through the remaining units. Where duplicate units are provided, a single flow-splitting device must be provided before each unit operation.

Where sludge return to duplicate biological treatment units is utilized, a single flow-splitting device should be provided for the return sludge flow.

All flow splitting devices must have a vertical inlet into the splitter and the flow should be split by overflowing horizontal surfaces that are capable of being adjusted to the same elevation. There should be flexibility within each unit operation to enable the wastewater flow to any unit out of service to be distributed to the remaining units in service.

Concerning reliability for fixed film rotating reactors, the required percentage (as noted in the Design Criteria A or B) pertains to media surface area in lieu of tank capacity.

Fixed film reactors must be preceded by primary clarification unless justification is submitted for other devices (such as primary fine screens), which provide for effective removal of grit, debris, settleable solids, and excessive oil and grease. An intermediate clarifier must precede second stage stationary media fixed film reactors.

Having a phosphorus limitation does not alter the applicability of a Design Criteria.

Design criteria A

The following recommended guidelines apply to any treatment facility that is designed to receive less than an average wet weather flow of 100,000 gallons per day (gpd), and an average of 170 pounds BOD₅ per day, and has standard secondary effluent limitations and no ammonia nitrogen limitations; or discharges to a class 7 stream designed to receive less than an average wet weather flow of 1,000,000 gpd, and an average of 1,700 pounds BOD₅ per day, and has no ammonia - nitrogen limitations.

1. Duplication of major treatment units is not required, but there must be at least two clarifiers provided for the treatment facility. Therefore, if no primary clarifier or intermediate clarifier is provided, at least two final clarifiers are required.
2. For fixed film rotating reactors, there must be a sufficient number of shafts such that with the largest shaft out of service, the remaining shafts will have at least 50% of the total required media surface area. If provided, duplication should, as a minimum be in accordance with Design Criteria B.
3. Treatment facilities with initial loadings at the time of start-up of less than one-half of design loadings must provide reliability in accordance with Design criteria B.

Design criteria B

The following recommended guidelines apply to any treatment facility not covered by Design Criteria A.

1. If primary fine screens are used, duplication must be provided in accordance with the following:
There must be a sufficient number of units of a size such that, with the largest flow capacity unit out of service, the remaining units will have a hydraulic capacity of at least 100% of the total peak instantaneous wet-weather flow (as defined in MPCA "Design Flow Determination" guideline) to that unit operation.
2. Duplication of all primary clarifiers, aeration basins, fixed film reactors, and final clarifiers, must be provided in accordance with the following:
There must be a sufficient number of units of a size such that, with the largest unit out of service, the remaining units will have a design load capacity of at least 50% of the total design loading to that unit operation.
3. For fixed film rotating reactors, the required percentage of media surface area must remain in service when either:
 - a. the tank with the largest media surface area is out of service, or
 - b. when the shaft with the largest media surface area is out of service.

Aeration equipment

The following addresses reliability of aeration equipment for all activated sludge unit operations:

1. Reliability in **diffused air systems**, to include bottom diffusers and jet aeration, must be provided in accordance with the following:

The blowers must be provided in multiple units, so arranged and in such capacities so as to meet the maximum air demand with the largest blower out of service.

- a. **Bottom diffusers:**

All facilities employing less than four independent aeration tanks must be designed to incorporate removable diffusers that can be serviced and/or replaced without dewatering the tanks.

The air diffusion system for each aeration basin must be designed such that the largest section of diffusers can be isolated without losing more than 25% of the oxygen transfer capacity of the system.

- b. **Jet aeration:**

Where only one aeration tank is provided, one spare aeration system (pump and aerator) must be provided on site and must be capable of being installed without dewatering the tank.

Where two or more tanks are provided, one spare aeration system (pump and aerator) must be provided on site unless at least 75% of the oxygen transfer capability of the system can be maintained with the largest aeration unit inoperable.

2. Reliability in **mechanical aeration systems**, to include surface aerators (horizontal shaft and vertical shaft, floating and fixed) and turbine aerators, must be provided in accordance with the following:
 - a. There must be a sufficient number of aerators to enable the design oxygen transfer of a particular basin to be maintained with the largest capacity unit in the basin out of service.
 - b. It is permissible to provide this backup capacity by providing a complete uninstalled unit on-site.
 - c. However, at least two aerators per unit operation must be provided such that replacement can be accomplished without dewatering the tank.
 - d. If only one aeration tank is provided, aerators must be provided such that replacement can be accomplished without dewatering the tank.
3. **Power for aeration** – Standby generating capacity normally is not required for aeration equipment, but should be considered. In cases with a history of power supply outages, power generation for minimum aeration to maintain biological growth may be required. For discharges to sensitive waters, full power generating capacity may be required.

Sequencing batch reactors

Reliability for sequencing batch reactors shall include a minimum of three operating basins so that with the largest unit out of service and adjustment of the sequencing of two of the basins, they can still accommodate average wet weather flows for treatment and can hydraulically pass peak instantaneous wet weather flows.