NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

WASTEWATER CERTIFICATION TRAINING PROJECT

CURRICULA GUIDE
for
WASTEWATER TREATMENT PLANT OPERATOR
CERTIFICATION TRAINING

"BASIC OPERATIONS COURSE"

Prepared for:
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PREFACE & ACKNOWLEDGEMENTS

The contents and production of this Guide represent the results of numerous individuals from State and local government and the private sector. Working together they produced a document which would ensure a comprehensive listing of knowledge and skills necessary to operate a wastewater treatment plant (WWTP) effectively, safely, and in compliance with the water quality standards of the State of New York.

The most significant contributions were made by a group of professional operators and managers who are routinely involved with the day-to-day operation of WWTPs in the State of New York. Thanks to their efforts and cooperation, the baseline information was established and organized according to New York state certification levels. A complete listing of the individuals involved in this process is provided in Section 10 at the end of this guide.

In addition to these individuals, the staff of the Bureau of Water Compliance Programs, New York State Department of Environmental Conservation (NYSDEC) is to be recognized for their insight and recognition of the need for such delineation, and for undertaking this project in a effort to align the training program with the State certification program. Two individuals in particular are to be recognized for their contributions: Mr. Andrew Weist, P.E., and Mr. Phil Smith, P.E., Chief of the Operation Assistance Section. Their guidance and assistance during this project were invaluable.

Other contributors to be recognized include Dr. William Engel, Vice President of ISTI and Ms. Susan McMaster, President of McMaster Training Associates, who conducted the "Facilitated Analysis for Systematic Training" (FAST) workshop. Their guidance during the peer review and consensus process contributed significantly to the establishment and organization of the baseline information required for certification training. Recognition is also due to Mr. Doug Nelson, Assistant Professor, State University of New York, for his contribution to the validation process and to the organization of courses and descriptions; to Mr. Jake Bair, Director of the Maryland Center for Environmental Training, for authoring the skill statements and to Ms. Julia Lannon and Ms. Julie Rison for word processing.

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New York State Wastewater Treatment Plant Operator Certification

Certification of wastewater treatment plant operators in New York State is mandated by Title 6 *New York Codes, Rules and Regulations (NYCRR)*, Section 650, Chapter X. The certification process is a system whereby an individual is determined to be qualified as a chief operator or assistant/shift operator for the purpose of meeting the requirements of the State Pollutant Discharge Elimination System (SPDES) Permit.

The New York State Wastewater Treatment Plant Operator Certification Program requires certification candidates to progressively complete a series of certification training courses. The following chart illustrates the training required for each certification Grade.

NOTE: All operators at "A", or activated sludge process facilities, must complete the activated sludge course.	**Grade 1**	**Introductory Wastewater Course (Home Study) or Basic Operations Course**
	Grade 2	**Basic Operations Course + Lab Course**
	Grade 3	**Supervision and Technical Operations Course**
	Grade 4	**Management Course**

With the exception of Grade 1, all certification candidates must complete the "BASIC OPERATIONS" course. Grade 1 certification candidates may also complete the "Basic Operations" course, or they may choose the alternative of completing an approved home study course in order to complete their training requirement.

Relationship Between Training and Certification

Successful completion of this training course is required as part of the qualification process, in order to establish eligibility to take the certification examinations. This course is not an exam review course and by itself cannot ensure successful passage of the certification examination.

The certification examination series draws from a universe of operational experiences and consequently addresses more information than can be presented or gained through classroom training alone. There is no substitute for practical experience and organized on-the-job training (OJT). Training can help the operator focus on need-to-know subjects and assist the operator to prepare for the certification examinations, but classroom training alone will not be sufficient. Successful completion of the certification examinations will not only require active participation in this course but will also require additional studies and practical work experience.

Employers and supervisors are encouraged to schedule work assignments which coincide with training topics. For example, work assignments at the headworks of the treatment facility should coincide with study of Module 2, and additionally include work experience with bar screens, comminution, grit removal and primary clarification.

Individuals participating in this training course should have good basic skills in mathematics, and have at least an eighth grade reading comprehension.

Curriculum Guide: Content & Organization

This Guide presents the core technical content and curricula to be included in the "BASIC OPERATIONS" course. Every module should include related math and safety applications. Individual course offerings may emphasize selected subjects based on local conditions, specific facilities designs, and the abilities of the training participants. The nine course modules were designed to incorporate criteria that a certified operator "needs-to-know" (NTK) as identified by the Blue Ribbon Committee in 1992. The nine modules and estimated delivery times are:

BASIC OPERATIONS

Module	Title	Hours
1	"INTRODUCTION TO WASTEWATER TREATMENT"	4
2	"PRELIMINARY & PRIMARY WASTEWATER TREATMENT"	8
3	"SECONDARY WASTEWATER TREATMENT PROCESSES"	10
4	"ADVANCED WASTEWATER TREATMENT"	4
5	"DISINFECTION & EFFLUENT DISPOSAL"	8
6	"SOLIDS MANAGEMENT"	8
7	"EQUIPMENT & SUPPORT SYSTEMS"	8
8	"MONITORING & REGULATORY REQUIREMENTS"	4
9	"MANAGEMENT & SUPERVISION"	6

Each module contains specific skill statements which were developed using the NTK criteria. Each module begins with a one page course synopsis which identifies:

- Target Audience
- Module Length
- Module Description
- Training Objectives

The Need-to-Know Criteria are keyed A - F to reflect the following five levels of understanding or performance:

A = Explain Operational Concepts
B = Make Routine Adjustments
C = Recognize Performance Problems
D = Troubleshoot Operational Problems
E = Implement Corrective Action
F = Perform Routine Maintenance

NTK which are entered in **bold** have been identified by the Blue Ribbon Committee as requiring the full range of knowledge; A through F. NTK in CAPITALS are primary knowledge and lower case entries are secondary knowledge.

The skill statements which follow the course synopsis provide very specific and measurable achievements. Statements using the term "must" are essential and critical knowledge and skill areas. Statements with "should" are important and often represent abilities which are supportive of the critical skill statements.

Skill statements provide direction to both the instructor and to the students regarding the outcome expectations of the training. Skill statements can serve as the basis for constructing an examination to evaluate students, and as a measure that students may themselves use to evaluate their progress in each course.

Continued Professional Development

This training course is just the beginning of your training and professional development. You are strongly advised and encouraged to take advantage of additional training opportunities and to begin your own independent studies and reading of professional journals and technical and trade publications.

NOTE: After each skill statement is cthe citation of the appropriate volume and chapter section of *Operation of Wastewater Treatment Plants* (California State University, Sacramento. Ken Kerri, editor). There are three volumes necessary for each student and instructor:

- *Volume I* (6th Edition, 2004) is referred to in abbreviated form as "SAC. 1"
- *Volume II* (6th Edition, 2003), is referred to as "SAC. 2" and
- *Advanced Waste Treatment*, (5th Edition, 2006) is referred to as "SAC. AWT."

Supervision and managerial skills listed in this document are available in another publication by California State University, Sacramento. This document is:

- *Manage for Success* (1st Edition, 2004) referred to as "SAC. MFS"

Manage for Success is an excellent resource for facility managers and each employee. However, it is not required for the Basic Operations Course. It is the course text for the Grade 3 "Supervision and Technical Operations Course" and the Grade 4 "Management Course".

In almost all cases specific references to the Sacramento volumes are possible for individual skills. Referencing plant-specific documents may also correspond to a skill statement. If so, then either the specific document will be listed or reference will be made to the Standard Operating Procedure, or "SOP", for that treatment facility.

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 1
"INTRODUCTION TO WASTEWATER TREATMENT"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 4 Hours

Module Description: This module is the first in a series designed to assist WWTP operators to prepare for certification. Topics include an overview of basic math for wastewater treatment; the chemistry, microbiology, and biology of wastewater treatment processes. The importance of sampling, laboratory, maintenance, management and safety are also briefly discussed.

Need-to-Know Criteria*: Wastewater Basics (Math, Chem., Micro. & Biology) (A-F)

Training Objectives: Specific skill statements are provided for each of the NTK criteria listed above on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
"CAPITAL" letters are primary knowledge
"lower case" letters are secondary knowledge
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TEACHING OUTLINE FOR MODULE 1

Note to Instructor: Need-to-Know "Basics" to a great degree involves word or phrase definition. Use the glossary in the Sacramento manuals liberally, and use the first hour to introduce the students to the glossary.

The "Language" of Wastewater Treatment 1 hour

Math Review 1 hour

Provide a simple diagnostic math test, 10 - 20 problems, keyed to the 8th grade level. Analyze test results after class and make recommendations regarding which students should undertake remedial math training.

1 hour

Review areas, volumes, fractions, and percentages, concluding with solving for one unknown. For example: $\frac{x}{24} = \frac{19.5}{20}$

Safety Overview 1 hour

WASTEWATER BASICS

1.1.1 Operators must describe the origins and general characteristics of domestic, industrial, and commercial wastewater. *(SAC. 1, Words)*

1.1.2 Operators must also describe the origins and typical characteristics of infiltration and inflow wastewater. *(SAC. 1, Words)*

1.1.3 Using the concepts of pH, temperature, solids concentrations, biochemical oxygen demand, chemical oxygen demand, nutrient loadings, dissolved oxygen, septicity, and toxicity, operators must describe how each physical, chemical, and biological characteristic of typical raw domestic wastewater may affect the waste treatment process. *(SAC. 1, Words)*

1.1.4 Operators must define preliminary treatment, primary, secondary, and advanced treatment, disinfection, solids processing and wastewater laboratory analysis. Additionally, every operator must describe why each step is performed, how each step is expected to improve wastewater quality, and the point in the treatment process at which each step is normally carried out. *(SAC. 1, 3.2)*

Mathematics

1.1.5 In mathematics, operators must be able to perform the following:

1.1.5.1 add, subtract, multiply, and divide whole numbers and decimals;

1.1.5.2 square and cube whole numbers and decimals;

1.1.5.3 convert fractions to percentages and decimals, and vice versa;

1.1.5.4 interpret graphs, including line, bar, percentage, and broken-line graphs;

1.1.5.5 read tables; and

1.1.5.6 using conventional formulas, solve for direct and inverse proportions, calculate area of rectangles, triangles, and circles; calculate surface area of cylinders, cones, and spheres; and determine volume of cubes, cylinders, cones, prisms, and spheres. *(SAC. 1, A.2)*

Safety

1.1.6 Operators must recognize and describe the nature and usual locations of the following types of typical hazards found in wastewater treatment plants: pathogens in the treatment stream, toxicity of treatment chemicals, open electrical circuits, moving mechanical equipment, obstructions and poor footing, oxygen deficient, toxic, or explosive atmospheres in confined areas, and slipping and tripping hazards.

1.1.6.1 Operators must demonstrate appropriate safety responses for each type of hazard listed above.

(SAC. 2, multiple entries in Chapter 14)

1.1.7 Operators must have a general understanding of the State Pollution Discharge Elimination System (SPDES) program. *(SAC. 2, 2.6)*

1.1.8 An operator should carry out tests, using Standard Methods procedures, to determine the following plant effluent characteristics: pH, dissolved oxygen, total chlorine residual, total suspended solids, and five-day biochemical oxygen demand. Further, operators must be able to interpret the results of such testing and specify the need for process adjustments when test results suggest inadequate plant performance. *(SAC. 2, 16.01, 16.4)*

1.1.9 Operators must accurately measure plant flow, using standard flow metering equipment or, in the case of breakdown, Parshall flume or other manual equipment.

(SAC. 2, 15.9)

1.1.10 Operators must identify the most critical chemical and physical parameters needed for successful operation of all secondary biological wastewater treatment systems, including:

1.1.10.1 pH;

1.1.10.2 available oxygen;

1.1.10.3 moderate temperature range; and

1.1.10.4 available food. *(SAC. 1, 2.3)*

1.1.11 Operators must define biomass, and specify the location of the biomass in lagoons, RBC's, trickling filters and other suspended growth systems. *(SAC. 1, 3.6)*

1.1.11.1 Operators must broadly define the term microlife, and describe how microorganisms in secondary systems act as the agents of conversion of organic waste into water, carbon dioxide and sludge.

(SAC. 1, 11.1031)

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 2
"PRELIMINARY & PRIMARY WASTEWATER TREATMENT"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 8 Hours

Module Description: This module is the second in a series designed to assist WWTP operators to prepare for certification. Topics include an overview of preliminary treatment; primary treatment; and physical chemical treatment.

Need-to-Know Criteria*: Bar Screens & Racks (A-F)
Comminution (A-F)
Grit Removal (A-F)
Primary Clarification (A-F)

Training Objectives: Specific skill statements for each of the NTK criteria listed above are provided on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
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TEACHING OUTLINE FOR MODULE 2

Bar Screens and Racks — 2 hours

1.) why gross solids must be removed
2.) safety around screens and racks
3.) cleaning
4.) inspection

Comminution — 1 hour

1.) purpose of comminutors
2.) cleaning, safety
3.) operations, design of typical units

Grit Removal — 1 hour

1.) origins of grit, its dangers to equipment
2.) calculating flow, cross-sectional area
3.) inspecting grit channels
4.) safe disposal of grit
5.) odor control techniques

Primary Clarification — 4 hours

1.) types and purpose of primary clarifiers
2.) components of clarifiers
3.) calculating removal efficiencies
4.) establishing sludge withdrawal rates
5.) "clarigesters"
6.) inspection; dry, loaded
7.) maintenance issues

INTRODUCTION TO PRELIMINARY AND PRIMARY TREATMENT

2.1.1 Operators must state the key objectives of preliminary treatment ("pretreatment") of wastewater, and must diagram the sequence of the typical procedures used to remove large solids from the waste stream and to freshen the wastewater, including:

2.1.1.1 screening,

2.1.1.2 shredding,

2.1.1.3 grit removal, and

2.1.1.4 pre-aeration. *(SAC. 1, 3.3)*

BAR SCREENS AND RACKS

Includes both mechanically and manually cleaned bar screens, and manually cleaned bar racks.

2.2.1 Operators must define screening and recognize from diagrams the working parts of bar screens and racks.

(SAC. 1, 3.31)

2.2.2 Operators must identify the hazards to health and safety presented during the process of screening raw wastewater. These include slippery footing, exposure to infectious diseases through skin contact and breathing, and septicity caused by oxygen depletion which may lead to the presence of toxic gases. *(SAC. 1, 4.20)*

2.2.3 For manually cleaned bar screens, operators must plan and carry out a cleaning schedule sufficient to minimize downstream head loss to specified limits. *(SAC. 1, 4.21)*

2.2.4 For mechanically cleaned bar screens, operators must safely inspect rake mechanisms for jamming by foreign objects, or for other malfunctions. In addition, when jamming has occurred, operators must shut down the mechanism, divert flow if necessary, and correct the defect. Operators must replace shear pins once the malfunction has been corrected.

(SAC. 1, 4.22)

2.2.5 After lock-out and flow diversion, operators must safely hose down and clean out the channel in which a rack or screen is set. *(SAC. 1, 4.22)*

COMMINUTION

Includes grinders, comminutors, and barminutors.

2.3.1 Operators must define comminution and recognize and identify from diagrams the working parts of comminutors. *(SAC. 1, 4.3)*

2.3.2 Operators must determine, by visual inspection or by listening, if a comminution device is working correctly. For example, "chirping" or other sounds of metal-to-metal contact may be perceived if a cutter bar is misaligned. *(SAC. 1, 4.33)*

2.3.3 Operators must establish and carry out a safe procedure for removing floating debris which accumulates in front of comminution devices on the surface of the waste stream. *(SAC. 1, 4.32)*

2.3.4 Operators must schedule and perform maintenance procedures for safely shutting down comminution devices in order to clean out rocks, scrap metal, and other settled objects from any traps located upstream from the comminutor. *(SAC. 1, 4.32)*

2.3.5 Operators must inspect the flow downstream of a comminution device to determine if "roping" of the ground material indicates only partial grinding is taking place. *(SAC. 1, 4.33)*

2.3.6 Operators must list the advantages and drawbacks to all comminution devices designed to leave shredded solids in the wastewater, including their resistance to treatment even when shredded. *(SAC. 1, 4.5)*

2.3.7 Operators must lubricate comminution devices according to manufacturers' specifications for lube-type, intervals, and lube-injection procedures. *(SAC. 1, 4.30-4.31)*

GRIT REMOVAL

Includes aerated grit chambers and conventional grit chambers, both manually and mechanically cleaned.

2.4.1 Operators must identify the typical origins of grit in the waste stream, and explain why it must be removed.

(SAC. 1, 4.4)

2.4.2 Working from diagrams, operators must identify the principal components of typical grit removal devices, including weirs, diffusers, air lifts, grit screws, conveyor devices, basins, channels, and baffles.

(SAC 1, 4.40)

2.4.3 Operators must perform the following grit removal system calculations: detention time, flow rate and velocity.

(SAC. 1, 4.40)

2.4.4 Operators should determine if short circuiting in the grit chamber is taking place.

(SAC. 1, 4.40)

2.4.5 If waste stream velocity through a grit chamber is too slow (less than .7 feet per second), causing settling of organic material (detritus), operators must increase velocity to an acceptable minimum, either by decreasing the grit chamber's cross-sectional area or by reducing the number of grit channels in service. *(SAC. 1, 4.40)*

2.4.6 If velocity through a grit chamber is high enough to prevent settling of inorganic material, (greater than 1.4 feet per second) operators must decrease the velocity to an acceptable maximum by increasing the chamber's cross-sectional area or by increasing the number of grit channels in service. *(SAC. 1, 4.40)*

2.4.7 Operators must carry out pre-operational inspections of both grit channels and/or aerated chambers, ensuring that if grit is mechanically cleaned from a channel or chamber, the "flights" operate smoothly and all tools or other foreign objects have been removed.

(SAC. 1, 4.40)

2.4.8 Operators must properly divert flow into or out of a grit channel or chamber by proper sequencing of gate openings or closings. *(SAC. 1, 4.40)*

2.4.9 For aerated grit chambers with proportional outlet weirs, operators must calculate detention time, and adjust air diffusion rates to a norm which will ensure maximum grit removal with minimum deposition of organic material.

2.4.10 Operators must demonstrate safe procedures for the removal and disposal of material collected in a grit channel or chamber, and must be able to outline standard operating procedures for this task appropriate to their individual plants. *(SAC. 1, 4.40)*

2.4.11 Through inspection, operators must recognize the need to apply odor control techniques in the grit removal system, particularly if the system is not aerated. *(SAC. 1, 4.40)*

2.4.12 After shut-down, operators must wash down a grit channel or chamber in a sanitary, safe fashion. *(SAC. 1, 4.40)*

2.4.13 Operators of cyclone grit separators must describe how vortex action is employed to separate organic particles which are lighter than water from inorganic particles (grit), which is heavier than water. They must also explain briefly why this process is often referred to as "cyclone" action. Operators must explain why too heavy a slurry will reduce the cyclone action, and thus the system's capacity.

2.4.14 Operators of grit washers must diagram how organic detritus is separated from grit before its use as fill material, or before it is conveyed for disposal at a landfill.

PRIMARY CLARIFICATION

Includes circular, rectangular, and "travelling bridge" clarifiers, Imhoff tanks, "clarigesters", and other primary sedimentation/ digestion units.

2.5.1 Operators of plants with primary clarification must identify and locate the main components of clarification unit(s), including the influent pipe, influent baffles or well, scum collection mechanism, scum discharge trough, scum storage and pumping equipment, sludge collection mechanism, sludge withdrawal pipe or plumbing, and the drive unit or "turntable."

(SAC.?, pp. 110-115)

2.5.2 Operators must locate each bearing or gear in their clarifiers, and be able to specify a lubrication program for each of them.

(SAC. 1,5.0)

2.5.3 Operators must calculate detention times, surface overflow rates, and BOD and suspended solids removal efficiencies for primary clarifiers. After comparing these rates to a clarifier's original design specifications, operators must make appropriate operating adjustments, if necessary. *(SAC. 1, 5.4, but also highly site specific)*

2.5.4 Operators must carry out solids inventory analyses, needed for establishing proper sludge withdrawal ("wasting") rates from primary clarifiers. They must also vary the length and frequency of sludge pumping, in order to maintain efficient sludge concentrations in the

waste sludge, but also to prevent septic conditions resulting from sludge blankets which have become too dense. *(SAC. 1, 5.64)*

2.5.5 For "travelling bridge" clarifiers, operators must program the bridge operation to obtain the highest workable percent solids in sludge, and maximum BOD and suspended solids removal efficiencies, without ever permitting development of septicity. *(SAC. 1, 5.6)*

2.5.6 Operators must carry out a program of routine observations of primary clarifiers, including inspection for floating debris and measurement of sludge blanket depth. *(SAC. 1,5.11)*

2.5.7 For "clarigester" units, operators must establish a supernating program sufficient to obtain maximum efficiency of the primary clarifier section of the unit. *(SAC. 1, 5.9)*

2.5.8 Operators must carry out safe scum removal procedures. If primary clarifier scum is not subjected to further treatment, operators must safely dispose of the scum through incineration, burial, or digestion. *(SAC. 1, 5.3)*

2.5.9 Operators must inspect a dry clarifier to ensure that there is proper clearance of adjustable sludge blades, that there are no cracks or other defects in the walls of the clarifier, and that no tools, foreign objects, or waste materials have been left in the unit. For rectangular clarifiers, operators must be able to inspect chains and "flights" to ensure that rust has not frozen any flight wearing shoe to a guide rail.

(SAC. 1,5.10)

2.5.10 In the event of serious malfunction, operators must contact the supplier and/or manufacturer of each primary clarifier in their plants. In addition, operators must design and keep an up-to-date maintenance log for each of their clarifier units, as well as explain the types of entries which should be kept in such a log. *(SAC. 1, 5.4)*

2.5.11 Prior to loading, operators must start up a clarifier drive unit and inspect both scum and sludge collectors for smooth and unrestricted operation. (Exception: Certain clarifiers have water lubricated bearings and gears which should only be operated according to manufacturers' directions.) *(SAC. 1, 5.10)*

2.5.12 Operators must inspect lubrication levels, drive alignment, and general assembly integrity of clarifier units prior to starting up or returning them to service. *(SAC. 1, 5.10)*

2.5.13 Operators must divert flow from a clarifier, shut the unit down, wash the unit out (diverting the wash flow to the head of the plant), and safely make routine (minor) repairs to the structure or drive mechanism. *(SAC. 1, 5.13-5.14)*

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 3
"SECONDARY WASTEWATER TREATMENT PROCESSES"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 10 Hours

Module Description: This module is the third in a series designed to assist WWTP operators to prepare for certification. The course examines the many secondary (biological) treatment processes used to treat wastewater. The biology of secondary treatment, rotating biological contactors, trickling filter, lagoons and secondary settling are covered in detail. The course explains the theory and the factors affecting the daily operations including the basic safety issues and process math related to each technology. Disinfection, odor control, effluent disposal and reporting and recordkeeping are also briefly discussed.

Need-to-Know Criteria*:

Secondary Treatment-Trickling Filters/Bio-Towers(A-F)
Waste Stabilization Ponds & Lagoons (A-F)
Secondary Treatment-Rotating Biological Contactors (A,B,C,D)
Secondary Clarifier Operation (A-F)
Disinfection (a)
Effluent Disposal (a)
DMR Reporting/Recordkeeping (a)

Training Objectives: Specific skill statements for each of the NTK criteria listed above are provided on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

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Italicized entries were added during a review by Instructors of the Certification Training Program.

TEACHING OUTLINE FOR MODULE 3

Introduction: Terms and Definitions 1 hour

Trickling Filters 4 hours

*1.) basic biological and physical principles
2.) main components
*3.) explanation of typical hazards to treatment effectiveness
*4.) influent BOD measurement, organic loading rate concept, hydraulic loading
5.) removal efficiency calculations
6.) ponding, filter flies, odors—remedies
7.) maintenance

Rotating Biological Contactors 3 hours

*1.) operating principles (fixed film, similar to trickling filters)
*2.) criticality of primary clarifier performance
3.) main components
4.) maintenance
5.) troubleshooting hazards to effective operation

Secondary Clarifiers 3 hours

*1.) calculating detention time
2.) calculating surface overflow rate
*3.) calculating weir overflow rate
4.) rising, clumping sludge
5.) maintenance

* = especially important

INTRODUCTION TO SECONDARY TREATMENT

3.1.1 Operators must define the term secondary treatment, in particular explaining the typical target removal rates for organic pollutants in secondary systems. (90 percent or better). *(SAC. 1, 3.6)*

3.1.2 Operators must define precisely the terms BOD (biochemical oxygen demand), soluble BOD, and suspended solids. *(SAC. 1, Words)*

3.1.3 Operators must describe the operating principles of the four most typical secondary treatment systems in use in the U.S.—trickling filters, rotating biological contactors, activated sludge systems and stabilization ponds. *(SAC. 1, 3.61-3.63, 3.8)*

3.1.4 Operators must describe the specific role of secondary treatment in achieving compliance with SPDES permits. *(Not specifically covered in any special section of SAC.)*

SECONDARY TREATMENT USING TRICKLING FILTERS

Includes standard rate, high rate and "roughing" filters, activated biofilter (ABF) towers.

3.2.1 Operators must explain the biological and physical principles at work in a trickling filter and, at a minimum, be able to describe the following:

3.2.1.1 the location and function of the zoogleal film;

3.2.1.2 the importance of oxygen transfer (respiration) to the health of the zoogleal film;

3.2.1.3 how soluble BOD absorption takes place;

3.2.1.4 how particulate BOD adsorption takes place;

3.2.1.5 the process of sloughing, and its importance to the vitality of the biological process; and

3.2.1.6 the process of recirculation, and its influence on trickling filter BOD removal efficiency.

(SAC. 1, 6.02, 6.22)

3.2.2 Operators must explain why the flow of inorganic solids to trickling filters must be reduced to the lowest practical level, and the nature of the damaging effect which will occur if inorganic solids are allowed to build up within a trickling filter. *(SAC. 1, 6.00, 6.02)*

3.2.3 Operators must identify and explain the functions of the main components of a typical trickling filter, including:

3.2.3.1 distributor arms,

3.2.3.2 arm dump gate,

3.2.3.3 orifices,

3.2.3.4 stay rods and turnbuckles,

3.2.3.5 center well,

3.2.3.6 distributor bearing,

3.2.3.7 influent pipe,

3.2.3.8 outlet pipe,

3.2.3.9 underdrain system,

3.2.3.10 ventilation ports,

3.2.3.11 filter media, and

3.2.3.12 retaining wall. *(SAC. 1, Table 6.1, Figure 6.3)*

3.2.4 Operators must recognize and devise effective countermeasures for typical hazards to the biological process at work in a trickling filter. Hazards include:

3.2.4.1 inadequate removal of settleable or suspended solids during preliminary and/or primary treatment;

3.2.4.2 clogged ventilation ports;

3.2.4.3 abnormally low air or influent temperatures;

3.2.4.4 toxic shock loads or excessive pH fluctuations in the influent feed to the trickling filter;

3.2.4.5 excessive pre-chlorination of influent;

3.2.4.6 excessively high or low hydraulic loading; and

3.2.4.7 mechanical failures (e.g., "freeze-ups", or arm binding).*(SAC. 1, 6.22, 6.32, 6.41-6.417)*

3.2.5 Operators must determine when excessive BOD is present in the primary clarifier effluent, by calculating total daily organic loadings in pounds of BOD per 1000 cubic feet of filter media. If BOD becomes excessive, operators must choose and implement one or more of the following control strategies:

3.2.5.1 bring additional filters "on-line" as needed;

3.2.5.2 increase recirculation;

3.2.5.3 increase primary clarifier sludge pumping rate; and

3.2.5.4 modify schedule for returning other plant recycles, such as digester supernatant, filtrate, etc. *(SAC. 1, 6.22, 6.417, SAC.2, 12.27)*

3.2.6 Operators must calculate the BOD removal efficiency of a trickling filter by comparing the BOD of trickling filter influent to the BOD of final trickling filter effluent, and then calculating the removal rate as a percentage. *(SAC. 1, 6.72, Appendix A. 133)*

3.2.7 Operators must calculate total hydraulic loadings in gallons per day per sq. ft. of media surface. If hydraulic loadings become excessive operators must choose and implement one or more of the following control strategies: *(SAC. 1, 6.71)*

3.2.7.1 reduce recirculation;

3.2.7.2 place filters in parallel (rather than series) operation if not already in that mode;

3.2.7.3 adjust the schedule of side stream flow return from digesters or other controllable sources;

3.2.7.4 use polymers or other flocculants to maximize performance (settling rates) in primary clarifiers if it is determined that a hydraulic overload is causing poor settling-out of solids; and

3.2.7.5 implement flow equalization strategies if possible. *(SAC. 1, 6.416)*

3.2.8 Operators must recognize and control ponding caused by:

3.2.8.1 excessive zoogleal film development;

3.2.8.2 accumulation of trash or fibers; and

3.2.8.3 insect larvae or snail growth filling the media voids. *(SAC. 1, 6.410)*

3.2.9 Always first choosing the most gentle response for the problem, (i.e., the response presenting the least shock to the zoogleal film biomass), operators must correct a ponding condition by executing any one or more of the following:

3.2.9.1 increasing the recirculation rate;

3.2.9.2 scouring the media surface with a high pressure water stream;

3.2.9.3 raking the affected portion of the media surface and removing accumulated debris;

3.2.9.4 gently dosing the trickling filter influent with chlorine to achieve a trickling filter effluent Cl_2 residual which never exceeds 0.5 mg/L;

3.2.9.5 flooding the filter for 24 hours;

3.2.9.6 shutting off flow to the filter for up to eight hours; and

3.2.9.7 removing and inspecting the media's top layer in the area of the ponding.

(SAC. 1, 6.410)

3.2.10 Operators must carry out all appropriate remedies for offensive odors coming from a trickling filter, including:

3.2.10.1 checking influent for possible septicity or toxicity, then pre-aerating or gently pre-chlorinating, if necessary;

3.2.10.2 verifying that ventilation ports are not clogged;

3.2.10.3 increasing the recirculation rate; and

3.2.10.4 checking for splashing of influent outside of the media area (over sides, on adjacent structures, etc.) *(SAC. 1, 6.411)*

3.2.11 Operators must recognize and control excessive filter fly populations, by:

3.2.11.1 increasing recirculation so that hydraulic loading is greater than 200 gpd per sq. ft. of media surface;

3.2.11.2 inspecting orifices for even flow distribution;

3.2.11.3 opening end gates slightly to flush the inside of the retaining wall;

3.2.11.4 flooding the filter for 24 hours once a week until fly populations are controlled; and

3.2.11.5 gently pre-chlorinating the influent coming to the trickling filter.
(SAC. 1, 6.412)

3.2.12 Operators must describe when and how to implement special cold weather operating strategies, including any of the following:

3.2.12.1 adjusting recirculation rate;

3.2.12.2 changing to parallel operation of filters when filters are normally staged in series;

3.2.12.3 adjusting orifices and splash plates to reduce random spraying of influent;

3.2.12.4 using canopies or wind screens to reduce heat loss;

3.2.12.5 physically removing ice chunks; and

3.2.12.6 opening distributor arm end gates to increase velocity of flow, so as to create a stream rather than a fine spray. *(SAC. 1, 6.415)*

3.2.13 Operators must demonstrate the lubrication of distributor arm bearings in trickling filters.
(SAC. 1, 6.5)

3.2.14 Operators must contact manufacturer's representatives to determine if their trickling filter's center arm houses a mercury seal, and must replace the seal or find a contractor who can do so. *(Not specifically covered in SAC.)*

3.2.15 Operators must explain why start-up of trickling filters is most desirable in late spring or early summer, because of maximum growth potential of the biomass during those seasons.
(SAC. 1, 6.21)

3.2.16 During start-up, operators must inspect the distributor arms and orifices to ensure free flow (no clogging) and even distribution of influent over the media. Operators must know proper procedures for cleaning clogged distributor arm orifices. *(SAC. 1, 6.21)*

3.2.17 During start-up, operators must plan and implement a gradually increasing recirculation rate, until the "standard" or design rate is reached. This will prevent the recirculation pump from running dry as a result of an initially excessive recirculation rate. *(SAC. 1, 6.2)*

3.2.18 In starting-up a new trickling filter distributor arm, operators must "log-in" the rotational speed of the distributor arm as a function of the flow in gpm through the arm.
(Not specifically covered in SAC.)

3.2.19 In shutting down a trickling filter, operators must gradually reduce the recirculation rate to avoid sending a surge of water to the filter bed. *(SAC. 1, 6.23)*

3.2.20 Operators must demonstrate when and how to open the end gates of the distributor arms to flush them out prior to cutting off influent flow. *(SAC. 1, 6.23)*

3.2.21 During shut-down of a trickling filter, operators must gradually phase out and then completely cut off influent flow and recirculation pumps. *(SAC. 1, 6.23)*

3.2.22 For "mothballing" a trickling filter (shut-down of more than 1-2 days), operators must develop from their operation and maintenance (O&M) manual a plan for long-term shutdown, at a minimum accomplishing the following:

3.2.22.1 close outlet valve to prevent backflow;

3.2.22.2 pump down or drain the underdrain system;

3.2.22.3 hose down all exposed structures;

3.2.22.4 inspect all components of the filter (arms, bed, ventilation system, underdrain channels, influent pipe, etc.) for trash and foreign objects;

3.2.22.5 check the oil level in the distributor turntable for proper level and for any water contamination; and

3.2.22.6 if biomass is heavy, rake the surface area to remove as much dried biomass as possible. *(SAC. 1, 6.23)*

SECONDARY CLARIFIER OPERATION

Includes both circular and rectangular secondary clarifiers.

3.3.1 Operators must explain precisely the concept of detention time, and its correlation to the degree of clarification achieved by a secondary clarifier. *(SAC. 1, Words, 5.620, 5.621)*

3.3.2 Operators must explain why and how excessively long detention of sludge in a secondary clarifier will lead to septicity and/or rising sludge. *(SAC. 1, 5.14)*

3.3.3 Operators must diagram the flow patterns of liquid and sludge into and out of a typical secondary clarifier in a trickling filter or rotating biological contactor (biodisc) facility. *(SAC. 1, 5.9-5.11)*

3.3.4 Operators must locate and identify the main components of secondary clarifiers, including:

—Parts common to all secondary clarifiers:

3.3.4.1 influent pipe,

3.3.4.2 effluent weirs,

3.3.4.3 effluent channel,

3.3.4.4 sludge collector mechanism,

3.3.4.5 sludge withdrawal system, and

3.3.4.6 sludge/scum collector drive mechanism. *(SAC. 1, 5.3, 5.5, 5.8-5.11)*

—Parts unique to rectangular clarifiers:

3.3.4.7 wearing shoes, and

3.3.4.8 sludge/scum chain and scrapers ("flights"). *(SAC. 1, Figure 5.3)*

—Parts unique to circular clarifiers:

3.3.4.9 the stilling well,

3.3.4.10 the collector blades and rubber squeegees, and

3.3.4.11 suction withdrawal mechanism, if applicable. *(SAC. 1, Figures 5.4 and 5.5)*

3.3.4.12 The effluent recirculation pump which is unique to secondary clarifiers in trickling filter secondary treatment. *(Not illustrated in SAC.)*

3.3.5 Operators must explain the significance of and carry out calculations for:

3.3.5.1 detention time in hours;

3.3.5.2 surface overflow rate in gpd per sq. ft.; and

3.3.5.3 solids loading rate in lbs. per day, per square foot of clarifier surface area.
(SAC. 1, 5.61)

3.3.6 Operators must interpret the results of the above calculations, knowing when to add units or remove units from service. *(SAC. 1, 5.14, 5.61)*

3.3.7 Operators must carry out the following performance inspections of secondary clarifiers:

3.3.7.1 monitor scum levels on water surface;

3.3.7.2 observe final effluent at the weirs to ensure the absence of pin floc, straggler floc, ash, and rising or bulking sludge; and

3.3.7.3 measure sludge blanket depth. *(SAC. 1, 5.14, 5.3)*

3.3.8 Operators of secondary clarifiers in plants using trickling filters must explain the concept of effluent recirculation and demonstrate when, why, and how to adjust effluent recirculation rates. *(SAC. 1, 6.02, 6.22, 6.32)*

3.3.9 Operators of secondary clarifiers must recognize and take remedial action for clumping and rising sludge, indicating denitrification. *(SAC. 1, 5.3)*

3.3.10 Operators must recognize the first symptoms of hydraulic overload and, if possible, take corrective action before the sludge blanket in secondary clarifiers is threatened with wash-out. *(SAC. 1, 5.23, 5.24, SWC. AWT 2.220)*

3.3.11 Operators of secondary clarifiers must create and implement an emergency response plan for dealing with mechanical or electrical failure of a secondary clarifier. The minimum objectives of such a plan must include:

3.3.11.1 removal of the sludge blanket as quickly as possible;

3.3.11.2 diversion of flow away from the affected clarifier;

3.3.11.3 protection against freeze-up, if failure occurs during cold weather; and

3.3.11.4 protection of the sludge collection mechanism from jamming or other malfunction.

3.3.12 Once a clarifier is loaded, operators must establish and maintain a correct sludge withdrawal rate. *(SAC. 1, 5.3)*

3.3.13 Operators must carry out routine inspections and mechanical maintenance of secondary clarifiers, including:

3.3.13.1 cleaning weirs and effluent channel;

3.3.13.2 changing or adjusting packing on all pumps;

3.3.13.3 lubricating drive motors, pumps, and collector mechanisms;

3.3.13.4 exercising all valves;

3.3.13.5 visually inspecting for proper rotation of collector mechanism;

3.3.13.6 listening for any unusual mechanical sounds (i.e., scraping, "chirping", whining, or bumping); and

3.3.13.7 inspecting for oil or grease leaks. *(SAC. 1, 5.10, Chapter 5 Troubleshooting Guide)*

3.3.14 Before starting up a secondary clarifier, operators must inspect for:

3.3.14.1 debris or other foreign material in the clarifier;

3.3.14.2 correct mechanical and electrical operation of the collector mechanism; and

3.3.14.3 correct operation of the sludge pumps after loading begins. *(SAC. 1, 5.10)*

.3.15 When taking a secondary clarifier out of service, operators must carry out the following shut-down tasks:

3.3.15.1 divert flow by shunting flow to another clarifier, or by preventing flow into the trickling filter or RBC feeding the clarifier to be shut down;

3.3.15.2 drain clarifier, returning contents to the head of the plant;

3.3.15.3 record "free-wheeling" collector mechanism RPM, log in, then shut down drive motor, lock out and tag; and

3.3.15.4 wash down clarifier, directing wash water back to the head of the plant.
(SAC. 1, 5.13)

SECONDARY TREATMENT USING ROTATING BIOLOGICAL CONTACTORS ("RBC's")

3.4.1 Operators must describe the broad biological and physical principles at work in an RBC, and be able to locate or illustrate (with sketches or examples) the following:

3.4.1.1 the location and function of the zoogleal mass;

3.4.1.2 the importance of oxygen transfer (respiration) to the health of the zoogleal film;

3.4.1.3 how soluble BOD absorption takes place;

3.4.1.4 how particulate BOD adsorption takes place;

3.4.1.5 the process of sloughing and its importance to the vitality of the biological process; and

3.4.1.6 the importance of first stage sizing of biodiscs in determining overall BOD removal efficiency. *(SAC. 1, 7.0, 7.122)*

3.4.2 Operators must describe the importance of solids removal in primary clarifiers whose effluent is fed to RBC's, and be able to define accurately the solids removal rates that must be achieved during preliminary and primary treatment in order for RBC's to operate successfully. *(SAC. 1, 7.0, 7.1)*

3.4.3 Operators must identify and explain the function of the main components of a typical RBC, including:

3.4.3.1 cover;

3.4.3.2 drive motor and speed reducer (for mechanically driven RBC's);

3.4.3.3 air control valve, air diffusers, and air caps (for air driven RBC's);

3.4.3.4 front and rear main bearings;

3.4.3.5 sprocket and drive chain;

3.4.3.6 chain guard and housing;

3.4.3.7 influent port or channel, and valve;

3.4.3.8 influent tank;

3.4.3.9 bulkheads (for multiple stages on a single shaft);

3.4.3.10 staging channels;

3.4.3.11 shaft;

3.4.3.12 media;

3.4.3.13 stages; and

3.4.3.14 emergency manual rotation assembly, if applicable.

(SAC. 1, Figures 7.7 and 7.8, Table 7.1)

3.4.4 Operators must recognize, explain, and devise effective counter-measures for typical natural and mechanical hazards to the biological process at work in an RBC, including:

3.4.4.1 excessive influent soluble BOD loadings;

3.4.4.2 high influent hydrogen sulfide concentrations;

3.4.4.3 inadequate removal of settleable solids during preliminary or primary treatment;

3.4.4.4 toxic shock loads;

3.4.4.5 temporarily low dissolved oxygen in the RBC's first stage;

3.4.4.6 accidental polarity reversal of drive motors, causing reverse rotation of shafts (extremely hazardous when flow is perpendicular to shaft);

3.4.4.7 extended power outages, requiring manual rotation of shaft 1/4 turn every 4 hours and fine-mist spraying of the biomass;

3.4.4.8 excess biomass accumulation (based on manufacturer's recommendations), potentially leading to shaft failure; and

3.4.4.9 hydraulic overloads. *(SAC. 1, 7.121, 7.124, 7.13)*

3.4.5 Unless mechanically sealed, an RBC's main shaft and drive bearings must be lubricated according to manufacturer's specifications (or once per week). Operators must execute this task competently and maintain a log of lubrication history. *(SAC. 1, 7.2-7.232)*

3.4.6 Operators must measure and record RPM's of an RBC shaft on a weekly basis.

(SAC. 1, 7.120, 7.2, 7.21. Also, manufacturer's recommendations)

3.4.7 Operators must calculate total organic loadings in the RBC influent in lbs. per day. *(SAC. 1, 7.1, 7.5)*

3.4.8 Operators must monitor dissolved oxygen and pH of RBC influent and be able to chemically alter pH, if necessary, to maintain it in the 6.5 to 8.5 range for maximum carbonaceous reduction. *(SAC. 1, 7.121)*

3.4.9 Operators must be able to observe the RBC biomass and determine if its color, thickness, uniformity, extent of sloughing, and odor indicate normal operation. *(SAC. 1, 7.122)*

3.4.10 Operators must diagnose the following indicators of abnormal biological performance:

3.4.10.1 a black biomass (often accompanied by bad odors), indicating high solids or BOD overload;

3.4.10.2 a white biomass (often accompanied by white growth throughout the building), indicating excessive sulfur compounds are feeding a competing bacteria and adversely affecting BOD removal efficiency; and

3.4.10.3 a thin, spotty biomass, or an excessively "shaggy" one. Either may indicate too great a sloughing rate and the possible presence of toxic or inhibiting substances, or, possibly, too great a daily variation in organic and/or hydraulic loadings. *(SAC. 1, 7.122)*

3.4.11 Operators must plan and carry out an appropriate process control response to each of the operating problems listed above, correctly choosing one or more of the following remedies:

3.4.11.1 operation of additional RBC units, if possible;

3.4.11.2 aeration of the RBC basins;

3.4.11.3 modification of the staging;

3.4.11.4 elimination of toxic substances from the process stream;

3.4.11.5 dilution of influent strength through recirculation of secondary effluent;

3.4.11.6 in-line flow equalization; and

3.4.11.7 modification of recycle flow schedule (digester supernatant, filtrate, etc.) to reduce organic loading on RBC. *(SAC. 1, 7.121)*

3.4.12 Operators must carry out comprehensive visual inspections of an RBC unit on a daily basis, to:

3.4.12.1 detect oil spills or leaks, loose or missing guards, gross misalignment of the shaft, or incorrect chain sag (tension);

3.4.12.2 recognize the sound of bumping of the shaft, chirping and scraping or rasping of metal on metal; and

3.4.12.3 safely feel for unusual vibrations or heat build-up. *(SAC. 1, 7.120, 7.23)*

3.4.13 Operators must carry out a complete start-up inspection of all mechanical and electrical equipment associated with an RBC, and verify that all components have been "prepped" correctly for start-up.

3.4.13.1 Prior to start-up, operators must visually inspect an RBC basin, chain drive, pillow blocks, cover, and other key components for debris or obstructions.

3.4.13.2 Before an RBC unit is placed in service operators must check for correct direction of rotation, RPM's, normal heat build-up, minimum vibration levels, correct motor amperage, and proper shaft alignment.

3.4.13.3 Operators must demonstrate how to start the flow of influent into an RBC basin, open the effluent valve, and then re-start the unit, thus completing mechanical start-up. *(SAC. 1, 7.111)*

3.4.14 Operators must demonstrate how to protect biomass integrity during power outages or short-term mechanical shut-down of an RBC unit, causing the shaft to stop turning for more than a few hours, by:

3.4.14.1 manually rotating the drum or bio-disc shaft 1/4 turn every hour, blocking to prevent roll-back; and

3.4.14.2 frequently enough to prevent any drying, wetting down the unsubmerged portions of the biomass with a gentle, fine spray. *(SAC. 1, 7.13)*

3.4.15 For shut-down greater than 24 hours, the operator must perform the following shut-down procedures:

3.4.15.1 turn off and lock-out electrical equipment;

3.4.15.2 close inlet valve(s);

3.4.15.3 drain the basin and remove the biomass with high-pressure hosing; and

3.4.15.4 pump out the resultant sludge, returning it to the head of the plant or to the secondary clarifier. *(SAC. 1, 7.14)*

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 4
"ADVANCED WASTEWATER TREATMENT"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 4 Hours

Module Description: This module is the fourth in a series designed to assist WWTP operators to prepare for certification. Advanced treatment such as nitrification/denitrification, phosphorous removal and filtration are discussed.

Need-to-Know Criteria*: Granular Media Filtration (A) *(B&C)*
Nitrification/Denitrification (A)
Phosphorous (A)

Training Objectives: Specific skill statements are provided for each of the NTK criteria listed above on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
"CAPITAL" letters are primary knowledge
"lower case" letters are secondary knowledge
A = Explain Operational Concepts
B = Make Routine Adjustments
C = Recognize Performance Problems
D = Troubleshoot Operational Problems
E = Implement Corrective Action
F = Perform Routine Maintenance

Italicized entries were added during a review by Instructors of the Certification Training Program.

TEACHING OUTLINE FOR MODULE 4

Introduction to Advanced Treatment: Purpose, General Techniques — ½ hour

Granular Media (Sand) Filtration or GMF — 1½ hours

1.) function of GMF
2.) definitions of operational concepts
3.) identification of filter types
4.) key operational parameters—run length, head, etc.

Nitrification/Denitrification and Phosphorous Removal — 2 hours

1.) dangers to receiving streams of nutrients
2.) ammonia conversion, ammonia stripping
3.) origins of ammonia, nitrate, phosphates in wastewater
4.) overview of current removal practices: chemical addition (phosphorous), biological systems

RAPID SAND AND OTHER GRANULAR MEDIA FILTRATION

4.1.1 Operators must describe the function of filtration and indicate the typical location of a filter in a wastewater process stream. *(SAC. AWT., 4.20, 4.251, Figure 4.30)*

4.1.2 Operators must describe the purpose of the backwash cycle in filtration systems. *(SAC. AWT., 4.0)*

4.1.3 Operators must specifically define the following terms or phrases:

4.1.3.1 breakthrough,

4.1.3.2 head loss, and

4.1.3.3 run length. *(SAC. AWT., 4.23)*

4.1.4 Operators must describe the differences between downflow, upflow, and biflow filters; single and multimedia filters; and gravity and pressure filters. *(SAC. AWT., 4.240, 4.3)*

4.1.5 Operators must identify and describe the function of the following gravity filter components:

4.1.5.1 influent piping and valve;

4.1.5.2 washwater trough;

4.1.5.3 media;

4.1.5.4 support gravel;

4.1.5.5 underdrain system;

4.1.5.6 effluent piping and valve;

4.1.5.7 washwater piping and valve; and

4.1.5.8 drains. *(SAC. AWT., 4.26-4.269, Figures 4.27-4.29 and 4.31-4.32)*

4.1.6 Operators must describe how filter influent characteristics, flow rate, media characteristics, and available head together determine run length of a filter. *(SAC. AWT., 4.271, 4.28-4.29)*

NITRIFICATION/DENITRIFICATION AND PHOSPHOROUS REMOVAL

4.2.1 Operators must explain or illustrate how the discharge of nitrogen and phosphorus into receiving waters promotes excessive growth of algae and depletes oxygen.

(SAC. AWT., 6.0, Lesson 8, #10, and Figure 2.23)

4.2.2 Operators must explain the environmental significance of converting ammonia and organic nitrogen to nitrate, and then removing nitrate from the wastewater stream through denitrification. They should also be able to diagram the "nitrogen cycle".

(SAC. AWT., 6.01, 6.100-6.101, Figure 2.23)

4.2.3 Operators must explain in general terms the negative effects on receiving streams of phosphorous, and explain the typical origins of phosphorous in wastewater.

(SAC. AWT., 5.00 and Chapter 16, Lesson 8, #12)

4.2.4 Operators must describe in general terms the process by which lime or metallic salts, such as alum or ferric chloride, may be used to precipitate phosphorous out of waste streams.

(SAC. AWT., 5.11, 5.12)

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 5
"DISINFECTION & EFFLUENT DISPOSAL"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 6 Hours

Module Description: This module is the fifth in a series designed to assist WWTP operators to prepare for certification. Advanced treatment such as nutrient removal and filtration are discussed along with odor control.

Need-to-Know Criteria*: Disinfection (A,B,C,D)
Effluent Disposal & DMR Reporting/Record- Keeping (A)
Odor Control (A-F)

Training Objectives: Specific skill statements are provided for each of the NTK criteria listed above on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
"CAPITAL" letters are primary knowledge
"lower case" letters are secondary knowledge
A = Explain Operational Concepts
B = Make Routine Adjustments
C = Recognize Performance Problems
D = Troubleshoot Operational Problems
E = Implement Corrective Action
F = Perform Routine Maintenance

TRAINING OUTLINE FOR MODULE 5

Introduction to Disinfection — 1 hour

1.) reasons for disinfection
2.) what happens in disinfection
3.) main disinfectants in use

Chlorine Use — 2 hours

1.) defining "demand," "free available," "combined residual"
2.) identifying key components of chlorine systems
3.) chlorine hazards
4.) dangers of excess chlorine in receiving streams
5.) dechlorination

Effluent Sampling — 1 hour

1.) defining types of samples
2.) general purpose of each type sample
3.) sampling points
4.) typical sampling requirements

Effluent Disposal — 2 hours

1.) understanding and describing the quality and character of the receiving stream
2.) defining "self-monitoring"
3.) legal responsibility for accurate reporting

Odor Control — 2 hours

1.) origins of odors, how produced in plants
2.) qualitative and quantitative odor analysis
3.) specific problem locations (headworks, etc.)
4.) remedial actions
5.) public relations problems

DISINFECTION

5.1.1 Operators must define the term disinfection and identify the primary reasons for the disinfection of wastewater effluent. Operators should also identify diseases commonly caused by waterborne bacteria, viruses, and other microorganisms.

(SAC. 1, Words, 10.00, 10.01)

5.1.2 Operators must explain the basic factors which influence the success of chlorine and bromine disinfection, including temperature, time of contact, concentration of disinfectant, pH, and quality of effluent in terms of BOD and suspended solids. *(SAC. 1, 10.05)*

5.1.3 Operators must explain the reactions of chlorine with water, ammonia, and readily oxidizable substances, such as the cell structures of waterborne microorganisms.

(SAC. 1, 10.02-10.031)

5.1.4 Operators must define the terms free available chlorine and combined chlorine residual.

(SAC. 1, Words, 10.031)

5.1.5 Operators must: (a) describe the influence of adequate mixing on the overall chlorination process, (b) define chlorine demand, and (c) calculate required chlorine dosages when given chlorine demand and wastewater flow rates. Operators must also describe and perform the test for residual chlorine. *(SAC. 1, 10.02, 10.06)*

5.1.6 For chlorine feed systems, operators must identify typical components and describe how they function, including: *(SAC. 1, 10.23, 10.5)*

5.1.6.1 for chlorine containers (100 lb., 150 lb., one ton), identify gas outlet(s), liquid outlet(s), fusible plug, maximum gas and/or liquid withdrawal rate; and

(SAC. 1, 10.400-10.402)

5.1.6.2 for gas chlorinators, define and describe:

a. direct feed (or dry feed);
b. solution feed;
c. vacuum feed (including manual and automatic flow and residual feed control);
d. evaporator;
e. scales;
f. piping, valves, and connections; and
g. rotometer. *(SAC. 1, 10.22, 10.25)*

5.1.7 Operators must describe the hazards of chlorine and the appropriate responses for each major hazard, including:

5.1.7.1 high heat and/or moisture, and their influence on Cl_2 when released into the atmosphere;

5.1.7.2 improper connections and leaks;

5.1.7.3 improper storage of chlorine containers;

5.1.7.4 chlorine gas trapped in piping between closed valves; and

5.1.7.5 any chlorine leak emergency requiring the use of an S.C.B.A. and/or emergency leak repair kit. *(SAC. 1, 10.3-10.32)*

5.1.8 Operators must describe the adverse effects, such as toxicity to fish and other aquatic organisms, that excess chlorine has on receiving streams. *(SAC. 1, 10.80)*

5.1.9 Operators must describe the purpose of dechlorination and identify components of a typical sulphur dioxide dechlorination system. *(SAC. 1, 10.80, 10.83)*

5.1.10 Operators must describe the operation of a hypochlorite feed system, and calculate proper feed rates using liquid or powdered chlorine derivatives.

5.1.11 Operators must calculate the concentration of sulphur dioxide required for dechlorination of any concentration of chlorine residual.

EFFLUENT SAMPLING, DISPOSAL AND REPORTING

5.2.1 Operators must describe precisely the terms of the SPDES permits which govern discharges from their plants. Operators must express these limits both as concentrations (mg/l), and pounds per day (lbs./day) in terms of monthly, weekly, and daily averages.

(Details of the SPDES program must be consulted.)

5.2.2 Operators should describe the seasonal, physical, and biological characteristics of the receiving water into which their plant effluent is being discharged. Their description should include:

5.2.2.1 typical dissolved oxygen, pH, and temperature ranges for those waters; and

5.2.2.2 typical lower and higher orders of organisms found during different seasons, including flora, fish, and aquatic animals. *(SAC. 2,13.3)*

Wastewater analysis is required at all treatment facilities for monitoring plant performance, thereby providing direction for process control activities, and for reporting to New York State under the SPDES system. Specific analyses and frequency of testing are plant specific and depend upon individual unit processes.

5.2.3 All operators must properly sample for the following common wastewater parameters:

5.2.3.1 dissolved oxygen (D.O.);

5.2.3.2 pH; and

5.2.3.3 chlorine residual.

5.2.4 For each specific unit process or State reporting requirement, operators must be able to identify preferred sampling points and any special precautions which should be taken with such sampling. Also, operators must be able to define grab, composite, and flow proportioned composite samples.

5.2.5 Operators must properly obtain "grab samples" and "composite samples." In addition, operators must list each sampling point in their plant, the type and nature of the sample to be drawn at each point and, for composite samples, the required interval which samples must represent. *(SAC. 2, 13.11, 13.4)*

5.2.6 Operators must define the term self-monitoring, and describe the general process by which the quality of final effluent is reported to appropriate State and Federal authorities.
(See SPDES regulations 6NYCRR Parts 701 and 702)

5.2.7 Operators must distinguish between those wastewater samples which require immediate analysis, and those which may be stored, specifying any significant preservation procedures or requirements for those in storage.

5.2.8 Operators must be able to specify the types of sampling and lab test records which, by law or regulation, must be kept in good order for review by regulatory staff or for use in preparing reports.

5.2.9 Operators must define and illustrate chain of custody, and describe how it must control the handling of samples from the moment they are taken to completion of analysis.

5.2.10 Operators must explain their responsibility under law for the correct operation of a plant, and for reporting accurately and truthfully information requested or required by regulatory agencies. *(See SPDES regulations 6NYCRR Parts 701 and 702.)*

5.2.11 Operators must be able to specify the duration for which each set of plant operating records must be kept, under law. *(See SPDES regulations 6NYCRR Parts 701 and 702.)*

5.2.12 Operators must properly complete, and know where to submit, Monthly Operating Reports, Discharge Monitoring Reports, and Notification of Non-Compliance Reports.
(See SPDES regulations 6NYCRR Parts 701 and 702.)

5.2.13 Operators must describe how to contact the regulatory agency and/or specific plant inspector responsible for SPDES monitoring of their facility.

(See SPDES regulations 6NYCRR Parts 701 and 702.)

5.2.14 Operators of spray irrigation equipment must describe evapotranspiration and its application to the spray irrigation process. *(SAC. 2, 8.60)*

5.2.15 Operators of spray irrigation systems must specify the application limits per acre per month established by the State for their facilities, and explain the general terms of logic by which these limits were derived. *(See State regulations.)*

5.2.16 Operators of other ground water or sub-surface disposal systems must demonstrate full understanding of New York State ground water protection laws and their specific sub-surface or irrigation discharge permits, especially with respect to application rates, ground water monitoring requirements and other site specific conditions.

(See State regulations; also SAC. AWT Table 8.12, 8.6)

ODOR CONTROL

5.3.1 Operators must describe typical origins for the most common odor producing gases found in or around wastewater collection and pumping systems and wastewater treatment plants, including:

5.3.1.1 ammonia,

5.3.1.2 hydrogen sulfide,

5.3.1.3 organic and organic decay odors, and

5.3.1.4 mercaptans. *(SAC. AWT., 1.1)*

5.3.2 Operators must be able to describe in general terms the anaerobic biological activities which metabolize organic material, sulfur compounds, and nitrogenous waste to produce odors.

(SAC. AWT., 1.11)

5.3.3 Operators must be able to explain the difference between qualitative testing and analytical testing of odors. *(SAC. AWT., 1.2)*

5.3.4 Operators must be able to describe the specific origins of odors in individual unit processes of wastewater treatment plants, including:

5.3.4.1 headworks;

5.3.4.2 preliminary treatment, particularly screening and grit collection;

5.3.4.3 primary clarifiers;

5.3.4.4 trickling filters, RBCs, ABFs

5.3.4.5 activated sludge aeration systems;

5.3.4.6 lagoons;

5.3.4.7 secondary clarifiers; and

5.3.4.8 sludge treatment processes, especially lime stabilization. *(SAC. AWT., 1.4)*

5.3.5 Operators must control odors generated at each of the unit processes listed above by:

5.3.5.1 maintaining clean headworks structure walls and channels, through regular water scouring of slime and sludge accumulations, and by enclosing headworks structures if normal control mechanisms are inadequate;

5.3.5.2 prompt grit and screenings removal, and thorough cleaning of all screens open to the air in preliminary treatment systems;

5.3.5.3 maintaining appropriate sludge withdrawal rates from primary clarifiers, and increasing the frequency of settled solids scraping on the bottoms of the clarifier; also, by applying oxidizing chemicals or polymers to the settling zone of clarifiers;

5.3.5.4 by maintaining an adequate supply of air to the biological film in trickling filters and RBCs, as well as assuring even distribution of raw wastewater over the film area, so that no portion of the area is threatened with dry-out;

5.3.5.5 by preventing the organic overload of lagoons;

5.3.5.6 by maintaining adequate sludge removal rates in secondary clarifiers, and by adequately maintaining and cleaning scum removal systems; and

5.3.5.7 by carefully cleaning and maintaining all sludge piping, pumping, and treatment systems. *(SAC. AWT., 1.48, Table 1.5)*

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 6
"SOLIDS MANAGEMENT"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 8 Hours

Module Description: This module is the sixth in a series designed to assist WWTP operators to prepare for certification. This course covers the collection, thickening, digestion, dewatering and disposal of the solids in a wastewater treatment plant. Various options, advantages and disadvantages of each, factors affecting daily operation, and basic process math are included.

Need-to-Know Criteria*: Sludge Thickening (A)
Aerobic Digestion (A)
Anaerobic Digestion (A,B,C)
Mechanical Sludge Dewatering (A,B,C,D)
Sludge Stabilization (A,B,C,D)
Final Disposal (A)

Training Objectives: Specific skill statements are provided for each of the NTK criteria listed above on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
"CAPITAL" letters are primary knowledge
"lower case" letters are secondary knowledge
A = Explain Operational Concepts
B = Make Routine Adjustments
C = Recognize Performance Problems
D = Troubleshoot Operational Problems
E = Implement Corrective Action
F = Perform Routine Maintenance

Italicized entries were added during a review by Instructors of the Certification Training Program.

TRAINING OUTLINE FOR MODULE 6

Sludge Thickening — 1 hour

1.) reasons for thickening
2.) gravity thickening
3.) dissolved air flotation
4.) variables which influence thickening

Aerobic Digestion — 1 hour

1.) defining the process, and differentiating it from anaerobic digestion
2.) defining key concepts (respiration, volatile solids, detention time, etc.)
3.) identifying main conditions for successful aerobic digestion

Anaerobic Digestion — 3 hours

1.) defining the process
2.) defining "stabilization"
3.) significance of loading rates, detention time, volatile solids content, etc.
4.) process control testing
5.) identifying symptoms of abnormal operation
6.) anaerobic digester safety

Mechanical Sludge Dewatering — 1½ hours

1.) defining, in terms of increasing solids to water ratio
2.) importance of pre-conditioning
3.) description and general operating principles of main types of sludge dewatering equipment (vacuum filters, belt filter presses, etc.)
4.) role of polymers

Drying Beds and Final Disposal — 1½ hours

1.) structure of drying beds
2.) performance limiting factors
3.) role of polymers
4.) alternatives for disposal
5.) legal constraints on disposal

SLUDGE THICKENING

6.1.1 Operators must explain in general terms the basic physical principles involved in gravity and flotation thickening of sludge, as well as the basic reasons for thickening sludge. In addition, operators should specify which type of thickening is most applicable for (a) primary sludge and (b) RBC and trickling filter sludge.

(SAC. AWT.,3.00)

6.1.2 For gravity thickening, operators must diagram flow patterns into and out of a typical thickening unit, and label major components including:

6.1.2.1 inlet distribution assembly;

6.1.2.2 rake or collector mechanism;

6.1.2.3 pickets;

6.1.2.4 scum removal mechanism; and

6.1.2.5 sludge withdrawal hopper and piping.

. *(SAC. AWT., 3.11, Figure 3.2)*

6.1.3 For flotation thickening, operators must diagram flow into and out of a typical flotation unit, and label major components including:

6.1.3.1 sludge inlet and distribution box;

6.1.3.2 top and bottom sludge collectors;

6.1.3.3 effluent weir and baffle;

6.1.3.4 effluent recycle piping including recycle pump, retention tank (including reaeration pump if so equipped, air system rotameter, liquid level indicator, and control), pressure control valve; and

6.1.3.5 chemical feed piping. *(SAC. AWT.,3.12, Figure 3.3)*

6.1.4 Operators must list and discuss the significance of variables which influence the operation of sludge thickeners including:

6.1.4.1 type of sludge;

6.1.4.2 age and temperature of sludge;

6.1.4.3 sludge blanket depth;

6.1.4.4 solids and hydraulic loading;

6.1.4.5 chemical conditioning;

6.1.4.6 for gravity conditioning, solids and hydraulic detention time; and

6.1.4.7 for flotation thickening, recycle rate and air/ solids ratio. *(SAC. AWT., p. 136)*

AEROBIC DIGESTION

6.2.1 Operators must describe in general terms the aerobic digestion process, and clearly distinguish anaerobic and aerobic digestion. *(SAC. 2, 3.22)*

6.2.2 Operators must define endogenous respiration, volatile solids, supernatant, aeration and detention time.

(SAC. 2, 3.220)

6.2.3 Operators must outline the main conditions for effective aerobic digestion, including adequate air supply, in cubic feet per minute per 1000 lbs. of sludge, aeration tank digester volume, supernatant draw-off schedule, and digested sludge removal schedule.

(SAC. 2, 3.221)

ANAEROBIC DIGESTION

6.3.1 Operators must describe in general terms the anaerobic digestion process, and specifically:

6.3.1.1 explain the meaning of volatility of sludge, the purpose of sludge digestion, and the anticipated reduction of volatile solids;

6.3.1.2 describe briefly the two major groups of organisms, namely the acid formers and the methane formers, at work in anaerobic digesters; and

6.3.1.3 define sludge stabilization as it is accomplished within an anaerobic digester.

(SAC. 2, 12.0, 12.00, 12.01)

6.3.2 Operators must define digester loading (lbs. volatile solids/cubic foot of digester sludge) and detention time. *(SAC. 2, 12.3(k))*

6.3.3 Operators must explain the significance of different digester operating temperatures, and must define psychrophilic, mesophilic, and thermophilic operation. *(SAC. 2, 12.01, 12.3)*

6.3.4 Operators must describe importance of maintaining proper mixing, temperature, and feed rates in order to maintain the balance between acid formation and methane fermentation.
(SAC. 2, 12.3)

6.3.5 Operators must differentiate between the functions of primary and secondary anaerobic digesters and identify the biological and physical activities occurring within each.
(SAC. 2, 12.01, 12.27)

6.3.6 Operators must perform process control testing on operating anaerobic digesters, specify acceptable ranges of performance, and recommend procedures to correct for the following abnormalities:

6.3.6.1 severe drop or rise in internal temperatures;

6.3.6.2 unbalanced volatile acids to alkalinity ratio;

6.3.6.3 poor digester gas composition (excess carbon dioxide, inadequate methane production), and/or low quantity;

6.3.6.4 low pH; and

6.3.6.5 poor solids reduction (i.e., inadequate percentage volatile solids reduction).
(SAC. 2, 12.3, 12.45)

6.3.7 Operators must be able to outline procedures for recovering a "sour" digester, including neutralizing the acids with a caustic material such as soda ash, lime, or ammonia, or by transferring alkalinity in the form of digested sludge from a secondary digester.
(SAC. 2, 12.23)

6.3.8 Operators must outline a complete set of safety procedures for working in and around anaerobic digesters. In particular, operators must explain the function of all gas control devices in a digester, and outline a safe shut-down procedure to be used for digesters prior to preventive or corrective maintenance or clean-out. *(SAC. 2, 12.12, 12.163)*

MECHANICAL SLUDGE DEWATERING

6.4.1 Operators must describe sludge dewatering as a volume reduction process, explain why sludge conditioning normally precedes dewatering, and specify the location of dewatering within a typical solids handling system. *(SAC. 2, 12.7; SAC. AWT., 3.4)*

6.4.2 Operators must describe the operating principles of vacuum filters, belt filter presses, and centrifuges, and describe typical feed sludge and anticipated sludge cake characteristics for each. *(SAC. AWT., 3.411, 3.412, 3.42)*

6.4.3 For vacuum filters, operators must describe how vacuum is used as the driving force to accomplish filtration.

6.4.4 Operators must describe what occurs in each of the following stages of processing by a belt filter press:

6.4.4.1 conditioning;

6.4.4.2 gravity drainage;

6.4.4.3 low pressure squeeze (wedge zone);

6.4.4.4 high pressure squeeze (pressure or shear zone); and

6.4.4.5 cake release. *(SAC. AWT., 3.4110-3.4114)*

DRYING BEDS AND FINAL DISPOSAL TECHNIQUES

6.5.1 Operators must describe the structure of typical sand drying beds, in particular describing:

6.5.1.1 typical sand depth,

6.5.1.2 the underdrain system, and

6.5.1.3 the depth of a typical sludge pour.

(SAC. AWT., 3.43)

6.5.2 Operators must list the principal limiting factors which affect the performance of sand drying beds, including:

6.5.2.1 sludge type and solids content;

6.5.2.2 degree of conditioning;

6.5.2.3 climate, and whether beds are roofed over;

6.5.2.4 application rates; and

6.5.2.5 sludge cake removal schedule. *(SAC. AWT., 3.430)*

6.5.3 Operators must describe in general terms the role of polymers (polyelectrolytes) in freeing water molecules from liquid sludge, in order to promote more rapid drying.
(SAC. AWT., 3.430)

6.5.4 Operators must outline the range of alternatives for the ultimate disposal of stabilized sewage sludge, including:

6.5.4.1 land application, either as thickened liquid or as cake, for soil conditioning;

6.5.4.2 incineration;

6.5.4.3 land fill disposal;

6.5.4.4 to permanent sludge lagoons. *(SAC. AWT., 3.61)*

6.5.5 Operators must list the key legal constraints regulating the final disposal of stabilized sewage sludge, including State regulations regarding:

6.5.5.1 agricultural reclamation and other agricultural uses;

6.5.5.2 landfill leachate monitoring;

6.5.5.3 air quality standards for incinerators; and

6.5.5.4 sludge storage and transportation. *(SAC. AWT., 3.60)*

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 7
"EQUIPMENT & SUPPORT SYSTEMS"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 8 Hours

Module Description: This module is the seventh in a series designed to assist WWTP operators to prepare for certification. Training subjects include basic hydraulics and flow measurement; types of equipment (theory of operation, application and recognition of normal and abnormal operating conditions); and preventative maintenance programs (electrical, mechanical and instrumentation).

Need-to-Know Criteria*: Pumps *& Blowers* (A-F)
Valves (A-F)
Hydraulic & Flow Measurement Equipment (Basic) (A,B,C,D,E,F)
Data Recording & Monitoring Equipment (A,C)
Meters (A,C)
Alarm Systems (A,C)
Control Systems (A,C)

Training Objectives: Specific skill statements are provided for each of the NTK criteria listed above on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
"CAPITAL" letters are primary knowledge
"lower case" letters are secondary knowledge
A = Explain Operational Concepts
B = Make Routine Adjustments
C = Recognize Performance Problems
D = Troubleshoot Operational Problems
E = Implement Corrective Action
F = Perform Routine Maintenance

Italicized entries were added during a review by Instructors of the Certification Training Program.

TRAINING OUTLINE FOR MODULE 7

Pumps and Blowers — 4 hours

1.) defining types and their uses
2.) identifying key parts of pumps
3.) how they actually work
4.) key concepts—cavitation, weepage, etc.
5.) pump efficiency testing, pump curves
6.) lock-out, tag-out
7.) repacking, mechanical seals
8.) associated valving requirements

Valves — 1 hour

1.) functions of valves
2.) safety with positive displacement pumps
3.) corrosion control, lubrication
4.) special applications—e.g. check valves

Hydraulic and Flow Measurement Equipment — 1 hour

1.) using Parshall flumes
2.) examples of other metering/measuring equipment
3.) calibration
4.) logging results

Data Recording and Monitoring Equipment — 1 hour

1.) purposes, types
2.) interpreting scales
3.) logging data

Meters, Alarm Systems and Controls — 1 hour

1.) purposes, types
2.) regular calibration
3.) interpreting scales, alarms
4.) testing alarm systems regularly
5.) design concepts of automated control systems

PUMPS AND BLOWERS

7.1.1 Operators must identify on sight and define the unique features of each of the following types of pumps: centrifugal, turbine, rotary, diaphragm, piston, plunger, screw, progressive cavity, airlift, ejector, and dry chemical metering pumps. *(SAC. 2, 15.00-15.116)*

7.1.2 For both centrifugal and rotary positive displacement pumps, operators must define the function of each of the following: packing lantern ring, packing gland, zerk fitting, thrust bearing, stabilizer bearing (whether "roller", "ball", or "sleeve"), and shaft.
(SAC. 2, 15.110, 5.115)

7.1.3 For centrifugal pumps only, operators must define the function of each of the following: impeller (open, semi-open, and closed), volute, inlet, discharge, seal, and wear plate rings.
(SAC. 2, 15.110)

7.1.4 For positive displacement pumps only, operators must define the functions of the check valve, stroke adjustment knob, surge suppressor, auto-lubrication mechanism, and packing.
(SAC. 2, 15.113, 15.115)

7.1.5 Operators must define the following terms: cavitation, pump curve, lock-out, and weepage.

7.1.6 For centrifugal pumps, operators must carry out all of the pump efficiency tests specified or recommended by the manufacturer or supplier. In addition, operators should establish a consistent schedule for efficiency testing of all centrifugal pumps and record results in the plant's maintenance log book. *(Pump efficiency testing is not covered in SAC.)*

7.1.7 Operators must prime any pump installed in a suction lift condition.
(Priming of pumps is not covered in SAC.)

7.1.8 Operators must diagram a possible alternate flow pattern which could be implemented prior to shutting down any pump. If no alternatives exist, operators must implement a contingency plan for directing flows while the pump is inoperative. *(Plant specific; not covered in SAC.)*

7.1.9 Operators must hydraulically and electrically "lock-out" any pumps in their plants.
(SAC. 2, 14.190)

7.1.10 For all pumps containing packing material, operators must replace packing and must diagnose the need for new packing by observing the rate of weepage and the remaining adjustment potential of the packing gland. *(SAC. 2, 15.799)*

7.1.11 For centrifugal pumps, operators must disassemble a pump to the extent necessary to replace mechanical seals or impellers. They should also remove a shaft for bearing or shaft sleeve replacement by manufacturer's maintenance representatives.
(SAC. 2, 15.121, 15.110, 15.71, 15.73)

7.1.12 Operators must make a comprehensive visual inspection prior to re-start of repaired pumping equipment to verify that check-valves and isolation valves are operable and/or allowing flow in the correct direction, all cut-off valves are open, electrical wiring is complete and secured, and equipment is grounded. *(SAC. 2, 15.190, 15.191)*

7.1.13 Operators must contact manufacturer's representatives or locate other technical assistance for help in maintaining any pump which they are not able to service adequately.

(Equipment specific)

7.1.14 Operators must drain and flush any pump in their facilities in which septicity is likely if proper cleaning is not carried out promptly after the pump is removed from service.

(SAC. 2, 15.14)

NOTE: Because blowers and compressors are similar to pumps in construction and operation, all of the skills listed here are more or less equally applicable to those pieces of equipment. For compressors and blowers, operators must also perform the following: clean and maintain or replace air intake filters; locate and maintain pressure relief valves and pressure switches; and identify and maintain support equipment such as moisture traps, air dryers, and regulators.

VALVES

Includes check valves, plug valves, gate valves, and sluice gate valves.

7.2.1 Operators must identify and describe the four typical applications of valves: flow control, directional control, pressure control, and isolation. *(SAC. 2, 15.13, 15.190, 15.191)*

7.2.2 Operators must explain why valves located on the discharge side of positive displacement pumps must be open before start-up. Operators must also explain why no valves should be closed until a positive displacement pump has been shut down, come to rest, and been locked out. *(SAC. 2, 15.113, 15.191)*

7.2.3 Operators must outline complete corrosion control, lubrication, and exercise program (for lock-up prevention) for valves. *(SAC. 2, 15 (Lesson 4 OF 7)*

7.2.4 For all valves with packing glands, operators must prevent leakage without excessively binding the valve stem. *(SAC. 2, 15 (Lesson 4 of 7)*

7.2.5 For gate valves and other manually adjustable flow control valves, operators must identify the full open point, full closed point, normal operating point, and proper throttling technique, if appropriate. *(Equipment specific)*

7.2.6 Operators must disassemble check valves in order to replace hinge pins, flappers, or slats.

(SAC. 2, 15.57)

HYDRAULIC AND FLOW MEASUREMENT EQUIPMENT

Hydraulic measurement equipment includes structural devices such as proportional and rectangular weirs and Parshall flumes, as well as mechanically active devices (with or without electrical sensing), such as Venturi flow meters, sonic flow meters, propeller meters, magnetic flow meters, and parabolic nozzles.

7.3.1 In order to use Parshall flumes successfully, operators must identify the "converging section," "throat," "diverging section," "upstream head," and "downstream head." Additionally, operators must determine if a flume is in a "full flow" condition or if it is partially submerged, and adjust flow readings accordingly. *(SAC. 2, 15.90-15.93)*

7.3.2 Operators must explain the importance of maintaining unrestricted hydraulic flow above, in, and below a flume. *(SAC. 2, 15.93)*

7.3.3 In order for operators to be certain that a weir is providing accurate flow data, they must define, locate, and describe the significance of the following: head behind weir, weir crest, and nappe (the overflowing sheet of water). *(Not specifically described in SAC.)*

7.3.4 Given relevant hydraulic data and flume or weir flow tables, operators must accurately measure flow through a flume or weir. *(Not specifically described in SAC.)*

7.3.5 If the flume or weir utilizes a floating or staff gauge, operators must maintain and calibrate that device. *(Not specifically described in SAC.)*

7.3.6 For mechanically active measurement devices, operators must demonstrate each specific calibration technique required to ensure that reliable data is being produced. In addition, operators must locate and interpret manufacturers' literature on maintenance and calibration of all mechanically active measurement devices in their plants.

(Plant specific; see also SAC. 2,15.98)

7.3.7 Operators must maintain flow logs. The log system must be so designed as to make immediately obvious data from mechanically active measurement devices which are unusual or well outside of expected values. *(SAC. 2, 19.1-19.110*

7.3.8 Operators must identify footing hazards of flume and weir structures and demonstrate the use of all appropriate safety devices, including toe guards, safety belts, footgear, and life rings.

(SAC. 2, 14.21-14.221

7.3.9 For all passive flow measurement devices, operators must outline appropriate maintenance programs, such as algae removal, leakage prevention, and grease removal.

(SAC. 2, 15.93, 15.95)

DATA RECORDING AND MONITORING EQUIPMENT

Data recording equipment includes volume counters, monitors, totalizers, recorders, and combination recorders.

7.4.1 Operators must recognize and describe the purpose of common data recording devices found in typical wastewater treatment plants. *(SAC. 2, 15.94-15.943)*

7.4.2 Operators must verify through manual calculations the accuracy of counters and flow recording devices. *(SAC. 2, 15.98)*

7.4.3 Operators must read and interpret the scales used in all common recording devices. *(SAC. 2, 15.98)*

7.4.4 Operators must establish and maintain accurate data logs for recording any operating data deemed necessary for adequate control of flow or unit processes. *(SAC. 2, 15.90, 15.120, 19.10, 19.2)*

7.4.5 For recorders, operators must remove and replace the material on which data is recorded (i.e., magnetic tape, paper charts, paper tape, etc.). *(SAC. 2, 15.96)*

METERS

Includes pressure gauges, rotometers, electrical meters (such as ammeters, watt/hour meters, multitesters, "MEGGER"), tachometers, thermometers, "wet" test equipment (such as pH, Cl_2, and D.O. meters), and safety test equipment (such as explosimeters).

7.5.1 Operators must identify the units of measurement used on any scale or gauge. *(Not specifically covered in SAC.)*

7.5.2 Operators must explain the necessity of regularly calibrating the following metering equipment:

7.5.2.1 D.O. meters,

7.5.2.2 pH meters,

7.5.2.3 Cl_2 residual meters,

7.5.2.4 atmosphere measuring devices, and

7.5.2.5 V.O.M.'s (for resistance readings in ohms). *(SAC. 2, 15.98 and SOP)*

7.5.3 Working from schematic plans of their facilities, operators must pinpoint the location of each permanently installed gauge or meter in their plants. In addition to locating each meter or gauge, operators must describe the purpose of the equipment monitored by each of those meters or gauges. *(Plant specific, refer to blueprints, schematics, or SOP)*

7.5.4 Operators must specify an expected value range (reading) under normal operating conditions for each permanently installed meter or gauge in their facilities.

(Plant specific, refer to blueprints, schematics, or SOP)

ALARM SYSTEMS

Alarm systems include high water, low water, and other level monitoring devices, boiler and other pressure alarm systems, fire and smoke alarm systems, mechanical and electrical malfunction alarm systems, chlorine leak detection systems, and permanently installed methane or H_2S detection systems.

7.6.1 For each alarm system in their facilities, operators must specify purpose, location of sensor, signal sending unit, signal receiving unit, and all modes of the alarm signal (sonic, visual, electronic, or telemetric). In addition, operators must demonstrate reset procedures.

(Plant specific, but see SAC. AWT., 9.20, 9.26, 9.313)

7.6.2 For any alarm system which is activated in a facility, operators must respond by identifying the specific cause triggering the alarm and then solving the problem or identifying and contacting those who can. *(Plant specific, but see SAC. AWT., 9.313, 9.371)*

7.6.3 Operators must diagram the reporting chain or network through which to communicate the need for emergency response procedures when an alarm system indicates an abnormal condition with which an operator himself cannot be expected to cope (e.g., fire, major chemical spill, or dangerous atmosphere). (*Plant specific, but see SAC. AWT., 9.370, 9.371)*

7.6.4 Operators must test alarm systems under non-emergency conditions, and develop and implement a schedule of performance tests which will ensure proper operational status at all times. *(Plant specific, but see SAC. AWT., 9.371)*

7.6.5 In the event of suspected malfunctions, operators must contact by telephone the manufacturer or manufacturer's representative able to service any emergency alarm system in their facility.

(Plant specific)

CONTROL SYSTEMS

7.7.1 Operators must describe the general design principles utilized in each major type of control system, including pneumatic, float, hydraulic, electrical, and timing systems.
(SAC. 2, 9.030, 9.20-9.26, 9.30)

7.7.2 Operators must establish and maintain the parameters within which their control systems operate, or have sufficient access to manufacturers' literature or technical representatives to be able to easily establish such parameters. For example, operators must demonstrate when to raise a low water float switch in a lift station in order to protect pumps from ingesting floating debris. *(Plant specific or refer to SOP)*

7.7.3 Operators must remove from operation every control system in their facilities for inspection and maintenance, perform all normally scheduled preventive maintenance tasks and then reactivate the control system. Additionally, operators must accurately log completed preventive maintenance on control systems. *(Plant specific or refer to SOP)*

7.7.4 Operators must have knowledge of appropriate clothing, equipment, and hazard avoidance techniques for preventing injury from electrical shock, poor footing, fire, or asphyxiation while maintaining or servicing control systems, particularly those installed in confined spaces. *(SAC. 2, 9.10-9.16)*

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 8
"MONITORING & REGULATORY REQUIREMENTS"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 4 Hours

Module Description: This module is the eighth in a series designed to assist WWTP operators to prepare for certification. Training subjects include legal requirements and regulations which govern effluent quality and disposal. SPDES permits and related sampling (handling and analysis), records and reporting requirements are also discussed.

Need-to-Know Criteria*: Effluent Disposal, DMR Reporting/Record-Keeping (A-F)
SPDES Sampling, Lab Techniques & Interpretation (A-F)
Legal Responsibilities & Reporting Requirements (A-F)
Storm Water Regulations & Compliance (A)
Industrial Pretreatment (A)

Training Objectives: Specific skill statements are provided for each of the NTK criteria listed above on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
"CAPITAL" letters are primary knowledge
"lower case" letters are secondary knowledge
A = Explain Operational Concepts
B = Make Routine Adjustments
C = Recognize Performance Problems
D = Troubleshoot Operational Problems
E = Implement Corrective Action
F = Perform Routine Maintenance

TRAINING OUTLINE FOR MODULE 8

Legal Responsibilities and Liability — 2 hours

1.) Clean Water Act
2.) the SPDES system
3.) calculations for Discharge Monitoring Reports (DMR)
4.) prompt communicating of violations
5.) description of criminal liability for falsification of data, careless operation, etc.
6.) protection of public from plant hazards
7.) toxicity prevention

Reporting — 1½ hours

1.) DMRs, and Monthly Operating Reports (MORs)
2.) importance of timely communication
3.) sludge production reports

Industrial Pretreatment — ½ hour

1.) overview of purposes
2.) description of potential impact of toxic industrial waste on plant

MONITORING AND REPORTING REQUIREMENTS

8.1.1 Operators must describe in general terms the Clean Water Act and its various amendments, and explain clearly the following:

8.1.1.1 how the authority for SPDES enforcement is vested in states, through primacy;

(SAC. 1, 2.6)

8.1.1.2 how discharge reports required by the SPDES program in New York are calculated (in both concentrations and pounds), made out, and to whom or what agency they are sent, on what schedule; and

(Refer to NYSDEC "DMR Manual", 2002 or SPDES Permit)

8.1.1.3 how severe violations are to be communicated to regulatory bodies.

(Refer to 6NYCRR Part 750-2.7 or SPDES Permit)

8.1.2 Operators must describe their potential criminal liability for deliberate and/or repeated violations of the Clean Water Act, especially with reference to:

8.1.2.1 falsification of operating or discharge data;

8.1.2.2 careless operating procedures;

8.1.2.3 sewage spills, particularly where a threat to public health;

8.1.2.4 poor sludge management resulting in sludge releases. *(Refer to 6NYCRR Part 750-2.4)*

8.1.3 Operators must list their responsibilities to protect the public from mechanical, electrical, or pathogenic hazards around or originating in the treatment plant.

(SAC. 2, 13.0)

8.1.4 Operators must describe the role of wastewater treatment plants, and pretreatment facilities, in the control of toxic chemicals and the prevention of their release into the environment, and specifically define the following terms:

8.1.4.1 priority pollutant;

8.1.4.2 bioassay;

8.1.4.3 Toxics Reduction Evaluation; and

8.1.4.4 pretreatment of industrial waste. *(Refer to 6NYCRR Part 750-1.2(a), 1.7(b), and 2.9(b))*

8.1.5 Operators should describe in general terms the laws of the State of New York regarding the storage and disposal of sewage sludge, especially as they relate to:

8.1.5.1 land application;

8.1.5.2 stabilization through composting;

8.1.5.3 incineration; and

8.1.5.4 disposal at sea. *(Refer to 6NYCRR part 360)*

8.1.6 Operators must describe in precise terms how local and State regulatory bodies are to be contacted in the case of a sewage spill or other severe violation of an environmental standard not specifically listed in a plant's SPDES permit. *(Refer to 6NYCRR Part 750-2.7)*

INDUSTRIAL PRETREATMENT

8.2.1 Municipal operators who inspect industrial pretreatment facilities must have a general understanding of:

8.2.1.1 the specific terminology by which industrial discharges are normally characterized;

8.2.1.2 concentration standards set by local pretreatment ordinances;

8.2.1.3 sampling techniques; and

8.2.1.4 potential impacts on POTW's of excessive or over-concentrated industrial waste discharge. *(See Pretreatment Facility Inspection, SAC.)*

NYSDEC Wastewater Certification Training Series:

B A S I C O P E R A T I O N S

MODULE 9
"MANAGEMENT & SUPERVISION"

Target Audience: Entry Level Operations/Maintenance Staff

Module Length: 6 Hours

Module Description: This module is the ninth in a series designed to assist WWTP operators to prepare for certification. Management and supervisory skills which relate to the daily operation of a WWTP are covered. Discussions include planning, budgeting and program organization (maintenance, health & safety, public education and training), and process management techniques such as graphing to apply laboratory results to process control.

Need-to-Know Criteria*: Management & Supervision Issues (planning, budgeting, etc.) (A,C,D,E)
Health & Safety Programs (A-F)
Training Programs (safety & technical) (A-F)
Public Relations & Pubic Education (A)
Energy Conservation (A)
Pollution Prevention for POTW's (A,C)

Training Objectives: Specific skill statements are provided for each of the NTK criteria listed above on the following pages. Skill statements should be handed out to the training participants and serve as a guide for developing training evaluations.

*KEY: **"Bold"** entries require full range of knowledge (A-F)
"CAPITAL" letters are primary knowledge
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TRAINING OUTLINE FOR MODULE 9

Supervision — 1 hour

1.) planning functions
2.) staff/work organizing
3.) establishing chain-of-command
4.) emergency reporting chain-of-command
5.) shift organizing
6.) staff evaluation

Health and Safety Programs — 1½ hours

1.) job safety analysis, hazard identification
2.) preparing Standard Operating Procedures (SOP) for hazardous jobs
3.) planning proactive safety training
4.) worker, community right-to-know; Material Safety Data Sheets (MSDS)

Operator Training — 1½ hours

1.) designing in-house training—listing the needs
2.) planning training rationally
3.) evaluating training

Public Relations — 1 hour

1.) planning for crisis
2.) pubic information campaigns
3.) organizing tours, newsletters
4.) involvement with the schools, science fairs, etc.

Energy Conservation and Pollution Prevention — 1 hour

1.) tracking energy usage—methods
2.) ECM's—defining and listing
3.) priority setting
4.) methods of pollution prevention

MANAGEMENT AND SUPERVISORY ISSUES

9.1.1 Operators must define and give a brief example of each important planning function which must be carried out by the leadership of a WWTP including:

9.1.1.1 capital improvement planning;

9.1.1.2 safety and emergency response planning;

9.1.1.3 preventative maintenance planning;

9.1.1.4 personnel and staff development planning;

9.1.1.5 public relations planning; and

9.1.1.6 abnormal operations planning. *(SAC. MFS 1.3, 8.3, 9.6, 11.0, 12.0, 13.2)*

9.1.2 Operators must briefly illustrate a staff organization plan providing for:

9.1.2.1 a clear chain-of-command from management to supervisory staff to line staff with provision for supervision of contract staff;

9.1.2.2 reporting chains for both normal and emergency situations;

9.1.2.3 shift organization and scheduling; and

9.1.2.4 apprenticeship and other training programs.

9.1.3 Operators must briefly outline a systematic and progressive staff evaluation design. *(SAC. MFS 1.4, 1.5, 1.33, 11.5)*

HEALTH AND SAFETY PROGRAMS

9.2.1 Operators must prepare a job safety analysis and then develop standard operating procedures for each hazardous job duty at the treatment plant, by:

9.2.1.1 appropriately identifying hazardous tasks or jobs;

9.2.1.2 analyzing the job and identifying each of its steps, in order;

9.2.1.3 identifying specific hazards associated with each step; and

9.2.1.4 preventing potential accidents by eliminating or reducing hazards.

(SAC. 2,14.0-14.203

9.2.2 Operators must prepare written SOP's for work tasks which involve any of the following:

9.2.2.1 confined space entry;

9.2.2.2 electrical maintenance or repair;

9.2.2.3 chlorine and SO_2 handling;

9.2.2.4 chemical handling;

9.2.2.5 excavation or trenching;

9.2.2.6 working in and around isolated or hazardous walkways;

9.2.2.7 heavy lifting;

9.2.2.8 isolating pressurized lines; and

9.2.2.9 working in oxygen deficient, flammable or toxic atmospheres. *(SAC. 2, 14.1 and 14.8)*

9.2.3 Operators must outline a safety training program for staff which addresses the following elements:

9.2.3.1 accident investigation, reporting and recordkeeping;

9.2.3.2 fire prevention;

9.2.3.3 power and pressurized liquid lock-out and tag-out;

9.2.3.4. use of protective clothing and gear, including SCBAs;

9.2.3.5 safe tool use;

9.2.3.6 avoidance of hazards;

9.2.3.7 first aid and CPR;

9.2.3.8 employee hygiene;

9.2.3.9 chemical handling and storage, and use of MSDS sheets; and

9.2.3.10 housekeeping. *(SAC. 2, 14.19, 14.4, and 14.8)*

9.2.4 Operators should explain in broad terms the intent of Title III of *SARA* (Emergency Planning and Community Right-to-Know Act), and list the substances stored and used at their plants which are classified as hazardous material. In addition, operators must be able to:

9.2.4.1 describe the emergency planning and response activities which have been developed for those chemicals;

9.2.4.2 state the functions of and proper location for all MSDS sheets which have been prepared for those substances; and

9.2.4.3 state how they communicate with their local emergency planning committee (LEPC). *(SAC. 2, 14.9 and SAC. MFS 11.6)*

9.2.5 Operators must list the pathogenic risks to wastewater workers from viruses, bacteria, parasites, and other microorganisms typically found in waste streams and aerosols around treatment plants. *(SAC. 2, 14.21-14.235)*

TRAINING PROGRAMS

9.3.1 Operators must design and implement in-house training programs for fellow staff, including:

9.3.1.1 apprenticeship programs;

9.3.1.2 safety training;

9.3.1.3 on-the-job training;

9.3.1.4 certification exam review training; and

9.3.1.5 start-up training for new equipment.

9.3.2 In order to participate in training design, operators must:

9.3.2.1 perform job and task analysis;

9.3.2.2 isolate the essential skills for each task;

9.3.2.3 create learning objectives for each skill;

9.3.2.4 design or acquire curriculum for each learning objective; and

9.3.2.5 create training agendas, and schedule training.

9.3.3 Operators participating as trainers must document the results of their training, by:

9.3.3.1 carrying out formal and informal evaluations of training;

9.3.3.2 keeping files in which are recorded training results of each trainee; and

9.3.3.3 assuring that training results are placed in each employee's personnel file in a timely fashion.

PUBLIC RELATIONS AND PUBLIC EDUCATION

9.4.1 Operators must demonstrate an understanding of methods for managing relations with both the public and the media, by:

9.4.1.1 listing procedures for dealing with the public during a plant or collection system crisis, such as a sewage spill;

9.4.1.2 outlining a media access, information release strategy for radio, TV, and newspapers;

9.4.1.3 designing a regular (non-crisis) public information campaign, via newsletters, radio and TV, etc. stressing the benefits of clean water, the specific accomplishments of the plant, and any new technologies to be implemented;

9.4.1.4 designing plant tours for the public, schools and other groups; and

9.4.1.5 participating in science fairs and other educational efforts in the community.

ENERGY CONSERVATION

The reference for this section is New York State Energy Research and Development Authority's (NYSERDA) Focus on Municipal Water and Wastewater Facility Energy Efficiency Basic Operator Training Presentation. References to the slides in this presentation will be identified as "NYSERDA Slide x". A copy of the presentation is included with the Basic Operations Course Curricula plus copies of additional energy efficiency materials that are to be provided to each attendee.

9.5.1 Operators must identify simple energy conservation measures (ECMs), so as to either reduce the amount of energy consumed at the WWTP or reduce the price paid for energy.

9.5.1.1 operators must describe the formula (tariff) used by their local power company to bill for electrical energy; *(NYSERDA Slides 11-22)*

9.5.1.2 operators must set be able to identify the components of a wastewater treatment plant and collection system that influence electricity use.. . . . *(NYSERDA Slides 30-37)*

9.5.1.3 operators will be able to outline the four steps to develop an energy efficiency plan *(NYSERDA Slides 38-54)*

9.5.1.3.1 operators must understand where energy is used in the treatment plant and ways to monitor energy use. *(NYSERDA Slides 40-41)*

9.5.1.3.2 operators understand methods to track energy use within their treatment system *(NYSERDA Slides 42-44)*

9.5.1.3.3 operators are able to identify opportunities for energy efficiency. *(NYSERDA Slides 45-49)*

9.5.1.3.4 operators understand what items must be considered when prioritizing the implementation of energy efficiency opportunities. *(NYSERDA Slide 50-51)*

9.5.2 Operators must demonstrate all safety procedures required when making the measurements needed to determine electrical power demand (and power factor) or equipment, including:

9.5.2.1 use of insulated tool handles;

9.5.2.2 removal of jewelry;

9.5.2.3 use of rubber mats;

9.5.2.4 use of rubber gloves;

9.5.2.5 avoidance of self-grounding;

9.5.2.6 use of two-person team for measurements;

9.5.2.7 prohibition of metal ladders or tape measures; and

9.5.2.8 use only of qualified and authorized personnel.

MUNICIPAL WWTP POLLUTION PREVENTION

9.6.1 Operators should list the key methods by which municipal WWTP's may avoid contributing unnecessarily to society's waste stream. Methods include:

9.6.1.1 energy conservation—electrical power, heat, fuel, etc.;

9.6.1.2 recycling of waste energy sources, such as methane from digesters into heat production, used oil, etc.;

9.6.1.3 adequate sizing of all components, to avoid spills, washouts, etc.; and

9.6.1.4 public education regarding disposal of hazardous wastes to the domestic waste stream.