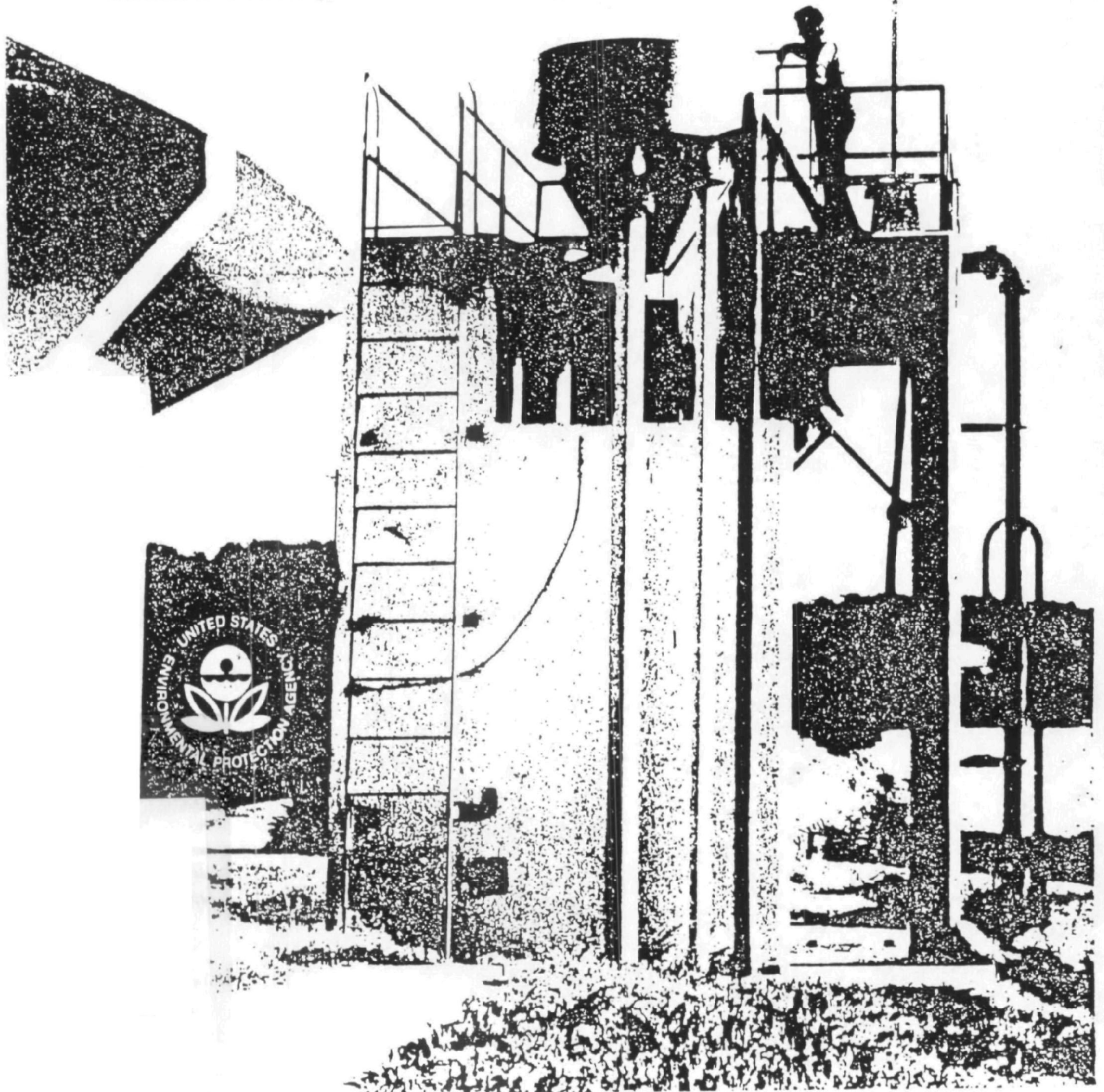


Volume II  
PART E

# Plant Operations for Wastewater Facilities

Wastewater Technology: A Two-Year Post High School Instructional Program





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*PLANT OPERATIONS FOR WASTEWATER FACILITIES, Part E*

*Flow Measurement  
Pumping and Piping  
Electric Power  
Gas Power*

*An Instructor's Guide for Use of Instructional Material  
In Wastewater Technology Training Programs*

*Funded by*

*US ENVIRONMENTAL PROTECTION AGENCY  
Municipal Permits & Operations Division  
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*Awarded to*

*CHARLES COUNTY COMMUNITY COLLEGE  
La Plata, Maryland*

*GREENVILLE TECHNICAL COLLEGE  
Greenville, South Carolina*

*LINN-BENTON COMMUNITY COLLEGE  
Albany, Oregon*

*ENVIRONMENTAL SYSTEMS ENGINEERING  
Clemson University  
Clemson, South Carolina*

*September 1975*



# For Information

## *ON FUNDING OF INSTRUCTIONAL PROGRAMS*

*Academic Training Section  
Water Quality Control Manpower Training Branch  
Municipal Permits & Operations Division  
US Environmental Protection Agency  
Washington, DC 20460  
703-557-7335*

## *ON PROJECT ADMINISTRATION AND CURRICULA DEVELOPMENT*

*John H. Austin, Professor and Head  
Environmental Systems Engineering  
Clemson University  
Clemson, South Carolina 29631  
803-656-3276*

## *ON PROGRAM IMPLEMENTATION*

*Carl Schwing  
Charles County Community College  
La Plata, Maryland 20646  
301-934-2251*

*James L. Chocklett  
Greenville Technical College  
Greenville, South Carolina 29606  
803-242-3170*

*Peter C. Scott  
Linn-Benton Community College  
Albany, Oregon 97321  
503-928-2361*



## Preface

Since 1970 Charles County Community College, Clemson University, Greenville Technical College and Linn-Benton Community College have been working together to prepare undergraduate students to enter occupations in water and wastewater treatment plant operations and maintenance. Through their efforts a two-year wastewater technology instructional program based on performance objectives has been developed and implemented.

Through a grant from the Environmental Protection Agency called *Criteria for the Establishment of Two-Year Post High School Wastewater Technology Programs (CEWT)* the four colleges set up program criteria and curriculum guidelines which are available in two volumes:

*Program Implementation Procedures*

*Volume II: Curriculum Guidelines, Criteria for Establishment and Maintenance of Two-Year Post High School Wastewater Technology Programs*

As a result of the implementation of the instructional program at Charles County Community College, Greenville Technical College and Linn-Benton Community College, six guides for instructors based on the course descriptions in *Plant Implementation Procedures* and the general criterion behaviors of *Volume II* have been prepared. *Plant Operations for Wastewater Facilities*, printed in five parts, is the second in the series which includes:

- Volume I Introduction to Environmental Technology*
- Volume II Plant Operations for Wastewater Facilities*
- Volume III Laboratory Control for Wastewater Facilities*
- Volume IV Management and Supervision Procedures for Wastewater Facilities*
- Volume V Process Interaction for Wastewater Facilities*
- Volume VI Advanced Waste Treatment*

### ACKNOWLEDGEMENTS

Since the beginning of the project many persons at the four cooperating institutions, as well as outside consultants have participated in the development of this program. Their efforts which have provided source material for this guide have been acknowledged in the volumes to which they made major contributions. *Plant Operations for Wastewater Facilities* has been written and produced by:

Technical Staff

K. C. Stoakes, Instructor, Environmental Technology Department, Linn-Benton Community College



John F. Wooley, Instructor, Environmental Technology Department, Linn-Benton Community College  
John W. Carnegie, Chairman of Environmental Technology, Linn-Benton Community College  
Fred L. Delvecchio, Director of Operator Training, Environmental Systems Engineering, Clemson University  
John H. Austin, Professor and Head, Environmental Systems Engineering, Clemson University

#### Editorial and Production Staff

Ada Louise Steirer, Freelance Editor, Clemson, South Carolina  
Marie N. Sims, Project Secretary, Environmental Systems Engineering, Clemson University  
Charlotte Holmes, Typing Services, Clemson, South Carolina  
Jan Willis, Editorial Assistant, Environmental Systems Engineering, Clemson University  
Eleanor McLasky, Typist, Environmental Systems Engineering, Clemson University  
Roma Norton, Typist, Environmental Systems Engineering, Clemson University  
Linda Flagg, Proofreader, Environmental Systems Engineering, Clemson University



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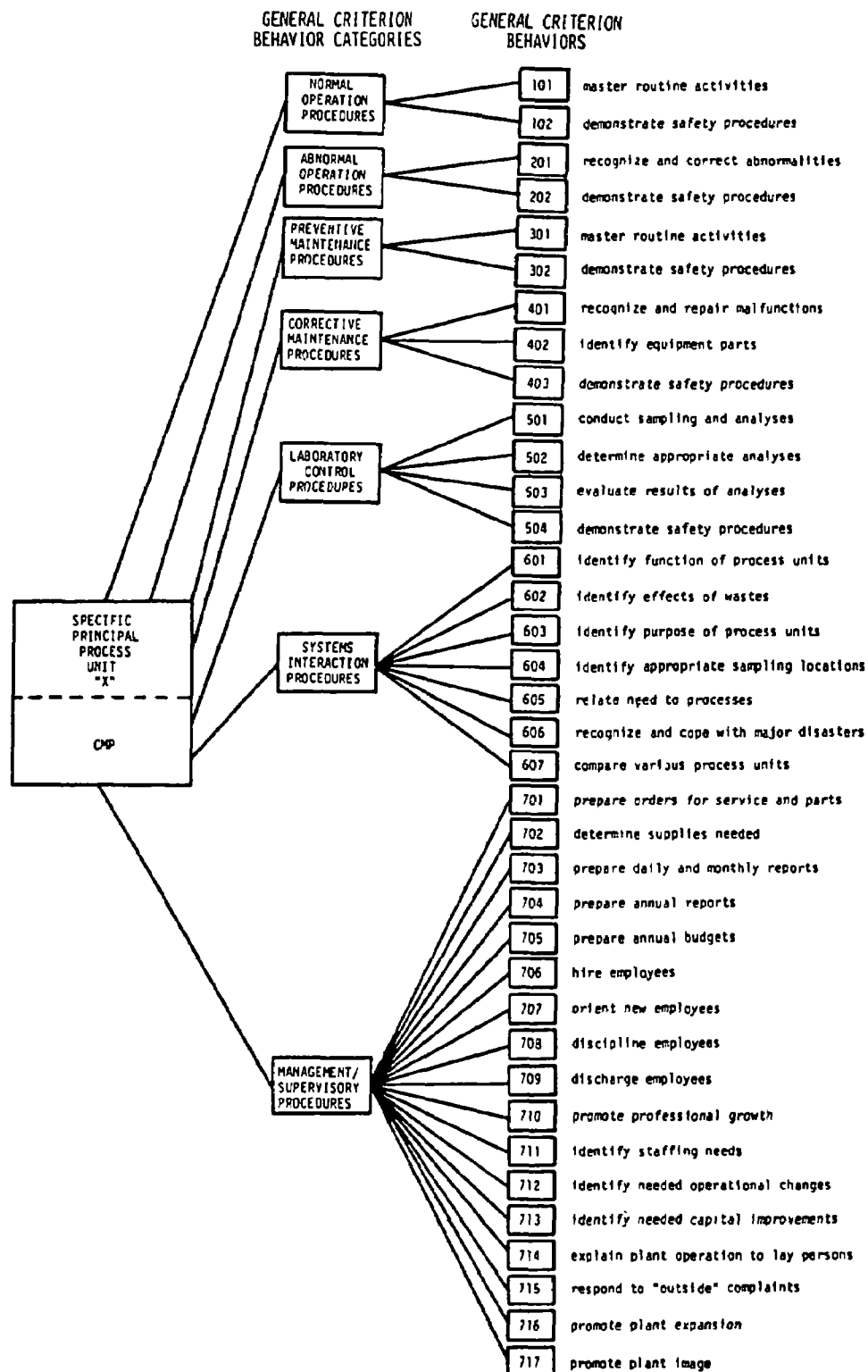


Figure 1: Relationship of general criterion behaviors (performance objectives) to the general categories and composite model plant (CMP).

## Performance Objectives

When the treatment plant operators, educators, consultants and representatives from professional water pollution control organizations came together to develop an effective instructional program, they recommended the use of performance or behavioral objectives because such objectives clearly outline:

1. What the student is expected to do as a result of the instructional program.
2. The conditions under which the student shall do it.
3. The standard of performance.

### COMPOSITE MODEL PLANT

First, they developed a composite model plant (CMP) of twenty-two process units which is really many wastewater treatment plants in one model. Such a mix of process units seldom occurs in a treatment plant, but if a student becomes competent in the operation and management of the CMP he should be able to perform successfully in any treatment plant.

### TASK ANALYSIS

Next, to ensure that the materials were specifically tailored to what the operator does on the job, a task analysis was conducted. They found that the tasks which an operator performs fell into seven general categories which were further divided into 37 tasks or general behaviors. (See figure 1, page vi.) The tasks were organized under:

1. Normal Operation Procedures. These include routine operating activities that do not vary significantly from day to day and that are designed to keep the plant functioning within a normal range of values. For example, the employee conducts routine samplings of the primary sludge and inspects pumping equipment and the wastestream to verify that the process is functioning properly.

2. Abnormal Operation Procedures. These include activities of the plant employee that result from unusual and undesirable conditions of the wastestream. The abnormal procedures enable the plant employee to recognize when the wastestream is abnormal and to return it to an acceptable, normal condition. An abnormal wastestream results when a normal operation procedure is not properly applied, a corrective maintenance procedure is needed or management/supervisory procedures are poor. For example, the plant employee should recognize that a black septic primary sludge sample is an abnormal condition of the wastestream and take appropriate action.

3. Preventive Maintenance Procedures. These include routine maintenance activities of the plant employee which prevent major equipment breakdown and subsequent corrective maintenance. For example, the employee would lubricate bearings and other moving parts, replace worn components and adjust components of the primary sludge pumps.





4. Corrective Maintenance Procedures. These include maintenance activities of the plant employee that usually result from the breakdown or malfunction of a unit of equipment or a component. For example, the employee would notice whether the primary sludge pump is malfunctioning and know when and how to correct the disorder or when and how to refer the problem to plant maintenance personnel.

5. Laboratory Control Procedures. These include special and routine activities relating to laboratory analysis, the specification of sampling procedures and locations and the general management of the laboratory facilities. For example, the employee would collect primary sludge samples and conduct the analyses.

6. Systems Interaction Procedures. These include activities of the plant employee which relate the functioning of specific units of equipment to other process units and to the system as a whole. For example, the employee would determine how the effective functioning of the primary sludge pumps relates to digester performance.

7. Management/Supervisory Procedures. These include activities relating to employment practices, record keeping, plant operation policy and the establishment of a constructive and realistic rapport between the plant and the community it serves. For example, the employee would keep records on primary sludge pumping, keep an inventory of spare parts and evaluate the adequacy of maintenance procedures by shift personnel.

## CURRICULUM DESIGN

After deciding what process equipment an operator must operate and maintain, and finding out what an operator does through

the task analysis, they listed the objectives a student must master to successfully operate a treatment plant. For example, the student will describe and perform the normal inspection procedure for the primary sedimentation unit including frequency of inspection, conditions to look for and the actions he should take.

## INSTRUCTOR'S GUIDES

The next step was the design of manuals to guide the instructor. In the guides varied learning activities and imaginative innovations which produce more learning than traditional teaching methods are emphasized. The instructional suggestions do not need to be followed slavishly, but should be modified and improved as much as possible.

The instructor's goal is to achieve the objectives of the curriculum by selecting activities which suit the student's needs and help him to master all the information and skills in the course. The most effective learning occurs when the student is a participant in the learning process, not a spectator.

An instructor should use learning activities which approximate the situations which the student will meet *in the treatment plant*. If it is not possible to teach in a treatment plant, *simulated situations* should be set up in the workshop or classroom so that the student can solve rather than discuss problems. *Group discussion* stimulated by *visual materials* is an effective learning technique. *Lecture*, however, is inefficient. Because the student is not actively involved during a lecture, the instructor should use lectures sparingly.

## Introduction to Modules of Instruction

In this instructor's guide the topics and ideas are presented as a series of modules, organized around the general objectives stated in the course descriptions for Plant Operation I, II, III and IV and the In-Plant Practicum which are found in the *Program Implementation Procedures* of the CEWT Program. Each module is designed to help the instructor plan a course of study for the operation of a treatment process using the CMP process unit. Each module is organized around sixteen objectives common to all processes.

The modules in *Plant Operations for Wastewater Facilities* are arranged in the order in which the CMP process units occur in the treatment plant. Each process is identified by a letter of the alphabet and the process unit is described in the heading of the module. If the instructor uses the modules in consecutive order, he and his students will follow the treatment of the wastestream from collection to its discharge into the receiving waters. Each module is designed so it can be used as a minicourse in a treatment process. Instructors are urged to group the modules to suit their individual curriculum needs and instructional situations.

Material in the modules can easily be adapted for courses which upgrade the training of operators in normal operation procedures, abnormal operation procedures, preventive maintenance procedures or corrective maintenance procedures by grouping the appropriate objectives from all the modules. For example, an instructor could develop a course

in corrective maintenance by grouping objectives 11 and 12 from each module.

### INSTRUCTIONAL PROCESS UNITS

Each module assumes that the composite model plant unit will be used for instruction in the process. If the recommended unit is not available, an alternate process unit may be substituted and the instructional materials adapted. The recommended CMP units and alternate units for all the processes are listed in table 1, page 4. Two modules on sludge dewatering are included because it is impossible for a student to master operation of this process by learning to operate one process unit. Remember, however, that a student will be more adequately prepared to work in almost any treatment plant if he is trained on the CMP unit. When it is not possible to use the recommended unit, students should be informed about the operation and function of the unit and hands-on training should be conducted on the best alternate unit available.

### PURPOSE OF THE MODULES

The modules in *Plant Operations for Wastewater Facilities* help the student to learn how to operate all the process units in the wastewater treatment plant. Normal operation, abnormal operation, preventive maintenance and corrective maintenance procedures are included. When the course is completed, he will know why each unit is

TABLE I

SPECIFIC PROCESS UNITS RECOMMENDED FOR USE IN IMPLEMENTATION OF THE TWO-YEAR  
POST HIGH SCHOOL WASTEWATER TECHNOLOGY INSTRUCTIONAL PROGRAM

Module	Process	CMP Unit	Recommended Teaching Unit	Alternate Teaching Unit
1	Collection	A	Combined system with industrial waste	Sanitary system with industrial waste
2	Chlorination	B	Vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator	Vacuum chlorinator with automatic feed to pipe, electrical control and electric evaporator
		N	Vacuum chlorinator with automatic feed to pipe and closed-loop pneumatic control	Vacuum chlorinator with automatic feed to pipe and closed electrical control
3	Screening and Grinding	C	Mechanically cleaned bubbler control unit with grinder	Mechanically cleaned electrode control unit with grinder
4	Grit Removal	D	Aerated unit with bucket elevator	Aerated unit with screw conveyor
5	Primary Sedimentation	E	Rectangular unit with telescopic valve drawoff, density meter time clock and trough with scraper	Circular unit with telescopic valve drawoff, density meter time clock and trough with scraper
6	Trickling Filtration	F	Rotary distributor, standard rate unit with dosing tank	Rotary distributor, high rate unit
7	Aeration	G	Diffused air unit with swing-type diffuser producing fine bubbles	Mechanical aeration unit with turbine and sparger
8	Secondary Sedimentation	H	Circular, peripheral-feed unit with suction	Circular, center-feed unit with suction
9	Pond Stabilization	I	Aerobic pond	Facultative pond
10	Thickening	J	Floatation unit with air	Floatation unit with vacuum
11	First Stage Digestion	K	Fixed cover, gas recirculation unit with external heat exchanger	Floating cover, gas recirculation unit with external heat exchanger



12	Second Stage Digestion	L	Floating cover unit with gas storage	Fixed cover unit
13	Sludge Conditioning	M	Chemical conditioning unit with counter-current elutriation	None
14a	Sludge Dewatering	O	Vacuum filter unit with cloth	Vacuum filter unit with coil
14b	Sludge Dewatering	O	Continuous feed centrifuge	None
15	Solids Disposal	P	Multiple hearth incinerator unit	Fluidized bed incinerator unit
16	Effluent Disposal	Q	Direct reuse system	Underground disposal system
17	Flow Measurement	R	Centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter	None
18	Pumping and Piping	S	System with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping	None
19	Electric Power	T	System using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms.	System using Y transformers, generators, electrical switchgear, automatic circuit actuators on motors and telemetering with alarms
20	Gas Power	U	System with internally produced gas with high pressure tanks and rotary positive displacement compressors	System with internally produced gas with high pressure tanks and reciprocating compressors



important to the treatment plant and how it affects and interacts with other process units in the treatment system.

#### STUDENT PREREQUISITES

Completion of Introduction to Environmental Technology and courses in basic mathematics and biology qualify the student to enter the course in Unit Operations for Wastewater Facilities. Concurrent courses in basic chemistry and laboratory control are suggested. (See pages 7 to 19 of *Program Implementation Procedures*.)

#### TERMINAL OBJECTIVE

When the student has completed the modules of instruction in this course, he should be able to do the following for each of the processes in the treatment plant:

1. Identify the process unit.
2. Describe the process unit in technical and nontechnical terms.
3. Describe the safety procedures for the process unit and explain how the procedures protect employees and visitors.
4. Identify the components of the process unit. Explain the purpose of each component, how the component works and why it is important.
5. Describe the normal operation procedures for the process unit components.
6. Perform the normal operation procedures for the process unit.
7. Describe and perform the start-up and shut-down procedures for the process unit.
8. Describe the abnormal operation procedures for the process unit.

9. Describe the preventive maintenance procedures for the process unit.

10. Perform the preventive maintenance procedures for the process unit.

11. Describe the corrective maintenance procedures for the process unit components.

12. Perform the corrective maintenance procedures for the process unit components.

13. Perform the safety procedures for the process unit and demonstrate how they protect employees and visitors.

14. Compare other process units to the composite model plant unit.

15. Name and locate the components of the process unit. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

16. Perform the abnormal operation procedures for the process unit.

#### RESOURCES

The listing of instructional resources suggests materials now available to instructors to accomplish the desired performance in the student.

Instructional materials 1 to 1866 are keyed to the reference, *Instructional Materials Available* which is available from:

Office of Water Program Operations  
US Environmental Protection Agency  
Washington, DC 20460

Two companion volumes to *Instructional Materials Available*, also available from EPA, offer suggestions for selecting audio-visual equipment:

*Selecting Audio-Visual Equipment*  
*Selecting Instructional Media and Instructional Systems*

The following journals list addresses of companies from whom literature about the process units which they manufacture can be obtained:

"Environmental Science and Technology"  
1155 Sixteenth Street, N.W.  
Washington, DC 20036

"Water and Sewage Works"  
434 South Wabash  
Chicago, IL 60605

"Water and Wastes Engineering"  
666 Fifth Avenue  
New York, NY 10019

If suitable materials are not available, instructors are urged to develop their own resources.

#### FORMAT OF THE MODULES

The module begins with a statement of purpose which explains what the student will be studying. Next, all the objectives of the module and code numbers keyed to a computerized list of instructional resources are listed for the instructor's convenience.

Objectives. Each module includes sixteen objectives which bring the student to the performance level required by the terminal objective. The knowledge and skills demanded of the student become more complex as he progresses through the sixteen objectives in a module. He begins by identifying components and learning facts about the components and processes. He uses

these facts to develop concepts and ideas. Finally, he relates the concepts and ideas to each other so that he can make decisions about plant procedures.

A glossary of verbs which follows this introduction defines the verbs used in the objectives so that the instructor is aware of what he is instructing the student to do and so that his evaluation of the student is based solely on what is stated in the objective.

Conditions. The conditions define the circumstances under which the student performs and is evaluated and lists the information, equipment and assistance to which the student will have access. The best available learning and testing conditions should be used. A process unit in a treatment plant or workshop has more impact on the students than photographs and drawings. For example, if the student is to be given a process unit, unit components, photographs or diagrams of a unit, the instructor should provide a process unit. If a process unit is not available, he would use components of the unit in combination with photographs of those components which he does not have available. Line drawings and diagrams should not be used if photographs and manufacturers' illustrations are available.

Acceptable Performance. The acceptable performance expands the objective and details the steps a student must follow to reach the objective. To move on to the next objective, at least 70% of each step or category must be mastered with no repeated errors between modules. For example, no student can complete the course of study if he consistently fails to give attention to moving parts as he



performs safety procedures or to describe the odor as he evaluates the characteristics of the wastestream. In this section the instructor will find the main topics of his lesson plan and for the evaluation of the student's performance.

Instructor Activity. The instructor should get to know his class by working with small groups and with each student. He should encourage students to learn from each other as they work together. He should involve the student in the instructional and learning process. Instructional activities are paired numerically with student activities.

Student Activity. This is a listing of activities which the student will take part in, in order to accomplish the specified performance.

#### EVALUATION TECHNIQUE

The instructor may use or adapt the learning activities listed under instructor activity and student activity as evaluation techniques. The technique chosen should reflect what the objective asks the student to do. For example, if a student is asked to *describe*, the evaluation technique is a *description*. The student should be evaluated under the conditions and to the performance level required for each objective.

## Glossary of Verbs

The glossary of verbs is included here so that the instructor will know exactly what the student is being asked to do to meet his objective. Notice the difference, for example, between the meanings of *identify* and *name*. When a student is asked to identify, the instructor is providing the name of the thing to be identified. But, when the student must name something, he must supply the name.

The list includes all the verbs from the objectives and the acceptable performance sections of all the modules, as well as some verbs used in the instructor and student activities.

	DEFINITION	APPLICATION
APPLY	To make use of as suitable, fitting or relevant.	Apply the preventive maintenance schedule for the second stage digestion unit.
CHECK	To inspect and ascertain the condition of, especially in order to determine that the condition is satisfactory.	Check the characteristics of each component.
COMMENT ON	To express an opinion or attitude about what has been seen or heard.	Comment on employee safety procedures.
COMPARE	To examine the character or qualities of, especially for the purpose of discovering resemblances or differences.	Compare other aeration units to the diffused air unit with swing-type diffuser producing fine bubbles.
CONSIDER	To give thought to with a view to purchasing, accepting or adopting.	Consider availability of replacement parts, capital costs, ease of repair, efficiency, maintenance costs, and so forth.
CORRECT	To alter or adjust to bring to some standard or required condition.	Correct the malfunction.
DEMONSTRATE	To illustrate or explain in an orderly and detailed way with many examples, specimens and particulars.	Demonstrate the start-up procedures in a treatment plant.





	DEFINITION	APPLICATION
DESCRIBE	To represent by words written or spoken for the knowledge or understanding of others, to transmit an image of the identifying features, the nature and characteristics of objects, events and actions.	Describe the safety procedures for the screening and grinding unit.
DEVELOP	To produce or generate.	Develop a picture file of first stage digestion units.
DISCUSS	To talk about, to present in detail, to exchange views or information about.	Discuss treatment plant case histories.
EVALUATE	To examine and make a judgement about quality, significance, amount, degree or condition of.	Evaluate the wastestream for abnormal conditions.
EXPLAIN	To make plain or clear, to present in detail.	Explain the purpose of each component, how the component works and why it is important.
IDENTIFY	To establish the identity of, pick out or single out an object in response to its name by pointing, picking up, underlining, marking or other responses.	Identify the components of the chlorination unit.
INDICATE	To state or express without going into detail.	Indicate whether the process unit is used for secondary sedimentation.
INSPECT	To view closely and critically, to determine quality or state, to detect errors or otherwise appraise.	Inspect a treatment plant.
LIST	To enumerate or specify.	List routine calculations for the pond stabilization unit.
LOCATE	To stipulate the position of an object in relation to other objects.	Locate the components of the trickling filtration unit.



	DEFINITION	APPLICATION
NAME	To supply the correct name, in oral or written form, for an object, class of objects, persons, places, conditions or events which are pointed out or described.	Name the components of the primary sedimentation unit.
OBSERVE	To pay careful, directed, analytical attention to.	Observe the thickening process during a plant tour.
PERFORM	To carry out an action or pattern of behavior. (Implies an act for which a process or pattern of movement has already been established, especially one calling for skill or precision, or for the assignment or assumption of responsibility.)	Perform the normal operation procedures for the grit removal unit.
POINT OUT	To indicate the position or direction of, especially by extending a finger toward the thing so indicated, to direct someone's attention to.	Point out characteristics which distinguish the first stage digestion unit from other units.
RECOMMEND	To mention or introduce as being worthy of acceptance, use or trial, to advise.	Recommend procedures to correct the unsafe conditions.
SELECT	To choose something from a number or group usually by fitness, excellence, or other distinguishing feature.	Select the reference materials and tools needed to perform the corrective maintenance.

## MODULE 17

### FLOW MEASUREMENT

*A centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter*

*Composite Model Plant Unit R*

**PURPOSE:** *In this module the student will learn to perform all the activities in the objectives as they apply to a centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

- OBJECTIVES:**
- 17.1 *Identify the flow measurement unit.*
  - 17.2 *Describe the flow measurement process in technical and non-technical terms.*
  - 17.3 *Describe the safety procedures for the flow measurement unit and explain how the procedures protect employees and visitors.*
  - 17.4 *Identify the components of a flow measurement unit. Explain the purpose of each component, how the component works and why it is important.*
  - 17.5 *Describe the normal operation procedures for the flow measurement unit components listed on page 17.*
  - 17.6 *Perform the normal operation procedures for the flow measurement unit.*
  - 17.7 *Describe and perform the start-up and shut-down procedures for the flow measurement unit.*
  - 17.8 *The abnormal operation procedures do not apply to composite model plant unit R.*
  - 17.9 *Describe the preventive maintenance procedures for the flow measurement unit.*
  - 17.10 *Perform the preventive maintenance procedures for the flow measurement unit.*
  - 17.11 *Describe the corrective maintenance procedures for the flow measurement unit components listed on page 17.*
  - 17.12 *Perform the corrective maintenance procedures for the flow measurement unit components.*
  - 17.13 *Perform the safety procedures for the flow measurement unit and demonstrate how they protect employees and visitors.*
  - 17.14 *Compare other flow measurement units to the centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter.*
  - 17.15 *Name and locate the components of the flow measurement unit*



*listed on page 17. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

17.16 *The abnormal operation procedures do not apply to composite model plant unit R.*

RESOURCES:	3	116	120	125	141	143	144	215	216	217	218
	307	308	309	316	317	320	321	324	421	459	511
	551	552	553	554	937	990	1033	1034	1399		

<<<<<<>>>>>>>>

OBJECTIVE 17.1: *Identify the flow measurement unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:  
Indicate whether the process unit is used for flow measurement.

INSTRUCTOR ACTIVITY: 1. Point out characteristics which distinguish the flow measurement unit from other process units.

STUDENT ACTIVITY: 1. Develop a picture file of flow measurement units.  
Mark distinguishing characteristics.

<<<<<<>>>>>>>>

OBJECTIVE 17.2: *Describe the flow measurement process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the flow measurement unit.

ACCEPTABLE PERFORMANCE: The student will:  
Describe the flow measurement unit, explaining the meaning of the metering system.  
Describe the purpose of flow measurement.

Describe how flow measurement affects:

- collection
- prechlorination
- screening and grinding
- grit removal
- primary sedimentation
- trickling filtration
- aeration
- secondary sedimentation
- pond stabilization
- thickening
- first stage digestion
- second stage digestion
- sludge conditioning
- post-chlorination
- sludge dewatering
- solids disposal
- effluent disposal
- pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe flow measurement.
2. Describe the flow measurement process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the flow measurement process while viewing photographs, diagrams and slides.
2. Observe and describe the flow measurement process during a plant tour.

<<<<<<>>>>>>>

OBJECTIVE 17.3:

*Describe the safety procedures for the flow measurement unit and explain how the procedures protect employees and visitors.*

CONDITIONS:

Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE:

The student will:

Describe the safety procedures for the flow measurement unit, commenting on:

- High-risk activities
- removing debris from channels



working with switches in automatic position

Sources of danger

acid wastes

caustic wastes

deep wells

electrical equipment

explosive gases

moving parts

open doors and covers

pits

poorly ventilated or open pits

slippery walks

toxic gases

Safety equipment

first-aid kit

lockout tags and keys

protective clothing

railings

stair safety treads

Explain how the procedures protect employees and visitors.

#### INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

#### STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the flow measurement unit.
4. Identify sources of danger and high-risk activities pictured in slides.

<<<<<<>>>>>>>

#### OBJECTIVE 17.4:

*Identify the components of a flow measurement unit. Explain the purpose of each component, how the component works and why it is important.*

**CONDITIONS:**

Given a flow measurement unit, unit components or a diagram, model or photographs of a unit and a list of components.

**ACCEPTABLE PERFORMANCE:**

The student will:

Identify components of the flow measurement unit and associated equipment:

- chart
- electrical-hydraulic transmission system
- fire-fighting equipment
- first-aid kit
- magnetic flowmeter
  - flow indicator
  - flow recorder
  - transmitter
- mechanical-hydraulic transmission system
- Parshall flume
  - float
  - float switch
  - flow indicator
  - stilling well
  - transmitter
- pen
- pneumatic transmission system
- rotameter
- signal converter
- totalizer
- Venturi meter
  - flow indicator
  - flushing pump
  - plunger
  - sight glass

Explain the purpose of each component, how the component works and why it is important.

**INSTRUCTOR ACTIVITY:**

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.



## STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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## OBJECTIVE 17.5:

*Describe the normal operation procedures for the flow measurement unit components listed on page 17.*

## CONDITIONS:

Given a flow measurement unit or slides or photographs of a flow measurement unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

## ACCEPTABLE PERFORMANCE:

The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

agitation	position
color	pressure
corrosion	sound
depth	temperature
flow	velocity
motion	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.





Describe routine sampling for the flow measurement process.

List routine calculations for the flow measurement process.

Describe routine procedures for recording data.

**INSTRUCTOR ACTIVITY:**

1. Describe the characteristics of the components of the flow measurement unit.
2. Describe the normal operation procedures for the flow measurement unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the flow measurement unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

**STUDENT ACTIVITY:**

1. Develop a checklist, listing the components of the flow measurement unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the flow measurement unit.
4. Observe and describe the normal operation procedures during a plant tour.

<<<<<<>>>>>>>>

**OBJECTIVE 17.6:**

*Perform the normal operation procedures for the flow measurement unit.*

**CONDITIONS:**

Given a flow measurement unit, the manual of normal operation procedures which the student has developed for the flow measurement unit and basic references.

**ACCEPTABLE PERFORMANCE:**

The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.



Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

<<<<<<>>>>>>>

OBJECTIVE 17.7:

*Describe and perform the start-up and shut-down procedures for the flow measurement unit.*

CONDITIONS:

Given a mock-up, model or photograph of a flow measurement unit and a flow measurement unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE:

The student will:

Start up and shut down a flow measurement unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.



## STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the flow measurement unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the flow measurement unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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## OBJECTIVE 17.8:

*The abnormal operation procedures do not apply to composite model plant unit R.*

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## OBJECTIVE 17.9:

*Describe the preventive maintenance procedures for the flow measurement unit.*

## CONDITIONS:

Given a flow measurement unit or pictures and drawings of a flow measurement unit and reference materials, including:

- inspection records
- manufacturer's maintenance guides
- plant drawings and specifications
- preventive maintenance schedule

## ACCEPTABLE PERFORMANCE:

The student will:

Describe these preventive maintenance procedures for the flow measurement unit:

- Cleaning
  - magnetic flowmeter
  - flow indicator
  - flow recorder
  - transmitter



## Cleaning (continued)

- Parshall flume
  - float
  - float switch
  - flow indicator
  - stilling well
  - transmitter

- pen

- Venturi meter
  - flow indicator
  - flushing pump
  - plunger
  - sight glass

## Lubrication

- Venturi meter
  - flushing pump

## Mechanical adjustment

- electrical-hydraulic transmission system
- magnetic flowmeter
  - flow indicator
  - flow recorder
  - transmitter

- mechanical-hydraulic transmission system

- Parshall flume
  - float
  - float switch
  - flow indicator
  - transmitter

- pneumatic transmission system

- signal converter

- totalizer

- Venturi meter
  - flushing pump

## Painting

- Venturi meter
  - flushing pump

## Replacement

- chart
- fire-fighting equipment
- first-aid kit
- magnetic flowmeter
  - flow indicator
  - flow recorder
  - transmitter

- Parshall flume
  - transmitter

- pen

- rotameter



Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

**INSTRUCTOR ACTIVITY:**

1. Describe and explain the preventive maintenance procedures for the flow measurement unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

**STUDENT ACTIVITY:**

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

<<<<<<>>>>>>>

**OBJECTIVE 17.10:**

*Perform the preventive maintenance procedures for the flow measurement unit.*

**CONDITIONS:**

Given a flow measurement unit and tools and reference materials, including:  
inspection records  
manufacturer's maintenance guides  
plant drawings and specifications  
preventive maintenance schedule

**ACCEPTABLE PERFORMANCE:**

The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.



Apply the preventive maintenance schedule for the flow measurement unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

**INSTRUCTOR ACTIVITY:**

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

<<<<<<>>>>>>>>

**OBJECTIVE 17.11:**

*Describe the corrective maintenance procedures for the flow measurement unit components listed on page 17.*

**CONDITIONS:**

Given a flow measurement unit or a mock-up, photographs or drawings of a flow measurement unit, the manual of operation procedures which the student has developed for the flow measurement unit, tools and reference materials, including:

catalogue of replacement parts  
equipment catalogues  
manufacturer's maintenance guides

**ACCEPTABLE PERFORMANCE:**

The student will:

Describe how an operator evaluates each component of the flow measurement unit for corrective maintenance, commenting on:

agitation	position
color	pressure
corrosion	sound
depth	temperature
flow	velocity
motion	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

**INSTRUCTOR ACTIVITY:**

1. Describe and explain the corrective maintenance procedures for the flow measurement unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

**STUDENT ACTIVITY:**

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

<<<<<<>>>>>>>>

**OBJECTIVE 17.12:**

*Perform the corrective maintenance procedures for the flow measurement unit components.*

**CONDITIONS:**

Given a flow measurement unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual



## ACCEPTABLE PERFORMANCE:

The student will:

Evaluate the components of the flow measurement unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

agitation	position
color	pressure
corrosion	sound
depth	temperature
flow	velocity
motion	vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

## INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

## STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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## OBJECTIVE 17.13:

*Perform the safety procedures for the flow measurement unit and demonstrate how they protect employees and visitors.*

## CONDITIONS:

Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.





ACCEPTABLE PERFORMANCE: The student will:

- Identify hazardous conditions in the flow measurement unit, commenting on:
  - high-risk activities
  - sources of danger
  - safety equipment
- Explain how the procedures protect employees and visitors.
- Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 17.14: *Compare other flow measurement units to the centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter.*

CONDITIONS: Given a process unit and reference materials, including:

- equipment catalogues
- laboratory reports
- manufacturer's bulletins
- manufacturer's operation manuals
- plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

- Compare composite model plant unit R with:
  - a V-notch weir unit.
  - a rectangular weir unit.
  - a proportional flow weir unit.
  - a Kennison nozzle unit.



## Consider:

availability of replacement parts  
 capital costs  
 dependency on surrounding environment  
 ease of repair  
 efficiency  
 flow-handling capabilities  
 maintenance costs  
 nuisance to neighbors  
 operational costs  
 operational skills  
 personnel requirements  
 reliability  
 resistance to upset  
 sensitivity of controls  
 space requirements  
 waste-handling capabilities

## INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit R with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

## STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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## OBJECTIVE 17.15:

*Name and locate the components of the flow measurement unit listed on page 17. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

## CONDITIONS:

Given a flow measurement unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

- contractor's plans of the flow measurement unit
- manufacturer's maintenance guides
- operation and maintenance manuals

**ACCEPTABLE PERFORMANCE:**

The student will:

Name and locate the components of the flow measurement unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

**INSTRUCTOR ACTIVITY:**

1. Point out components of the flow measurement unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the flow measurement unit and normal operation procedures.

**STUDENT ACTIVITY:**

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the flow measurement unit and normal operation procedures.

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**OBJECTIVE 17.16:**

*The abnormal operation procedures do not apply to composite model plant unit R.*

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## MODULE 18

### PUMPING AND PIPING

*A system with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping*

*Composite Model Plant Unit S*

**PURPOSE:** *In this module the student will learn to perform all the activities in the objectives as they apply to a system with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

- OBJECTIVES:**
- 18.1 *Identify the pumping and piping unit.*
  - 18.2 *Describe the pumping and piping process in technical and non-technical terms.*
  - 18.3 *Describe the safety procedures for the pumping and piping unit and explain how the procedures protect employees and visitors.*
  - 18.4 *Identify the components of a pumping and piping unit. Explain the purpose of each component, how the component works and why it is important.*
  - 18.5 *Describe the normal operation procedures for the pumping and piping unit components listed on page 36.*
  - 18.6 *Perform the normal operation procedures for the pumping and piping unit.*
  - 18.7 *Describe and perform the start-up and shut-down procedures for the pumping and piping unit.*
  - 18.8 *Describe the abnormal operation procedures for the pumping and piping process.*
  - 18.9 *Describe the preventive maintenance procedures for the pumping and piping unit.*
  - 18.10 *Perform the preventive maintenance procedures for the pumping and piping unit.*
  - 18.11 *Describe the corrective maintenance procedures for the pumping and piping unit components listed on page 36.*
  - 18.12 *Perform the corrective maintenance procedures for the pumping and piping unit components.*
  - 18.13 *Perform the safety procedures for the pumping and piping unit and demonstrate how they protect employees and visitors.*
  - 18.14 *Compare other pumping and piping units to the system with magnetically connected, pneumatically controlled, diesel driven,*



*centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.*

18.15 *Name and locate the components of the pumping and piping unit listed on page 36.*

*explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

18.16 *Perform the abnormal operation procedures for the pumping and piping unit.*

RESOURCES:	3	116	120	125	141	143	144	196	197	209	271
	272	307	308	309	316	317	320	321	324	421	459
	511	551	552	553	554	937	990	1033	1034	1399	

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OBJECTIVE 18.1: *Identify the pumping and piping unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:  
Indicate whether the process unit is used for pumping and piping.

INSTRUCTOR ACTIVITY: 1. Point out characteristics which distinguish the pumping and piping unit from other process units.

STUDENT ACTIVITY: 1. Develop a picture file of pumping and piping units.  
Mark distinguishing characteristics.

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OBJECTIVE 18.2: *Describe the pumping and piping process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the pumping and piping unit.

**ACCEPTABLE PERFORMANCE:**

The student will:

Describe the pumping and piping unit, explaining the meaning of:

- hydraulic system
- piping system
- pumping and piping system
- pumping system

Describe the purpose of pumping and piping.

Describe the pumps in the pumping and piping unit which are used for:

backwash	settled sewage
priming	sludge
process water	sludge return
raw sewage	waste sludge
recirculation	water seals
recycle	

Describe the valves in the pumping and piping unit, commenting on the:

butterfly valve	gate valve
bypass valve	influent valve
check valve	inlet valve
discharge valve	suction valve
effluent valve	

Describe the pipes in the pumping and piping unit, commenting on the:

bypass line	primary sludge line
discharge line	recirculation line
effluent line	recycle line
line	sludge line
influent line	suction line
overflow line	transfer line

Describe how pumping and	piping affects:
aeration	primary sedimentation
collection	screening and grinding
effluent disposal	secondary sedimentation
first stage digestion	second stage digestion
flow measurement	sludge conditioning
grit removal	sludge dewatering
pond stabilization	solids disposal
post-chlorination	thickening
prechlorination	trickling

**INSTRUCTOR ACTIVITY:**

1. Use diagrams, photographs and slides to describe pumping and piping.



2. Describe the pumping and piping process during a plant tour. React to the student's description of the process.

## STUDENT ACTIVITY:

1. Describe the pumping and piping process while viewing photographs, diagrams and slides.
2. Observe and describe the pumping and piping process during a plant tour.

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## OBJECTIVE 18.3:

*Describe the safety procedures for the pumping and piping unit and explain how the procedures protect employees and visitors.*

## CONDITIONS:

Given a list of operation and maintenance procedures.

## ACCEPTABLE PERFORMANCE:

The student will:

Describe the safety procedures for the pumping and piping unit, commenting on:

High-risk activities

handling contaminated equipment

removing debris from channels

working with switches in automatic position

Sources of danger

air tanks and lines

acid wastes

caustic wastes

deep wells

electrical equipment

explosive gases

flooding tunnels

heat

hoist equipment under tension

hot manifolds

hot pipes

loose clothing

moving parts

open doors and covers

rotating and reciprocating parts

slippery walks

toxic gases



Safety equipment  
earmuffs and earplugs  
explosion proof flashlights  
fire-fighting equipment  
first-aid kit  
goggles  
grounded tools and extension cords  
lockout tags and keys  
protective clothing  
safety solvents

Explain how the procedures protect employees and visitors.

**INSTRUCTOR ACTIVITY:**

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

**STUDENT ACTIVITY:**

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the pumping and piping unit.
4. Identify sources of danger and high-risk activities pictured in slides.

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**OBJECTIVE 18.4:**

*Identify the components of a pumping and piping unit. Explain the purpose of each component, how the component works and why it is important.*

**CONDITIONS:**

Given a pumping and piping unit, unit components or a diagram, model or photographs of a unit and a list of components.





## ACCEPTABLE PERFORMANCE:

The student will:

Identify components of the pumping and piping unit and associated equipment:

belt	pipe
control system	pump
coupling	seal
fire-fighting equipment	speed controller
first-aid kit	switch
gage	valve
motor	

Explain the purpose of each component, how the component works and why it is important.

## INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

## STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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## OBJECTIVE 18.5:

*Describe the normal operation procedures for the pumping and piping unit components listed above.*

## CONDITIONS:

Given a pumping and piping unit or slides or photographs of a pumping and piping unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

## ACCEPTABLE PERFORMANCE:

The student will:

Describe the characteristics of each component which the operator checks to determine whether the



component is functioning normally, commenting on:

capacity	odor
color	position
corrosion	pressure
exfiltration	sound
flow	temperature
infiltration	vibration
motion	

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the pumping and piping process.

List routine calculations for the pumping and piping process.

Describe routine procedures for recording data.

#### INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the pumping and piping unit.
2. Describe the normal operation procedures for the pumping and piping unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the pumping and piping unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

#### STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the pumping and piping unit and their normal characteristics.
2. Develop a manual of normal operation procedures.



3. Describe the normal operation procedures during a slide show of components of the pumping and piping unit.
4. Observe and describe the normal operation procedures during a plant tour.

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**OBJECTIVE 18.6:**

*Perform the normal operation procedures for the pumping and piping unit.*

**CONDITIONS:**

Given a pumping and piping unit, the manual of normal operation procedures which the student has developed for the pumping and piping unit and basic references.

**ACCEPTABLE PERFORMANCE:**

The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

**INSTRUCTOR ACTIVITY:**

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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**OBJECTIVE 18.7:**

*Describe and perform the start-up and shut-down procedures for the pumping and piping unit.*

**CONDITIONS:**

Given mock-ups, models or photographs of the components of a pumping and piping unit and the components of a pumping and piping unit with the manufacturer's operation manual.

**ACCEPTABLE PERFORMANCE:**

The student will:

Start up and shut down a pumping and piping unit, following the manufacturer's instructions.

**INSTRUCTOR ACTIVITY:**

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

**STUDENT ACTIVITY:**

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the pumping and piping unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the pumping and piping unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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**OBJECTIVE 18.8:**

*Describe the abnormal operation procedures for the pumping and piping process.*

**CONDITIONS:**

Given a wastestream in a treatment plant or color photographs of a wastestream, a checklist of the conditions of the wastestream and plant records and reference materials.

**ACCEPTABLE PERFORMANCE:**

The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

flow	pH
ice	sludge density
industrial wastes	velocity

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the wastestream must be checked.

Describe what an operator does if he observes abnormal conditions, including:

- operational changes
- reporting to supervisors
- sampling procedures

Describe how the actions of the operator will improve the condition of the wastestream.

**INSTRUCTOR ACTIVITY:**

1. Describe and explain the abnormal conditions of the wastestream illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

**STUDENT ACTIVITY:**

1. Evaluate and explain the abnormal conditions of the wastestream which are illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.



4. Evaluate and explain the condition of the wastestream during a plant tour. Describe and explain the abnormal operation procedures.

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**OBJECTIVE 18.9:**

*Describe the preventive maintenance procedures for the pumping and piping unit.*

**CONDITIONS:**

Given a pumping and piping unit or pictures and drawings of a pumping and piping unit and reference materials, including:

inspection records  
 manufacturer's maintenance guides  
 plant drawings and specifications  
 preventive maintenance schedule

**ACCEPTABLE PERFORMANCE:**

The student will:

Describe these preventive maintenance procedures for the pumping and piping unit:

Cleaning	pump
gage	seal
motor	speed controller
pipe	switch
pump	valve
speed controller	Painting
valve	motor
Lubrication	pipe
motor	pump
pump	speed controller
seal	valve
speed controller	Replacement
valve	belt
Mechanical adjustment	fire-fighting equipment
belt	first-aid kit
control system	seal
coupling	Wear measurement
gage	belt coupling
motor	seal

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.



Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the pumping and piping unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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OBJECTIVE 18.10:

*Perform the preventive maintenance procedures for the pumping and piping unit.*

CONDITIONS:

Given a pumping and piping unit and tools and reference materials, including:  
 inspection records  
 manufacturer's maintenance guides  
 plant drawings and specifications  
 preventive maintenance schedule

ACCEPTABLE PERFORMANCE:

The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the pumping and piping unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

**INSTRUCTOR ACTIVITY:**

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

<<<<<>>>>>

**OBJECTIVE 18.11:**

*Describe the corrective maintenance procedures for the pumping and piping unit components listed on page 36.*

**CONDITIONS:**

Given a pumping and piping unit or a mock-up, photographs or drawings of a pumping and piping unit, the manual of operation procedures which the student has developed for the pumping and piping unit, tools and reference materials, including:

catalogue of replacement parts  
equipment catalogues  
manufacturer's maintenance guides

**ACCEPTABLE PERFORMANCE:**

The student will:

Describe how an operator evaluates each component of the pumping and piping unit for corrective maintenance, commenting on:

capacity	odor
color	position
corrosion	pressure
exfiltration	sound
flow	temperature
infiltration	vibration
motion	

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.



Describe what an operator does when he discovers a malfunction, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

**INSTRUCTOR ACTIVITY:**

1. Describe and explain the corrective maintenance procedures for the pumping and piping unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

**STUDENT ACTIVITY:**

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

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**OBJECTIVE 18.12:**

Perform the corrective maintenance procedures for the pumping and piping unit components.

CONDITIONS:

Given a pumping and piping unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:

catalogue of replacement parts  
equipment catalogues  
manufacturer's maintenance guides  
manufacturer's operation manual

**ACCEPTABLE PERFORMANCE:**

The student will:

Evaluate the components of the pumping and piping unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

capacity	corrosion
color	exfiltration



flow	pressure
infiltration	sound
motion	temperature
odor	vibration
position	

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

**INSTRUCTOR ACTIVITY:**

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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**OBJECTIVE 18.13:**

*Perform the safety procedures for the pumping and piping unit and demonstrate how they protect employees and visitors.*

**CONDITIONS:**

Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

**ACCEPTABLE PERFORMANCE:**

The student will:

Identify hazardous conditions in the pumping and piping unit, commenting on:  
high-risk activities



sources of danger  
safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 18.14:

*Compare other pumping and piping units to the system with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.*

CONDITIONS:

Given a process unit and reference materials, including:  
equipment catalogues  
laboratory reports  
manufacturer's bulletins  
manufacturer's operation manuals  
plant maintenance and operation records

ACCEPTABLE PERFORMANCE:

The student will:

- Compare composite model plant unit S with:
- a system with magnetically connected, pneumatic controlled, diesel driven, air lift pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.
  - a system with magnetically connected, pneumatically



controlled, diesel driven, screw lift pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, hand driven pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, water driven pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, air driven pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and the appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, pneumatic ejector pump electrode controlled; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

Consider:

- availability of replacement parts
- capital costs
- dependency on surrounding environment
- ease of repair
- efficiency
- flow-handling capabilities
- maintenance costs
- nuisance to neighbors
- operational costs
- operational skills
- personnel requirements
- reliability
- resistance to upset
- sensitivity of controls
- space requirements
- waste-handling capabilities

INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit S with the other units.



3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

## STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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## OBJECTIVE 18.15:

*Name and locate the components of the pumping and piping unit listed on page 36. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

## CONDITIONS:

Given a pumping and piping unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the pumping and piping unit.  
 manufacturer's maintenance guides  
 operation and maintenance manuals

## ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the pumping and piping unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

## INSTRUCTOR ACTIVITY:

1. Point out components of the pumping and piping unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the pumping and piping unit and normal operation procedures.

## STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.



2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the pumping and piping unit and normal operation procedures.

<<<<<<>>>>>>>>

**OBJECTIVE 18.16:**

*Perform the abnormal operation procedures for the pumping and piping unit.*

**CONDITIONS:**

Given a wastestream in a treatment plant and reference materials, including:

industrial waste records  
operation logs  
operator manuals  
plant performance guides

**ACCEPTABLE PERFORMANCE:**

The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

flow	pH
ice	sludge density
industrial wastes	velocity

Select the references he needs to return the wastestream to normal.

Perform the abnormal operation procedures.

**INSTRUCTOR ACTIVITY:**

1. Observe the student as he evaluates the wastestream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the wastestream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

**STUDENT ACTIVITY:**

1. Evaluate the wastestream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the wastestream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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## MODULE 19

### ELECTRIC POWER

*A system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms*

*Composite Model Plant Unit T*

**PURPOSE:** *In this module the student will learn to perform all the activities in the objectives as they apply to a system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

- OBJECTIVES:**
- 19.1 *Identify the electric power unit.*
  - 19.2 *Describe the electric power process in technical and nontechnical terms.*
  - 19.3 *Describe the safety procedures for the electric power unit and explain how the procedures protect employees and visitors.*
  - 19.4 *Identify the components of an electric power unit. Explain the purpose of each component, how the component works and why it is important.*
  - 19.5 *Describe the normal operation procedures for the electric power unit components listed on page 55.*
  - 19.6 *Perform the normal operation procedures for the electric power unit.*
  - 19.7 *Describe and perform the start-up and shut-down procedures for the electric power unit.*
  - 19.8 *The abnormal operation procedures do not apply to the composite model plant unit T.*
  - 19.9 *Describe the preventive maintenance procedures for the electric power unit.*
  - 19.10 *Perform the preventive maintenance procedures for the electric power unit.*
  - 19.11 *Describe the corrective maintenance procedures for the electric power unit components listed on page 55.*
  - 19.12 *Perform the corrective maintenance procedures for the electric power unit components.*
  - 19.13 *Perform the safety procedures for the electric power unit and demonstrate how they protect employees and visitors.*
  - 19.14 *Compare other electric power units to the system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms.*



- 19.15 *Name and locate the components of the electric power unit listed on page 55. explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*
- 19.16 *The abnormal operation procedures do not apply to the composite model plant unit T.*

RESOURCES:	3	116	120	125	141	143	144	212	213	307	308
	309	312	313	316	317	320	321	324	421	459	511
	551	552	553	554	937	990	1033	1034	1399		

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**OBJECTIVE 19.1:** *Identify the electric power unit.*

**CONDITIONS:** Given a unit, a model of a unit or a photograph of a unit.

**ACCEPTABLE PERFORMANCE:** The student will:  
Indicate whether the process unit is used for electric power.

**INSTRUCTOR ACTIVITY:** 1. Point out characteristics which distinguish the electric power unit from other process units.

**STUDENT ACTIVITY:** 1. Develop a picture file of electric power units. Mark distinguishing characteristics.

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**OBJECTIVE 19.2:** *Describe the electric power process in technical and nontechnical terms.*

**CONDITIONS:** Given photographs of the electric power unit.

**ACCEPTABLE PERFORMANCE:** The student will:  
Describe the electric power unit, explaining the meaning of:  
delta





electrical distribution system  
electrical generation and distribution system  
electrical service  
electrical supply  
internal electrical system  
plant electrical system  
three-phase

Describe the purpose of the electric power unit.

Describe how electric power affects:

collection  
prechlorination  
screening and grinding  
grit removal  
primary sedimentation  
trickling filtration  
aeration  
secondary sedimentation  
pond stabilization  
thickening  
first stage digestion  
second stage digestion  
sludge conditioning  
post-chlorination  
sludge dewatering  
solids disposal  
effluent disposal  
flow measurement  
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe electric power.
2. Describe the electric power process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the electric power process while viewing photographs, diagrams and slides.
2. Observe and describe the electric power process during a plant tour.

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OBJECTIVE 19.3:

*Describe the safety procedures for the electric power unit and explain how the procedures protect employees and visitors.*

**CONDITIONS:**

Given a list of operation and maintenance procedures.

**ACCEPTABLE PERFORMANCE:**

The student will:

Describe the safety procedures for the electric power unit, commenting on:

High-risk activities

activating or deactivating circuits

working with switches in automatic position

Sources of danger

electrical equipment

explosive atmosphere

explosive gases

flammable solvents

hot equipment

moving parts

noise

open doors and covers

rotating equipment

slippery walks

solvents

toxic gases

Safety equipment

earmuffs or earplugs

explosion proof flashlight

fire-fighting equipment

first-aid kit

load break ratings on switchgear

lockout tags and keys

padlocks

protective clothing

railings

rubber mats under all switchgear panels

shorting sticks

wooden ladders

Explain how the procedures protect employees and visitors.

**INSTRUCTOR ACTIVITY:**

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation / maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

**STUDENT ACTIVITY:**

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the electric power unit.
4. Identify sources of danger and high-risk activities pictured in slides.

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**OBJECTIVE 19.4:**

*Identify the components of an electric power unit. Explain the purpose of each component, how the component works and why it is important.*

**CONDITIONS:**

Given an electric power unit, unit components or a diagram, model or photographs of a unit and a list of components.

**ACCEPTABLE PERFORMANCE:**

The student will:

Identify components of the electric power unit and associated equipment:

ammeter	load bus
automatic control actuator	load distribution panel
diesel motor	magnetic starter
disconnect switch	motor control center
elapsed-time meter	overvoltage relay
emergency lighting system	power-factor meter
exciter	power-generation
feeder breaker	control
fire-fighting equipment	primary feeder breaker
first-aid kit	transformer breaker
frequency meter	undervoltage relay
generator	voltmeter
ground detector	watt-hour meter
lighting transformer	

Explain the purpose of each component, how the component works and why it is important.

**INSTRUCTOR ACTIVITY:**

1. Point out and name components in diagrams, photographs or models.



2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

**STUDENT ACTIVITY:**

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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**OBJECTIVE 19.5:**

*Describe the normal operation procedures for the electric power unit components listed on page 55.*

**CONDITIONS:**

Given an electric power unit or slides or photographs of an electric power unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

**ACCEPTABLE PERFORMANCE:**

The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

color	position
corrosion	sound
motion	temperature
odor	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why a component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:  
making adjustments



deciding about corrective maintenance  
reporting to supervisors  
reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the electric power process.

List routine calculations for the electric power process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the electric power unit.
2. Describe the normal operation procedures for the electric power unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the electric power unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the electric power unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the electric power unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 19.6:

*Perform the normal operation procedures for the electric power unit.*

CONDITIONS:

Given an electric power unit, the manual of normal operation procedures which the student has developed for the electric power unit and basic references.

ACCEPTABLE PERFORMANCE:

The student will:

Check and evaluate the characteristics of each component, explaining his actions.



Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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OBJECTIVE 19.7:

*Describe and perform the start-up and shut-down procedures for the electric power unit.*

CONDITIONS:

Given a mock-up, model or photograph of an electric power unit and an electric power unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE:

The student will:

Start up and shut down an electric power unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.

6. Observe the student as he evaluates his shut-down procedures.

**STUDENT ACTIVITY:**

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the electric power unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the electric power unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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**OBJECTIVE 19.8:**

*The abnormal operation procedures do not apply to the composite model plant unit T.*

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**OBJECTIVE 19.9:**

*Describe the preventive maintenance procedures for the electric power unit.*

**CONDITIONS:**

Given an electric power unit or pictures and drawings of an electric power unit and reference materials, including:

- inspection records
- manufacturer's maintenance guides
- plant drawings and specifications
- preventive maintenance schedule



## ACCEPTABLE PERFORMANCE:

The student will:

Describe these preventive maintenance procedures for the electric power unit:

Cleaning	frequency meter
ammeter	generator
automatic control actuator	ground detector
diesel motor	lighting transformer
disconnect switch	load bus
elapsed-time meter	load distribution
emergency lighting system	panel
exciter	magnetic starter
feeder breaker	motor control center
frequency meter	overvoltage relay
generator	power-factor meter
lighting transformer	power-generation
load bus	control
load distribution panel	primary feeder
magnetic starter	breaker
motor control center	transformer breaker
overvoltage relay	undervoltage relay
power-factor meter	voltmeter
power-generation control	watt-hour meter
primary feeder breaker	Painting
transformer breaker	diesel motor
undervoltage relay	exciter
voltmeter	generator
watt-hour meter	motor control center
Lubrication	Replacement
-diesel motor	fire-fighting
exciter	equipment
generator	first-aid kit
Mechanical adjustment	Wear measurement
ammeter	diesel motor
automatic control actuator	exciter
diesel motor	generator
disconnect switch	magnetic starter
elapsed-time meter	overvoltage relay
emergency lighting system	primary feeder
exciter	breaker
feeder breaker	undervoltage relay

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.





Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

**INSTRUCTOR ACTIVITY:**

1. Describe and explain the preventive maintenance procedures for the electric power unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

**STUDENT ACTIVITY:**

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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**OBJECTIVE 19.10:**

*Perform the preventive maintenance procedures for the electric power unit.*

**CONDITIONS:**

Given an electric power unit and tools and reference materials, including:

inspection records  
manufacturer's maintenance guides  
plant drawings and specifications  
preventive maintenance schedule

**ACCEPTABLE PERFORMANCE:**

The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the electric power unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.



## INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

## STUDENT ACTIVITY:

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

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## OBJECTIVE 19.11:

*Describe the corrective maintenance procedures for the electric power unit components listed on page 55.*

## CONDITIONS:

Given an electric power unit or a mock-up, photographs or drawings of an electric power unit, the manual of operation procedures which the student has developed for the electric power unit, tools and reference materials, including:

catalogue of replacement parts  
equipment catalogues  
manufacturer's maintenance guides

## ACCEPTABLE PERFORMANCE:

The student will:

Describe how an operator evaluates each component of the electric power unit for corrective maintenance, commenting on:

color	position
corrosion	sound
motion	temperature
odor	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:

evaluation of capabilities of plant personnel to perform the procedures



selection of replacement parts  
record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the electric power unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

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OBJECTIVE 19.12:

*Perform the corrective maintenance procedures for the electric power unit components.*

CONDITIONS:

Given an electric power unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:  
catalogue of replacement parts  
equipment catalogues  
manufacturer's maintenance guides  
manufacturer's operation manual

ACCEPTABLE PERFORMANCE:

The student will:

Evaluate the components of the electric power unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

color	position
corrosion	sound
motion	temperature
odor	vibration



Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

**INSTRUCTOR ACTIVITY:**

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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**OBJECTIVE 19.13:**

*Perform the safety procedures for the electric power unit and demonstrate how they protect employees and visitors.*

**CONDITIONS:**

Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

**ACCEPTABLE PERFORMANCE:**

The student will:

Identify hazardous conditions in the electric power unit, commenting on:

- high-risk activities
- sources of danger
- safety equipment

Explain how the procedures protect employees and visitors.



Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 19.14:

*Compare other electric power units to the system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms.*

CONDITIONS:

Given a process unit and reference materials, including:  
equipment catalogues  
laboratory reports  
manufacturer's bulletins  
manufacturer's operation manuals  
plant maintenance and operation records

ACCEPTABLE PERFORMANCE:

The student will:

Compare composite model plant unit T with:  
a system using Y transformers, generators, electrical switchgear, automatic circuit actuators on motors and telemetering with alarms.  
a system with internally produced gas with gas holder covers and centrifugal blowers.

Consider:

availability of replacement parts  
capital costs  
dependency on surrounding environment  
ease of repair  
efficiency



flow-handling capabilities  
 maintenance costs  
 nuisance to neighbors  
 operational costs  
 operational skills  
 personnel requirements  
 reliability  
 resistance to upset  
 sensitivity of controls  
 space requirements  
 waste-handling capabilities

## INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit T with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

## STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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## OBJECTIVE 19.15:

*Name and locate the components of the electric power unit listed on page 55. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

## CONDITIONS:

Given an electric power unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the electric power unit  
 manufacturer's maintenance guides  
 operation and maintenance manuals

## ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the electric power unit.



Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the electric power unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the electric power unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the electric power unit and normal operation procedures.

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OBJECTIVE 19.16:

*The abnormal operation procedures do not apply to the composite model plant unit T.*

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## MODULE 20

### GAS POWER

*A system with internally produced gas  
with high pressure tanks and  
rotary positive displacement compressors*

*Composite Model Plant Unit U*

**PURPOSE:** *In this module the student will learn to perform all the activities in the objectives as they apply to a system with internally produced gas with high pressure tanks and rotary positive displacement compressors. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

- OBJECTIVES:**
- 20.1 Identify the gas power unit.*
  - 20.2 Describe the gas power process in technical and nontechnical terms.*
  - 20.3 Describe the safety procedures for the gas power unit and explain how the procedures protect employees and visitors.*
  - 20.4 Identify the components of a gas power unit. Explain the purpose of each component, how the component works and why it is important.*
  - 20.5 Describe the normal operation procedures for the gas power unit components listed on page 73.*
  - 20.6 Perform the normal operation procedures for the gas power unit.*
  - 20.7 Describe and perform the start-up and shut-down procedures for the gas power unit.*
  - 20.8 Describe the abnormal operation procedures for the gas power process.*
  - 20.9 Describe the preventive maintenance procedures for the gas power unit.*
  - 20.10 Perform the preventive maintenance procedures for the gas power unit.*
  - 20.11 Describe the corrective maintenance procedures for the gas power unit components listed on page 73.*
  - 20.12 Perform the corrective maintenance procedures for the gas power unit components.*
  - 20.13 Perform the safety procedures for the gas power unit and demonstrate how they protect employees and visitors.*
  - 20.14 Compare other gas power units to the system with internally produced gas with high pressure tanks and rotary positive displacement compressors (composite model plant unit U).*
  - 20.15 Name and locate the components of the gas power unit listed on page 73. Name and select reference materials which explain*





*the normal operation procedures, the purpose of each component, how the component works and why it is important.*

20.16 *Perform the abnormal operation procedures for the gas power unit.*

RESOURCES:	3	116	120	125	141	143	144	307	308	309	316
	317	320	321	324	421	459	511	551	552	553	554
	937	990	1033	1034	1399						

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**OBJECTIVE 20.1:** *Identify the gas power unit.*

**CONDITIONS:** Given a unit, a model of a unit or a photograph of a unit.

**ACCEPTABLE PERFORMANCE:** The student will:  
Indicate whether the process unit is used for gas power.

**INSTRUCTOR ACTIVITY:** 1. Point out characteristics which distinguish the gas power unit from other process units.

**STUDENT ACTIVITY:** 1. Develop a picture file of gas power units. Mark distinguishing characteristics.

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**OBJECTIVE 20.2:** *Describe the gas power process in technical and nontechnical terms.*

**CONDITIONS:** Given photographs of the gas power unit.

**ACCEPTABLE PERFORMANCE:** The student will:  
Describe the gas power unit, explaining the meaning of:  
digester gas system  
high pressure gas system



low pressure gas system  
plant gas system  
process gas system  
sludge gas system  
waste gas system

Describe the purpose of the gas power unit.

Describe how gas power affects:  
first stage digestion  
second stage digestion  
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe gas power.
2. Describe the gas power process during a plant tour.  
React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the gas power process while viewing photographs, diagrams and slides.
2. Observe and describe the gas power process during a plant tour.

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OBJECTIVE 20.3:

*Describe the safety procedures for the gas power unit and explain how the procedures protect employees and visitors.*

CONDITIONS:

Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE:

The student will:

Describe the safety procedures for the gas power unit, commenting on:

High-risk activities

draining water from lines

hoisting

removing debris from channels

working with switches in automatic position

Sources of danger

acid wastes

belts

caustic wastes

cleaning rags



## Sources of danger (continued)

- couplings
- deep wells
- disconnected pipelines
- electrical equipment
- explosive gases
- explosive mixtures
- gas leaks
- H<sub>2</sub>S gas
- high pressure
- improper disposal of spent gas scrubber contents
- iron sulfide
- moving parts
- negative pressure
- open doors and covers
- rotating equipment
- slippery walks
- solvents
- spent gas scrubber contents
- toxic gases
- valve chains
- valve handles
- welding torches
- Safety equipment
  - continuous operation gas monitor
  - explosion meter
  - explosion proof equipment
  - fire-fighting equipment
  - First-aid kit
  - high volume ventilation equipment
  - hydrogen sulfide amp tools
  - lockout tags and keys
  - nonsparking tools
  - protective clothing
  - railings
  - salt tablets
  - stair safety treads

Explain how the procedures protect employees and visitors.

## INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.



## STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the gas power unit.
4. Identify sources of danger and high-risk activities pictured in slides.

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## OBJECTIVE 20.4:

*Identify the components of a gas power unit. Explain the purpose of each component, how the component works and why it is important.*

## CONDITIONS:

Given a gas power unit, unit components or a diagram, model or photographs of a unit and a list of components.

## ACCEPTABLE PERFORMANCE:

The student will:

Identify components of the gas power unit and associated equipment:

drip trap	manometer
explosion-proof switchgear	meter
fire-fighting equipment	moisture accumulator
first-aid kit	pressure gage
flame arrestor	pressure switch
gas booster	primary gas receiver
gas compressor	secondary gas receiver
gas filter	vacuum relief valve
gas holder cover	valve
gas scrubber	waste gas burner
gas storage	

Explain the purpose of each component, how the component works and why it is important.

## INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.



4. Question the students about the purpose of each component, how the component works and why it is important.

## STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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## OBJECTIVE 20.5:

*Describe the normal operation procedures for the gas power unit components listed on page 73.*

## CONDITIONS:

Given a gas power unit or slides or photographs of a gas power unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

## ACCEPTABLE PERFORMANCE:

The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vibration
position	

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

- making adjustments
- deciding about corrective maintenance



reporting to supervisors  
reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the gas power process.

List routine calculations for the gas power process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the gas power unit.
2. Describe the normal operation procedures for the gas power unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the gas power unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the gas power unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the gas power unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 20.6:

*Perform the normal operation procedures for the gas power unit.*

CONDITIONS:

Given a gas power unit, the manual of normal operation procedures which the student has developed for the gas power unit and basic references.

ACCEPTABLE PERFORMANCE:

The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.



Perform the routine sampling.  
Perform the routine calculations.  
Perform the routine record keeping.

**INSTRUCTOR ACTIVITY:**

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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**OBJECTIVE 20.7:**

*Describe and perform the start-up and shut-down procedures for the gas power unit.*

**CONDITIONS:**

Given a mock-up, model or photograph of a gas power unit and a gas power unit with the manufacturer's operation manual.

**ACCEPTABLE PERFORMANCE:**

The student will:

Start up and shut down a gas power unit, following the manufacturer's instructions.

**INSTRUCTOR ACTIVITY:**

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

**STUDENT ACTIVITY:**

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the gas power unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the gas power unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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**OBJECTIVE 20.8:**

*Describe the abnormal operation procedures for the gas power process.*

**CONDITIONS:**

Given a gas stream in a treatment plant or a written description of a gas stream, a checklist of the conditions of the gas stream and plant records and reference materials.

**ACCEPTABLE PERFORMANCE:**

The student will:

Evaluate the gas stream for abnormal conditions, commenting on:

flow  
gas composition  
toxic gases

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the gas stream must be checked.

Describe what an operator does if he observes abnormal conditions, including:

operational changes  
reporting to supervisors  
sampling procedures





Describe how the actions of the operator will improve the condition of the gas stream.

INSTRUCTOR ACTIVITY:

1. Describe and explain the abnormal conditions of the gas stream.
2. Describe and explain the abnormal operation procedures described in plant records and case histories.
3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Evaluate and explain the abnormal conditions of the gas stream which the instructor describes.
2. Describe and explain the abnormal operation procedures described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.
4. Evaluate and explain the condition of the gas stream during a plant tour. Describe and explain the abnormal operation procedures.

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OBJECTIVE 20.9:

*Describe the preventive maintenance procedures for the gas power unit.*

CONDITIONS:

Given a gas power unit or pictures and drawings of a gas power unit and reference materials, including:  
 inspection records  
 manufacturer's maintenance guides  
 plant drawings and specifications  
 preventive maintenance schedule

ACCEPTABLE PERFORMANCE:

The student will:

Describe these preventive maintenance procedures for the gas power unit:

Cleaning	gas filter
drip trap	gas scrubber
flame arrestor	gas storage
gas booster	meter
gas compressor	moisture accumulator



Cleaning (continued)	
pressure gage	pressure gage
pressure switch	pressure switch
valve	vacuum relief valve
waste gas burner	valve
	waste gas burner
Lubrication	Painting
gas booster	flame arrestor
gas compressor	gas compressor
gas scrubber	gas scrubber
meter	gas storage
valve	meter
Mechanical adjustment	moisture accumulator
drip trap	primary gas receiver
explosion-proof switch-	secondary gas receiver
gear	valve
flame arrestor	Replacement
gas booster	fire-fighting equipment
gas compressor	first-aid kit
gas scrubber	gas filter
meter	gas scrubber
moisture accumulator	manometer

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

#### INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the gas power unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

#### STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.



3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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**OBJECTIVE 20.10:**

*Perform the preventive maintenance procedures for the gas power unit.*

**CONDITIONS:**

Given a gas power unit and tools and reference materials, including:

- inspection records
- manufacturer's maintenance guides
- plant drawings and specifications
- preventive maintenance schedule

**ACCEPTABLE PERFORMANCE:**

The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the gas power unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

**INSTRUCTOR ACTIVITY:**

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

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**OBJECTIVE 20.11:**

*Describe the corrective maintenance procedures for the gas power unit components listed on page 73.*

**CONDITIONS:**

Given a gas power unit or a mock-up, photographs or drawings of a gas power unit, the manual of operation procedures which the student has developed for the gas power unit, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides

**ACCEPTABLE PERFORMANCE:**

The student will:

Describe how an operator evaluates each component of the gas power unit for corrective maintenance, commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vibration
position	

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

**INSTRUCTOR ACTIVITY:**

1. Describe and explain the corrective maintenance procedures for the gas power unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

**STUDENT ACTIVITY:**

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.



3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

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**OBJECTIVE 20.12:**

*Perform the corrective maintenance procedures for the gas power unit components.*

**CONDITIONS:**

Given a gas power unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

**ACCEPTABLE PERFORMANCE:**

The student will:

Evaluate the components of the gas power unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vibration
position	

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

**INSTRUCTOR ACTIVITY:**

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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**OBJECTIVE 20.13:**

*Perform the safety procedures for the gas power unit and demonstrate how they protect employees and visitors.*

**CONDITIONS:**

Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

**ACCEPTABLE PERFORMANCE:**

The student will:

Identify hazardous conditions in the gas power unit, commenting on:  
high-risk activities  
sources of danger  
safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

**INSTRUCTOR ACTIVITY:**

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

**STUDENT ACTIVITY:**

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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**OBJECTIVE 20.14:**

*Compare other gas power units to the system with internally produced gas with high pressure tanks and rotary positive displacement compressors (composite model plant unit U).*

**CONDITIONS:**

Given a process unit and reference materials, including:  
equipment catalogues  
laboratory reports  
manufacturer's bulletins  
manufacturer's operation manuals  
plant maintenance and operation records

**ACCEPTABLE PERFORMANCE:**

The student will:

Compare composite model plant unit U with:  
a system with internally produced gas with high pressure tanks and reciprocating compressors.  
a system with internally produced gas with gas holder covers and centrifugal blowers.

Consider:

availability of replacement parts  
capital costs  
dependency on surrounding environment  
ease of repair  
efficiency  
flow-handling capabilities  
gas-handling capabilities  
maintenance costs  
nuisance to neighbors  
operational costs  
operational skills  
personnel requirements  
reliability  
resistance to upset  
sensitivity of controls  
space requirements

**INSTRUCTOR ACTIVITY:**

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit U with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

**STUDENT ACTIVITY:**

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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**OBJECTIVE 20.15:**

*Name and locate the components of the gas power unit listed on page 73. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

**CONDITIONS:**

Given a gas power unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the gas power unit  
manufacturer's maintenance guides  
operation and maintenance manuals

**ACCEPTABLE PERFORMANCE:**

The student will:

Name and locate the components of the gas power unit.  
Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

**INSTRUCTOR ACTIVITY:**

1. Point out components of the gas power unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the gas power unit and normal operation procedures.

**STUDENT ACTIVITY:**

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.





3. Name and select the reference materials which describe the gas power unit and normal operation procedures.

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**OBJECTIVE 20.16:**

*Perform the abnormal operation procedures for the gas power unit.*

**CONDITIONS:**

Given a gas stream in a treatment plant and reference materials, including:

- industrial waste records
- operation logs
- operator manuals
- plant performance guides

**ACCEPTABLE PERFORMANCE:**

The student will:

Evaluate the gas stream for abnormal conditions, commenting on:

- flow
- gas composition
- toxic gases

Select the references he needs to return the gas stream to normal.

Perform the abnormal operation procedures.

**INSTRUCTOR ACTIVITY:**

1. Observe the student as he evaluates the gas stream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the gas stream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

**STUDENT ACTIVITY:**

1. Evaluate the gas stream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the gas stream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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