MWEA Collections Systems Committee

Wastewater Collections: A Need-to-Know

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CHAPTER ONE

What You Need to Know About Wastewater Collections Basics

1.1.0 Collection systems operators must be able to describe their responsibility for protecting public health and human and natural environments by safely consolidation, isolating, and conveying wastewater to treatment facilities.

1.2.0 Operators must be able to describe the origins of **domestic, industrial, and commercial wastewater.**

1.3.0 Operators must be able to define and distinguish between **sanitary sewers, storm sewers, and combined sewers.**

1.4.0 Operators must be able to define and distinguish between **gravity sewers, pressure sewers, and vacuum sewers.**

1.5.0 Operators must be able to define:

- 1.5.1 aerobic
- 1.5.2 anaerobic
- 1.5.3 anoxic
- 1.5.4 septic

1.6.0 Operators must be able to define **infiltration, exfiltration, and inflow**, and must also be able to recognize the typical indicators of each, including higher than normal flows, increased pumping time, muddy water, and a decline in expected flows.

1.7.0 Operators must be able to describe the specific influence of the following on pumping, piping, screening, and valving components of a collection system:

- 1.7.1 pH of the system
- 1.7.2 temperature of the waste system
- 1.7.3 dissolved oxygen (DO) levels or septicity of the waste stream
- 1.7.4 flow levels
- 1.7.5 grit
- 1.7.6 slope

1.8.0 Operators must be able to describe the specific dangers of the following when they are carried in, or associated with, the waste stream:

- 1.8.1 grease
- 1.8.2 flammable solvents and other light hydrocarbons
- 1.8.3 oil
- 1.8.4 hydrogen sulfide
- 1.8.5 methane
- 1.8.6 floating solids, such as plastics and other trash
- 1.8.7 “Sharps” such as needles and razor blades
- 1.8.8 toxic substances
- 1.8.9 pathogenic organisms

1.9.0 To provide warning to treatment plants, operators must be able to test for or visually recognize and describe abnormal sewage, including:

1.9.1 septic sewage
1.9.2 sewage with abnormally high biochemical oxygen demand (BOD)
1.9.3 sewage contaminated with industrial waste, including oil
1.9.4 sewage carrying excessive grit or other inorganic material
1.9.5 sewage carrying large amounts of storm debris, such as sticks or leaves.

1.10.1 Operators should be able to anticipate any negative impact that an abnormal waste stream might have on the treatment plant or on the collection system and its components.

1.11.0 Operators must be able to describe the environmental impact of spill of both “normal” and “abnormal” sewage in general terms. Further, they must know appropriate procedures for reporting and remediating such spills.

1.12.0 Operators must be able to perform the following mathematical calculations:

1.12.1 add, subtract, multiply, and divide whole numbers, decimals, and proper and improper fractions
1.12.2 square and cube whole numbers, decimals, and proper and improper fractions
1.12.3 convert fractions to decimals and vice versa
1.12.4 interpret graphs, including line, bar, percentage, and broken line graphs
1.12.5 read tables
1.12.6 use conventional formulas to solve for direct and inverse proportions
1.12.7 calculate the areas of two-dimensional planes, including triangles, squares, rectangles, and circles
1.12.8 calculate the surface areas of three-dimensional solids, including cylinders, cones and spheres
1.12.9 calculate the volumes of three-dimensional solids, including cubes and cylinders

1.13.0 Operators must be able to define and use common units of measurement, including:

1.13.1 parts per million (ppm)
1.13.2 milligrams per liter (mg/l)
1.13.3 pounds per square inch (psi)
1.13.4 feet of head
1.13.5 lbs/gal (1 gal = 8.34 lbs)
1.13.6 cubic feet per second (cfs)
1.13.7 gallons per minute (gpm)
1.13.8 gal/cu ft (7.48 gal = 1 cu ft)
1.13.9 feet per second (ft/sec)
1.13.10 inches of mercury (Hg)
1.13.11 inches of water
1.13.12 millions of gallons per day (mgd)

1.14.0 Operators must be able to convert pounds per square inch to feet of head, using the formula:

1 psi = 2.31 feet of head

1.15.0 Operators must be able to define the relationship between pressure and force, using the basic hydraulic concept of **Q = AV** (Flow = Area x Velocity).

1.16.0 Operators must be able to identify the segments of a sewage collection system, including:

1.16.1 lateral
1.16.2 branch
1.16.3 main (or trunk)
1.16.4 interceptor
1.16.5 outfall

1.17.0 Operators must be able to describe reporting requirements associated with overflows, bypasses, and system failures, including:

1.17.1 reporting to collection system owner
1.17.2 reporting to state regulatory authorities

1.18.0 Operators must be able to outline their responsibility for providing public notification concerning spills and for restricting public access to spill sites.

1.19.0 Operators must be able to maintain logs of repairs, upgrades, and maintenance so as to provide historical data, define funding needs, and facilitate long-term planning.

STUDY SUGGESTIONS FOR CHAPTER ONE

Wastewater Collection Basics

1. Unless otherwise noted, all study suggestions refer to six of the excellent training manuals for water and wastewater treatment operators prepared by Professor Ken Kerri of the University of California at Sacramento. In order of importance to collection system operators, they are:

a. Operators and Maintenance of Wastewater Collection Systems. (2 Volumes), Ken Kerri, Project Director, Hornet Foundation, Inc., California State University, Sacramento, 1991 edition of Volume 1 and 1087 edition of Volume 2.

b. Operation of Wastewater Treatment Plants. (2 Volumes), Ken Kerri, Project Director, Hornet Foundation, Inc., California State University, Sacramento, 1989 edition of Volume 1 and 1088 edition of Volume 2.

For information on purchasing any of these training manuals, contact Hornet Foundation, California State University, Sacramento, 6000 J Street, Sacramento, CA 95819-2654, phone: 916-278-6142.

2. O & M of Wastewater Collection Systems. Volume 1, pp. 3-20, contains basic collection system definitions and descriptions. See pp. 42-52 for diagrams and descriptions of gravity sewers, pressure sewers, and vacuum sewers, including their components and appurtenances. See also pp. 23-109 for general information on the purpose, components, and design of collection systems.

3. O & M of Wastewater Collection Systems. Volume 1, pp. 16-17, 36-37, and 183-185, explains detection and correction of infiltration and exfiltration. Do the practice questions on p. 186. Smoke testing to locate inflow and exfiltration is described on pp. 227-234.

4. O & M of Wastewater Collection Systems. Volume 1, pp. 347-353, describes procedures for controlling hydrogen sulfide. Read these pages and answer the questions on pp. 349 and 353.

5. O & M of Wastewater Collection Systems. Volume 1, pp. 479-518, a comprehensive discussion of arithmetic. This appendix entitles "Applications of Arithmetic to Collection Systems" covers all the calculations a collection systems operator might use.

6. O & M of Wastewater Collection Systems. Volume 2, pp. 366-390, for information on keeping work reports and records. Pages 390-393 describe report writing. Pages 392-395 discuss public relations.

REVIEW QUESTIONS FOR CHAPTER ONE

Wastewater Collection Basics

1. A sewer system that collects wastewater and storm of surface water runoff is called:
   a. Domestic sewer
   b. Mixed sewer
   c. Storm sewer
   d. Combined sewer

2. A single collection system for wastewater and industrial waste is known as:
   a. Sanitary sewer
   b. Combined sewer
   c. Conduit sewer
   d. Storm sewer

3. The minimum scouring velocity to prevent the settling of solids in the sewer is:
   a. 1 ft/sec
   b. 1 ft/min
   c. 2 ft/sec
   d. 2 ft/min

4. The best reason to control infiltration and inflow is to:
   a. Prevent pipe damage
   b. Prevent hydraulic overloads
   c. Prevent pipe movement
   d. Prevent soil erosion

5. Volatile solvents in a collection system:
   a. Are often used for grease control
   b. Prevent the "rotten egg" odor
   c. Can produce an explosion hazard
   d. Cause settling of solids and corrosion of pipes

6. You discover that a toxic substance has just entered the sanitary sewer system. Your first action should be to:
   a. Notify the Mayor's Office
   b. Notify the wastewater facility
   c. Blockade the are
   d. Locate the source

7. A gradual increase in sewer flows from fall to spring is most often attributed to:
   a. Exfiltration
   b. Infiltration
   c. Surcharged manholes
   d. Conductor conduits

8. The flow or current in an electrical circuit is measure as:
   a. Volts
   b. Watts
   c. Amps
   d. Ohms

9. Find the volume of a wet well with a 6-foot diameter and 15-foot depth.
   a. 71 ft^3
   b. 424 ft^3
   c. 1696 ft^3
   d. 3171 ft^3

10. Convert the cubic footage of water in question 9 to gallons.
   a. 531 gallons
   b. 3171 gallons
   c. 12,686 gallons
   d. 32,719 gallons

11. In the basic hydraulic formula Q = AV, Q can be expressed as:
   a. MGD
   b. ft^3/sec
   c. gpm
   d. all of the above

12. A lift station wet well gauge reads 60 inches. Convert the reading to psi.
   a. 25.9

b. 11.6
c. 2.2
d. 5.0

13. Slow-moving flow in sewers can allow organic matter to settle and can result in:
    a. Hydrogen sulfide generation
    b. Exfiltration
    c. Lift station failure
    d. Hydraulic overloads

14. A flow of 1 mgd is equal to:
    a. 1.0 ft^3/sec
    b. 1.54 ft^3/sec
    c. 2.0 ft^3/sec
    d. 2.5 ft^3/sec

15. Muddy water and increased flow during rainfall are symptoms of:
    a. Hydrogen sulfide generation
    b. Exfiltration
    c. Problems at the wastewater plant
    d. Inflow and Infiltration

16. The sewer line that leaves the wastewater treatment plant is called:
    a. Interceptor
    b. Trunk
    c. Outfall
    d. Branch

17. A manhole is overflowing with sewage. The operator must:
    a. Correct the problem
    b. Clean the area of impact
    c. Report the incident to appropriate authorities and regulators
    d. All of the above

18. A characteristic of methane gas is that it:
    a. Is not poisonous
    b. Is greenish yellow in color
    c. Is explosive
    d. Has a specific gravity of .5

CHAPTER TWO

What You Need to Know About Personal and Public Safety

2.1.0 For the following common hazards operators must be able to describe the potential dangers, list appropriate safety precautions, select and use proper safety equipment and/or personal protection devices, and demonstrate proper first-aid techniques for injuries.

- 2.1.1 pathogenic organisms in the waste stream
- 2.1.2 toxic chemicals
- 2.1.3 oxygen deficient, toxic, or explosive atmospheres
- 2.1.4 open electrical circuits
- 2.1.5 flammable materials
- 2.1.6 moving mechanical equipment
- 2.1.7 noise levels over 85 decibels
- 2.1.8 slipping, tripping, and falling hazards
- 2.1.9 confined spaces

*This chapter describes general safety skills. See also individual chapters which contain information about specific hazards, skills, and equipment.

2.2.0 Operators must be able to design and implement a safety program that includes:

- 2.2.1 use of personal safety equipment
- 2.2.2 demonstration of procedures for hazard prevention
- 2.2.3 maintenance and calibration of safety equipment and monitoring devices

2.3.0 Operators must be able to define:

- 2.3.1 oxygen deficiency
- 2.3.2 fumes
- 2.3.3 vapors
- 2.3.4 dusts
- 2.3.5 mists
- 2.3.6 olfactory fatigue
- 2.3.7 asphyxiants
- 2.3.8 combustible
- 2.3.9 explosive
- 2.3.10 flash point
- 2.3.11 corrosivity

2.4.0 Operators must be able to identify and use the following person protection devices properly:

- 2.4.1 rain gear
- 2.4.2 cold weather gear

2.4.3 hard hats
2.4.4 safety glasses, goggles, and face shields
2.4.5 ear plugs and ear muffs
2.4.6 gloves (rubber, latex, leather, and canvas)
2.4.7 safety shoes and boots (steel toe and instep)
2.4.8 rubber boots (steel toe preferred)
2.4.9 leather and rubber aprons, leggings, arm protectors
2.4.10 traffic vests
2.4.11 flotation vests and life rings

2.5.0 Operators must be able to identify and describe the proper use of the following pieces of safety equipment:

2.5.1 self-contained breathing apparatus (SCBA)
2.5.2 cartridge respirators
2.5.3 dust masks
2.5.4 safety harnesses
2.5.5 lifelines, safety lines, and tether lines
2.5.6 tripods (“manlifts”)
2.5.7 winches
2.5.8 first-aid kits
2.5.9 manhole barricades
2.5.10 ventilators
2.5.11 noise detectors
2.5.12 fire extinguishers (Class A, B/C, D, and ABC)
2.5.13 flashlights, lanterns, and flares

2.6.0 Operators must be able to inspect safety equipment for signs for “wear and tear” or inoperability, both before and after use. Operators must familiarize themselves with daily, weekly, monthly, and annual inspections schedules, for the equipment at the facilities.

2.7.0 Operators must be able to demonstrate the following first-aid skills:

2.7.1 use of first-aid kit for the treatment of minor injuries such as cuts, scratches, and eye irritations
2.7.2 ability to provide basic life support to an accident victim (i.e. maintaining breathing and circulation, demonstrating proper procedures for requesting medical assistance)
2.7.3 knowledge of the danger inherent to assisting any individual apparently in need of first aid, such as the possibility of aggravating the victim’s injuries or putting themselves in danger.

2.8.0 Operators should have basic knowledge of first aid and cardiopulmonary resuscitation (CPR). In some cases, certification is required.

2.9.0 Operators must be able to perform a safety analysis of each structure or work area they encounter. Such an analysis must consider:

2.9.1 hazards associate with the work area itself (for example, no toe guards, poor lighting confined space)

2.9.2. hazards associated with the nature of the work to be performed (for example, hosing down floors, mixing chemical, cleaning out pumps)

2.9.3 hazards associated with the specific time at which the work will be performed (for example, night work, adverse weather conditions, coordination with other crews working simultaneously).

2.10.0 To prevent recurrence of accidents, operators should be able to perform job safety analysis as a follow-up to all accidents occurring in their work areas.

2.11.0 Operators should be able to develop a standard operating procedure (SOP) for every task they are assigned.

2.12.0 Operators must be able to test for hazardous atmosphere in sewers, manholes, lift stations, and other below-ground collection system structures. Testing skills include:

2.12.1 properly use an explosimeter to detect and measure concentrations of explosive gases and vapors, including methane

2.12.2 properly use an oxygen meter to detect oxygen deficiency (less the 19.5% O_2) and to measure exact oxygen levels

2.12.3 properly use a toxic or explosive gas detector to measure free hydrogen sulfide (H_2S).

2.13.0 Operators must be able to list the common physical symptoms of acute exposure to an oxygen deficient atmosphere, including dizziness, headache, light-headedness, nausea, euphoria, blurred vision, and discomfort in breathing.

2.14.0 Operators must be able to define *Threshold Limit Value* (TLV), *Permissible Exposure Limit* (PEL), *Short-term Exposure Limit* (STEL), *Lower Explosive Limit* (LEL), and *Immediate Danger to Life or Health* (IDLH). Operators must be able to apply these terms when performing the tests described above.

2.15.0 Operators must be able to define *pathogen* and outline specific procedures for reducing the hazards of infection form waterborne pathogenic organisms.

2.16.0 Operators must be able to define *aerosol* and explain the conditions under which pathogens may become airborne.

2.17.0 Operators must be able to list examples of waterborne infectious diseases such as poliomyelitis, typhoid, cholera, bacillary and amoebic dysentery, tuberculosis, tetanus, and hepatitis. Operators must always assume the presence of such diseases in wastewater.

2.17.1 Operators must be able to explain how appropriate personal hygiene and immunization can reduce the risks of contracting infectious diseases.

2.18.0 Operators must be able to identify and interpret chemical labeling systems, particularly the National Fire Prevention Association (NFPA) system. Operators must also be able to interpret Material Safety Data sheets (MSDSs).

2.19.0 Operators must be able to describe proper rescue techniques for confined spaces, including self-rescue, non-entry rescue, and entry rescue.

2.20.0 Operators must be able to describe the proper use of ventilators in both routine and rescue operations in confined spaces. Specifically, operators must be able to:

2.20.1 describe situations in which a ventilator should be used to force fresh air into a work area.
2.20.2 describe situations in which a ventilator should be used to exhaust toxic substances from an area.
2.20.3 detail the use of multiple ventilators with series of manholes (upstream or downstream, or both) and describe situations in which such a strategy may be necessary.
2.20.4 describe the use of ventilator hoses as resuscitation devices during rescue operations. (The placement of a fresh-air ventilator hose directly over the face of an unconscious coworker may be the most significant life-saving act performed during the rescue)

2.21.0 Operators should be able to use SCBA respirators properly. In some cases, this may be required.

2.22.0 Operators should be able to define *conductor, insulator, open circuit*, and *closed circuit*.

2.23.0 Operators must be aware that a fatal electrocution can occur, and must understand that electrical troubleshooting and repair may be performed only by qualified and authorized personnel, and only after completely locking out and tagging affected equipment.

2.24.0 Operators must be able to describe and implement methods for protecting the public and prohibiting trespassing on sewer repair job sites, including:

2.24.1 barricading the work area from public access
2.24.2 properly storing tools and securing equipment when not in use
2.24.3 ensuring that diesel and gasoline exhausts are positioned away from all ventilation systems
2.24.4 wearing traffic control vests

2.25.0 Operators should have a valid driver's license and be able to demonstrate safe defensive driving techniques when traveling to and from job sites.

2.26.0 Operators should be able to safely transport equipment, including trucks, backhoes, rolling stock, and trailers. Operators must also be able to perform backing-up maneuvers with such equipment in tow.

2.27.0 Operators must be able to perform routine inspections of their equipment in insure that it is road-worthy.

2.28.0 Operators must be able to devise and implement traffic-control procedures that protect both the public and the job site. Operators should be able to:

2.28.1 outline and comply with state highway administration, local and employer guidelines for establishing traffic control procedures

2.28.2 define and outline functions of various control zones, including advance warning areas, transition areas, work areas, termination areas, and buffer spaces

2.28.3 correctly identify barricade systems, hand signals, and properly set up barricade systems

STUDY SUGGESTIONS FOR CHAPTER TWO

Personal and Public Safety

1. O & M of Wastewater Collections Systems, Vol 1, has a chapter entitled "Safe Procedures", pp. 111-175. This comprehensive chapter describes specific collection system hazards, safety equipment, and hazard prevention techniques. This is a "must read" for all collection system operators. Use the review questions throughout the chapter. See also Chapter 3, Section 3.70, "Excavation and Shorings".

REVIEW QUESTIONS FOR CHAPTER TWO

Personal and Public Safety

1. Diseases or infections a collection system operator could be exposed to include all following *except*:
   a. Polio
   b. Tetanus
   c. Malaria
   d. Roundworm

2. A manhole has an oxygen level of 17%. This would be considered"
   a. Oxygen deficient
   b. Safe to enter
   c. An eutrophic area
   d. A depression zone

3. Collection system gases that have a specific gravity greater than 1.0:
   a. Are explosive
   b. Are colorless
   c. Are heavier than air
   d. Are lighter than air

4. Bacteria, viruses, and cysts that can cause disease are called:
   a. Pathogens
   b. Aerobic
   c. Anaerobic
   d. Anoxic

5. After periods of exposure to certain odors, a person may lose the ability to detect (smell) those odors. This condition is called:
   a. Offset fatigue
   b. Air gap
   c. "N" factor
   d. Olfactory fatigue

6. Gas hazards a collection system operator may encounter include:
   a. Poisonous or toxic gases
   b. Explosive gases
   c. Oxygen deficient atmosphere
   d. All of the above

7. When describing a particular gas, "LEL" stands for:
   a. Lower Elevation Limit
   b. Lower Explosive Limit
   c. Lower Entrance Limit
   d. Lower Evaporation Limit

8. To safely extinguish an electrical fire, and operator should use a Class _____ fire extinguisher:
   a. A
   b. B
   c. C
   d. D

9. Death from electrical shock can occur with amperage as low as:
   a. 33 milliamps
   b. 10 milliamps
   c. 1 milliamp
   d. Volts kill—not amps

10. A gasoline-driven air ventilator located close to a confined working area can create an atmospheric hazard due to:
    a. Carbon monoxide generation
    b. High oxygen exchange
    c. Gas compaction
    d. Gas dilution

11. Gas test equipment should:
    a. Indicate the level of an atmosphere hazard
    b. Produce an audio alarm when test indicates danger
    c. Be tested for accuracy and reliability
    d. All of the above

12. All the following gases encountered in a sewer collection system are considered explosive *except*:
    a. Carbon dioxide
    b. Hydrogen
    c. Methane
    d. Hydrogen sulfide

13. When testing for combustible or toxic gases, what should be the order of the tests?
    a. Explosive conditions, combustible gas-oxygen deficiency, hydrogen sulfide
    b. Combustible gas-oxygen deficiency, explosive conditions, hydrogen sulfide
    c. Hydrogen sulfide, explosive conditions, combustible gas-oxygen deficiency
    d. Explosive conditions, hydrogen sulfide, combustible gas-oxygen deficiency

14. Which of the following describes chlorine gas?
    a. Colorless
    b. Tasteless
    c. Explosive
    d. Nonflammable

15. Prior to safely dismantling a pump, an operator should:
    a. Lockout and tag
    b. Isolate
    c. Relieve pressure
    d. All of the above

16. When the oxygen content of air is _____, it can be fatal.
    a. 15-20%
    b. 21-23%
    c. Below 10%
    d. Above 25%

17. To get the most accurate measurement of atmospheric conditions inside a manhole:
    a. Ventilate the manhole before testing to maintain meter accuracy
    b. Conduct the test through manhole cover hole before opening
    c. Test the manhole at various levels (top, midway, bottom)
    d. Drop a burning match or cigarette into the manhole if it continues to burn, then the conditions are safe

18. The primary advantage of the parachute-type safety harness is that it:
    a. Prevents a limp body from falling out
    b. Easily fits the average operator
    c. Works with tripods on the deeper manholes
    d. Opens to prevent a free fall is an operator slips

19. When routing traffic through a work area, you should take precautions to:
    a. Regulate speed
    b. Prewarn motorists
    c. Guide traffic
    d. All of the above

20. Best protection against exposure to toxic acids, bases, and other hazardous liquids can best be done with:
    a. Proper boots and gloves
    b. Dilution with water
    c. Adequate ventilation
    d. The use of an SCBA

21. Limitations of canister-type respirators include:
    a. Uselessness in oxygen deficient atmospheres
    b. Uselessness after expiration date
    c. Effectiveness only in certain class atmosphere
    d. All of the above

22. Symptoms an operator might experience in an oxygen-deficient atmosphere include:
    a. Dizziness
    b. Difficulty breathing
    c. Nausea
    d. All of the above

23. The Material Safety Data Sheet (MSDS) provides the operator with:

a. Standard procedures for operation of the SCBA
b. Standard procedures for operation and care of respirators
c. Properties, hazards, and precautions for a specific chemical
d. Information on the "chain of custody" for particular chemicals

CHAPTER THREE

What You Need to Know About Collection System Structures

3.1.0 Operators must be able to identify and use:

3.1.1 manhole cones (eccentric and concentric)
3.1.2 manhole barrels
3.1.3 manhole shelves
3.1.4 manhole frames and covers (lids)
3.1.5 drop manholes
3.1.6 catch basins
3.1.7 inlets
3.1.8 lampholes
3.1.9 slant and vertical lateral cleanouts
3.1.10 siphons and inverted siphons
3.1.11 diversion structures
3.1.12 valves (including ball valves, check valves, globe valves, plug valves, gate valves, foot valves, mud valves, butterfly valves, air petcock valves, air-release valves, telescoping valves, sluice gate valves, and multiport valves)
3.1.13 pipes and fittings (including flexible and rigid pipe fittings and joints)

3.2.0 Operators must be able to list and describe the four typical valve applications.

3.2.1 flow control
3.2.2 directional control
3.2.3 pressure controls
3.2.4 isolation

3.3.0 Operators must be able to explain the proper setting (open) of valves located on the discharge side of all pumps (particularly positive displacement pumps, but excepting centrifugal blowers) at time of startup.

3.4.0 Operators must be able to explain the correct procedure for valve closure on positive displacement pumps: the pump must be shut down, must come to rest, and must be locked out.

3.5.0 Operators must be able to identify typical jointing techniques used for pipe-to-pipe and pipe-to-valve connections, including chemical welds, heat welds, flanging, threading, and compression joints.

3.6.0 Operators must be able to identify typical plumbing component materials, including: copper, bronze, brass, lead, ductile iron, cast iron, stainless steel, cast steel, PVC, vitrified clay, concrete, and asbestos/cement (A/C).

3.7.0 Operators must be able to use maps and blueprints to detail the size, location, elevation, station number, and characteristics of all manholes and cleanouts in a collection system.

3.8.0 Operators should be able to use constructions and survey instruments to determine the elevation of the invert of all pipes and plumbing entering or exiting a structure.

3.9.0 Operators should be able to interpret and devise color-coding systems for distinguishing individual piping networks (including electrical conduit).

3.10.0 Operators must be able to demonstrate and describe safe methods for performing the following tasks:

- 3.10.1 making flow measurements
- 3.10.2 taking samples
- 3.10.3 making line and manhole inspections
- 3.10.4 performing line maintenance
- 3.10.5 changing flow patterns through a diversion structure
- 3.10.6 lamping a line

3.11.0 Operators must be able to describe and perform air and water testing for collection system leaks.

3.12.0 Operators must be able to describe the use (and limitations) of smoke and dye test for detecting violations of sewer use ordinances, such as those which prohibit the connection of roof gutters or basement sumps.

3.13.0 When inspecting manholes, operators must be able to detect signs of unauthorized entry, illegal dumping, or vandalism. Evidence may include high water grease line, debris, and signs of poor entry procedures.

3.14.0 Operators must be able to recognize and prescribe corrective maintenance for typically encountered problems, including:

- 3.14.1 submerged manhole covers
- 3.14.2 deteriorating walls
- 3.14.3 hydrogen sulfide (H_2S) damage

3.15.0 Operators must be able to identify and describe the use of common constructions materials used for preventive and corrective maintenance in collection systems, including:

- 3.15.1 pre-cast concrete
- 3.15.2 brick

3.15.3 cement compounds
3.15.4 waterproofing materials
3.15.5 grouts, caulks putties, and other sealing compounds

3.16.0 On gate valves and other manually adjustable flow-control valves, operators must be able to adjust gate stops to lock in those valves = normal operating ranges. On such valves, operators must also be able to identify:

3.16.1 full open point
3.16.2 full closed point
3.16.3 normal operating point
3.16.4 proper throttling technique

3.17.0 Operators should be able to outline methods for preventing leakage on all valves with packing glands, without excessively binding valve stems.

3.18.0 Operators should be able to disassemble check valves to replace hinge pins, flappers, and slats.

3.19.0 Operators should be able to outline a complete corrosion control and lock-up prevention program for valves.

3.20.0 Operators should be able to set up and implement and effective and practical program for coating and/or painting all plumbing in a facility. Operators should be able to select proper coating for all materials, considering such factors as corrosion and rust control, cathodic protection, submersion, and potential presence of oxidizers, caustics, and acids.

3.21.0 Operators must be able to describe the causes and effects of cathodic deterioration.

3.22.0 Operators should be able to perform minor plumbing repairs, using compatible materials to prevent the possibility of cathodic deterioration.

3.23.0 Operators must be able to describe and demonstrate proper valve startup and shutdown procedures, including:

3.23.1 determining the operational status of each valve in the system
3.23.2 enabling or disabling each valve electrically, mechanically, hydraulically, or pneumatically
3.23.3 determining the operational status of, and enabling or disabling, all other devices in operation in the system

3.24.0 Operators must identify steps necessary for appropriate lockout/tagout of equipment before beginning work on equipment.

STUDY SUGGESTIONS FOR CHAPTER THREE

Collections System Structures

1. See Chapter 3, "Wastewater Collection Systems" of O & M of Wastewater Collection Systems, Vol. 1, pp. 23-109. This chapter explains the purpose, the components, and the design of wastewater collection systems. Its supplement on construction, inspection, and testing is also a good reference. See pp. 61-62 for a description of typical plumbing construction materials. Answer the questions on p. 63.

2. O & M of Wastewater Collections Systems, Vol. 1, pp. 183-186 contains general information on leakage, inflow, and infiltration. Pages 257-366 describe pipeline cleaning and maintenance methods. Pages 367-428 cover underground repair.

REVIEW QUESTIONS FOR CHAPTER THREE

Collections Systems Structures

1. Manholes are used to:
   a. Change in horizontal alignment
   b. Provide rest area in large sewers
   c. Increase flow velocities
   d. Provide test of oxygen deficiency meters

2. A shaft in which wastewater is allowed to fall or drop from a higher level to the bottom of the manhole is:
   a. A vertical offset
   b. A drop manhole
   c. A downspout
   d. A drop joint

3. Rising stem and non-rising stem are term used to describe:
   a. Pump stations
   b. Cleanouts
   c. Manholes
   d. Gate valves

4. A disadvantage associated with the use of butterfly valves in wastewater lift stations is:
   a. Large amounts of space required
   b. Rising stem often makes valve difficult to open in tight situations
   c. Tendency to accumulate debris
   d. Not suitable for use with automatic valve actuators

5. The valve that has the greatest friction loss is:

a. Gate valve
b. Check valve
c. Glove valve
d. Butterfly valve

6. The invert of a pipe refers to:
a. Center of the bottom on the inside
b. Center of the bottom on the outside
c. Center of the pipe
d. Top of the pipe

7. Manholes are located at station 10 + 30 and station 13 + 50. The distance between the manholes is:
a. Standard distance 300 ft
b. 350 ft
c. 320 ft
d. 1350 ft

8. Using the manholes in question 8, an operator measures the time takes for dye to travel from manhole to manhole at 2 minutes and 45 seconds. What is the velocity in the sewer?
a. 1.0 ft/sec
b. 2.2 ft/sec
c. 5 ft/sec
d. 1.9 ft/sec

9. Velocity (V) equals:
a. Time (T) times Area (A)
b. Distance (D) divided by Time (T)
c. Time (T) divided by Area (A)
d. Flow (Q) times Area (A)

10. The “scouring velocity” in a sewer should be a minimum of:
a. 0.5 ft/min
b. 1.0 ft/min
c. 1 ft/sec
d. 2 ft/sec

11. A pressure pipeline used to carry wastewater flowing in a gravity collection system under a depression such as a creek is called:
a. Inverted siphon
b. Drop connection
c. Vertical riser
d. Slanted riser

12. Which of the following is not a manhole component?
a. Barrel
b. Bench
c. Frame and cover

d. Drop joint

13. Hinge pins, flappers, and slats are components found in:
    a. Check valves
    b. Parshall flumes
    c. Manholes
    d. Lampholes

14. Signs of hydrogen sulfide gas in a sewer include all of the following *except*:
    a. Rotten egg odor
    b. High wastewater pH
    c. Oxygen deficiency
    d. Deteriorating wall in manhole

CHAPTER FOUR

Collection System Maintenance Equipment

4.1.0 Operators must be able to identify and describe the use of the following pieces of collection line inspection equipment:

4.1.1 manhole plugs (with or without air pressure lines)
4.1.2 pipe plugs
4.1.3 deflection gauges
4.1.4 sewer balls (pigs)
4.1.5 smoke generators
4.1.6 closed circuit television monitoring systems (CCTV)

4.2.0 Operators should be able to identify and state the function of the following CCTV components:

4.2.1 camera
4.2.2 TV cable and cable reel
4.2.3 video monitor
4.2.4 measure meter
4.2.5 system control unit
4.2.6 light head assembly
4.2.7 tow cables
4.2.8 video tape equipment
4.2.9 power plant
4.2.10 keypad data entry

4.3.0 Operators must be able to describe the use of smoke bombs, smoke blowers, and pipe plugs for performing smoke tests to detect I & I sources. Operators must be able to describe and implement safety precautions for smoke testing, including prior notification of the public and of fire and police departments.

4.4.0 Operators must be able to perform life deflection tests. Operators should be able to use the following pieces of equipment to perform these tests:

- 4.4.1 tag lines
- 4.4.2 pulling rings
- 4.4.3 return winches
- 4.4.4 pulley assemblies
- 4.4.5 line deflection mandrels

4.5.0 Operators must be able to identify, list the components of, and state the specific uses and limitations of the following sewer-cleaning devices:

- 4.5.1 high-velocity water cleaners (“jet rodders”)
- 4.5.2 hand rodders and power rodders
- 4.5.3. scooters
- 4.5.4 balling systems
- 4.5.5 flushing systems

4.6.0 Operators must be able to describe the application of the following lines repair methods of systems:

- 4.6.1 sealing/grouting units
- 4.6.2 shotcrete
- 4.6.3 slip-lining systems
- 4.6.4 line encapsulation systems
- 4.6.5 cured in place

4.7.0 Operators should be able to use the following equipment when installing line-repair systems:

- 4.7.1 manhole plugs
- 4.7.2 slings
- 4.7.3 repair clamps

4.8.0 Operators must be able to state the specific dangers of performing trenching and shoring operations. Operators must be able to list the precautions and equipment necessary to minimize the following specific hazards:

- 4.8.1 hazardous atmosphere
- 4.8.2 cave-ins
- 4.8.3 falling equipment
- 4.8.4 traffic hazards
- 4.8.5 injury to onlookers

4.9.0 Operators must be able to describe the use of the following equipment in trenching and shoring operations:

- 4.9.1 braces (struts)

4.9.2 sheeting
4.9.3 stingers
4.9.4 cleats
4.9.5 screw jacks
4.9.6 hydraulic cylinder shores

4.10.0 Operators should be able to describe routine preventative maintenance procedures and must be able to set up and keep a maintenance log for all equipment listed in this chapter. Where maintenance procedures are not common knowledge, operators should be able to list procedures for obtaining maintenance information from manufacturers and/or employers.

STUDY SUGGESTIONS FOR CHAPTER FOUR
Collection System Maintenance Equipment

1. See O & M of Wastewater Collection Systems. Vol 1, "Inspecting and Testing," pp. 181-256. For information on closed circuit television monitoring systems, see ppl 193-226 and the appendix, pp. 242-256.

2. See the supplement to Chapter 3, "Construction, Inspection and Testing," in O & M of Wastewater Collection Systems, Vol. 1, pp. 71-109. Excavation and shoring are described on pp. 71-78. See the diagrams on pp. 74, 75, 76, and 79. Also review the tables on p. 73. Air and water testing procedures are outlined on pp. 95-103. See also pp. 257-366 which describe pipeline cleaning and maintenance methods. Pages 367-428 cover "Underground Repair."

3. O & M of Wastewater Collection Systems, Vol. 2, pp. 121-234, outlines equipment maintenance for collection systems. Sewer rehabilitation is described on pp. 235-294.

REVIEW QUESTIONS FOR CHAPTER FOUR
Collection System Maintenance Equipment

1. To get consistent pictures and help prevent the camera from getting stuck in the line, the TV camera should:
   a. Float in the liquid from the manhole to manhole
   b. Be pulled through obstructions at a steady pace
   c. Be pulled upstream to downstream
   d. Be pulled downstream to upstream

2. When setting up the TV camera footage meter, is should read zero:
   a. When the camera is centered in the manhole

b. When the camera enters the pipe on the upstream side
c. When the camera enters the pipe on the downstream side
d. At the beginning of each day

3. When using a hydraulic cleaner to remove an obstruction, the nozzle should:
   a. Be placed in the downstream manhole
   b. Be placed in the upstream manhole
   c. Be removed until the blockage is located
   d. Be forced by hand to the obstruction

4. To remove roots, it is bests to use:
   a. A sewer ball
   b. A scooter
   c. A high velocity nozzle
   d. A hydraulic cutter

5. An effective method for removing debris in a large diameter pipe is:
   a. Balling
   b. Flushing
   c. Using a bucket machine
   d. Using hand rods

6. A limitation of the high velocity cleaner is that it is:
   a. Ineffective in cleaning slow flowing sewers
   b. Not very effective in cleaning large diameter pipe
   c. Ineffective in cleaning manhole walls and bench
   d. Ineffective in emergency blockage situations

7. A process of sewer line rehabilitation which involves the use of polyester fiber felt tube, lined on one side with polyurethane and impregnated with a liquid thermal setting resin. Is:
   a. Slip lining
   b. Shotcrete
   c. Cured in place
   d. Poly-u-liner

8. When removing screw jacks used for shoring, operators must:
   a. Remove the screw jacks in the same order they were installed
   b. Remove the crew jacks from the bottom to the top
   c. Leave the screw jacks in
   d. Remove the crew jacks from the top to the bottom

CHAPTER FIVE

Engines, Motors and Generators

5.1.0 Operators must be able to identify and state the basic operating principles of gasoline (both 2-cycle and 4-cycle) and diesel engines, and be able to select or prepare the appropriate fuel for each.

5.2.0 Operators should be able to locate the following components of gasoline and diesel engines:

- 5.2.1 throttle
- 5.2.2 choke
- 5.2.3 battery
- 5.2.4 pull-rope
- 5.2.5 spark plugs or glow plugs
- 5.2.6 air filter, fuel filter and oil filter
- 5.2.7 oil drain plug
- 5.2.8 cooling system
- 5.2.9 fan belt

5.3.0 Using typical operating gauges (tachometer, oil and fuel gauges, and temperature gauges), operators must be able to determine whether an engine is operating safely and efficiently.

5.4.0 Operators should be able to perform routine preventive maintenance on internal combustion engines including:

- 5.4.1 changing and cleaning filters
- 5.4.2 changing crankcase oil
- 5.4.3 replacing and gapping new spark plugs and points (for gasoline engines)
- 5.4.4 inspecting and replacing belts
- 5.4.5 checking and maintaining battery, battery cables, and terminal posts
- 5.4.6 checking and maintaining coolant levels
- 5.4.7 determining and filling the need for wintertime fuel additives

5.5.0 Operators should be able to perform simple troubleshooting techniques for engines, including:

- 5.5.1 checking spark plug connections
- 5.5.2 checking for blocked fuel lines
- 5.5.3 diagnosing engine flooding
- 5.5.4 checking air filters for blockage
- 5.5.5 priming dry injectors (for diesel engines)

5.6.0 Operators must be able to recognize and describe the proper responses to the following hazards associated with electric motor operation:

- 5.6.1 loose wires
- 5.6.2 damaged insulation
- 5.6.3 ground faults
- 5.6.4 short circuits resulting from leaks, spills or dry chemicals
- 5.6.5 accidental turn-on of motors during maintenance

5.7.0 Operators must be able to recognize and describe proper responses to safety hazards associated with generator operation, including:

- 5.7.1 exposed rotating shafts
- 5.7.2 heat build-up
- 5.7.3 exposed electrical terminals
- 5.7.4 inadequate insulation
- 5.7.5 moisture build-up
- 5.7.6 free hydrogen (H_2) gas in atmosphere

5.8.0 Using typical operating parameters (voltage, amperage, kilowatt-hours), operators must be able to determine that a generator is running safely and efficiently. Operators must be able to state correct procedures for recording generator performance data.

5.9.0 Operators must be able to determine the stand-by power requirements for a facility, and identify which internal systems are served and which systems are not served by stand-by power. For generator systems that have not been designed for automatic startup after power failure, operators must be able to demonstrate manual startup and shutdown procedures.

5.10.0 Operators must be able to inspect generators to ensure that they are running properly, are producing no excess heat or vibration, and are correctly coupled to their motors.

5.11.0 Operators must be able to bring a generator on-line and return it to standby under both test and real emergency conditions.

5.12.0 Operators should safely be able to use the following pieces of test equipment:

- 5.12.1 volt-ohm meter (VOM)
- 5.12.2 continuity tester
- 5.12.3 ammeter
- 5.12.4 megger

5.13.0 Operators must be able to recognize and describe the proper responses to hazards associated with battery bank operation, including:

- 5.13.1 battery acid (H_2SO_4)
- 5.13.2 electric shock
- 5.13.3 improper grounding
- 5.13.4 use of insufficiently insulated safety gear

5.14.0 Operators must be able to locate and interpret performance specification for a battery bank, including:

- 5.14.1 voltage
- 5.14.2 amp/hours
- 5.14.3 specific gravity of electrolyte

5.15.0 Operators must be able to safely mix and dilute battery electrolyte

5.16.0 Operators must be able to test voltage and specific gravity of battery electrolyte, both while in standby mode and while battery (or bank) is under full load conditions.

5.17.0 Operators must be able to demonstrate the following preventive maintenance operations for batteries and battery bank:

5.17.1 checking electrolyte levels (adding electrolyte or distilled water when necessary)
5.17.2 cleaning terminals
5.17.3 inspecting cables for deteriorating insulation, foreign matter, and tight terminal connections

5.18.0 Operators should be able to locate, identify, and describe the following components in a lift station:

5.18.1 communitors, screens, and bar racks
5.18.2 flow equalization basins
5.18.3 influent pipes
5.18.4 force mains
5.18.5 pump inlet piping including eccentric and concentric reducers
5.18.6 pump inlet and outlet isolation valves
5.18.7 stilling wells
5.18.8 cathodic protection
5.18.9 electrical controls including starter, breakers, overloads, ground fault protectors, and automatic speed controls
5.18.10 pressure and vacuum gauges

5.19.0 Operators should be able to diagnose and outline procedures for correcting common lift station power problems including:

5.19.1 failure of one or more phases of power
5.19.2 tripping of fuses, breakers, ground fault interrupters and thermal overload protectors
5.19.3 motor failure
5.19.4 starter or magnetic starter failure

5.20.0 Operators must be able to list and describe the three basic steps for sate removal of lift station components needing repair, replacement, or maintenance.

STUDY SUGGESTIONS FOR CHAPTER FIVE

Engines, Motors, and Generators

1. O & M of Wastewater Collection Systems, Vol. 2, discusses motors on pp. 140-159. Pay particular attention to the troubleshooting section on pp. 153-158. See the “Additional Reading” list on

p. 159. General information on lubrication can be found on pp. 224-227. This section includes a sample lubrication chart showing schedule and type of lubrication.

2. Electrical dangers are described on p. 129 of O & M of Wastewater Collection Systems, Vol. 2. Electrical system tools, meters, and testers are discussed on pp. 132-135. Be sure to answer the questions on p. 135. Electrical system equipment maintenance is described on pp. 135-140. Do the questions on pp. 139 and 140.

REVIEW QUESTIONS FOR CHAPTER FIVE

Engines, Motors, and Generators

1. A device used to measure the specific gravity of a liquid is:
   a. Hydrometer
   b. Manometer
   c. Barometer
   d. Spectrometer

2. When replacing a defective three-phase motor, an operator determines that the new motor rotation is incorrect. The operator should:
   a. Disconnect the motor until correct motor is found
   b. Switch the motor frame until mounting corrects rotation
   c. Reverse any two motor leads to change the rotation
   d. Advise the power company to correct the problem

3. To prevent the possibility of bodily injury when working on gasoline engines = electric fuel pumps:
   a. Always disconnect the battery-to-ground cable
   b. Drain the fuel from the pump
   c. Always disconnect the positive battery lead
   d. Turn off the governor control

4. A hazard not associated with battery operations is:

a. Acid burns
b. Electric shock
c. Explosive fumes
d. Oxygen deficiency

5. A device used to measure the resistance (in million ohms) between a motor winding and the motor housing is called:

a. A fault tester
b. A megger
c. An ammeter
d. A parameter

CHAPTER SIX
Coupling and Drive Mechanisms

6.1.0 For belt-driven equipment, operators must be able to locate and describe the functions of belts, belt guards, sheaves (pulleys), drive shafts, and pump shafts.

6.2.0 Operators must be able to diagnose and prescribe corrective maintenance for typical malfunctions of coupling mechanisms, including:

6.2.1 damaged interlocking devices
6.2.2 vibration due to misalignment
6.2.3 damaged or stretched belts
6.2.4 stripped gears
6.2.5 worn sprockets
6.2.6 excessive wobble

6.3.0 Operators must be able to select proper replacement belts and sheaves for belt-driven equipment, and must be able to adjust tension to prevent slippage at startup.

6.4.0 Operators must be able to lock out all coupled and belt-driven equipment before maintenance or inspection. Before startup, operators must be able to verify proper operation of all couplings and drive mechanisms, performing pre-startup inspections and making adjustments when necessary.

STUDY SUGGESTIONS FOR CHAPTER SIX
Coupling and Drive Mechanisms

1. There are sections on the operation and alignment of couplings on p. 110 and on pp. 216-220 of O & M of Wastewater Collections Systems, Vol. 2. Study these sections and answer the related questions on p. 220.

REVIEW QUESTIONS FOR CHAPTER SIX

Coupling and Drive Mechanisms

1. When replacing belts on belt-driven equipment, you should not:
   a. Use matched sets of new belts
   b. Use the right type of belt
   c. Pry or "roll" belts on
   d. All of the above

2. The coupling that allows for both types of misalignment and end play by using a "U" joint bearing assembly is:
   a. Flexible disc
   b. Flexible diaphragm
   c. Flexible drive shaft
   d. Chain

3. A coupling that will require lubrication is:
   a. Roller chain
   b. Gear
   c. Serpentine
   d. All of the above

CHAPTER SEVEN

Metering and Monitoring Equipment

7.1.0 Operators must be able to identify, calibrate, and use the following types of meters:

7.1.1 pressure gauges (both compound and vacuum)
7.1.2 rotameters
7.1.3 electrical meters, including ammeters, watt/hour meters, multi-testers, and meggers
7.1.4 electronic tachometers (with or without strobe)
7.1.5 thermometers
7.1.6 pH meters
7.1.7 chlorine (Cl_2) meters
7.1.8 dissolved oxygen (DO) meters

7.2.0 Operators must be able to interpret data and use the following types of hydraulic test equipment:

7.2.1 proportional and rectangular weirs

7.2.2 Parshall flumes
7.2.3 Venturi flow meters
7.2.4 sonic flow meters
7.2.5 magnetic flow meters

7.3.0 Operators must be able to recognize, interpret, and define the function of each of the following types of alarm systems:

7.3.1 level monitoring devices, including high and low water alarms
7.3.2 smoke and fire alarms
7.3.3 mechanical and electrical malfunction alarms

7.4.0 Operators must be able to identify, interpret, and describe the function of the following pieces of recording equipment:

7.4.1 volume counters
7.4.2 totalizers
7.4.3 flow recorders
7.4.4 combination recorders

7.5.0 Operators must be able to perform manual calculations to verify the accuracy of counters and flow-recording devices.

7.6.0 Using dyes and floats, operators must be able to determine flow rates and velocities in gravity sewer pipes, and use this information to calculate flow for a given geographical area.

7.7.0 Given tank volume drawdown or rise rates, operators must be able to calculate pump flow rates.

7.8.0 Operators must be able to define the following terms as they apply to Parshall flumes:

7.8.1 converging section
7.8.2 diverging section
7.8.3 throat
7.8.4 upstream head
7.8.5 downstream head

7.9.0 Operators must be able to explain in detail the importance of maintaining unrestricted hydraulic flow above, in, and below a flume.

7.10.0 Operators must be able to determine whether a flume is in “full flow” condition or is partially submerged, and must be able to adjust flow reading accordingly.

7.11.0 Operators must be able to describe methods for determining if a weir is providing accurate flow data. This includes defining and explaining the significance of:

7.11.1 weir crest
7.11.2 feet of head (behind weir)
7.11.3 nappe

7.12.0 For sharp-crested weirs, operators must be able to describe the proper orientation of the weir plate, so as to place the level on the downstream side.

7.13.0 Operators must be able to calibrate floating or staff gauges used in weirs and flumes.
7.14.0 Operators must be able to outline the hazards associated with flume and weir structures. Operators must be able to use safety devices specific to these structures, including toe guards, safety belts, foot gear, and life rings.

7.15.0 Operators must be able to diagram the reporting chain or network through which emergency response procedures are initiated when alarm systems indicate a problem which one operator cannot effectively handle by himself (for example: fire, major chemical spill, or dangerous atmosphere).

7.16.0 Operators should be able to perform routine maintenance on recording and monitoring equipment, including replacing the recording medium (for example: magnetic tape, paper charts), cleaning electronic and mechanical parts, and replacing belts, inkers, rollers, and pens.

STUDY SUGGESTIONS FOR CHAPTER SEVEN

Metering and Monitoring Equipment

1. Refer to O & M of Wastewater Collection Systems, Vol. 1, pp. 36-42, for general information of flow and flow measurement.

2. See pp. 129-135 of O & M of Wastewater Collection Systems, Vol. 2, for information on electricity and electrical meters such as ammeters, voltmeter, and multi-testers. Answer the questions on p. 135.

REVIEW QUESTIONS FOR CHAPTER SEVEN

Metering and Monitoring Equipment

1. The meter used to measure the flow rate of gases and liquids moving vertically up a calibrated tube is called:
   a. Rotameter
   b. Megmeter
   c. Magnometer
   d. Millimeter

2. Flow, pressure, and friction loss in a pipe system are similar to _____ in an electrical system:
   a. Watts, amperes, and BTUs
   b. Watts and resistance
   c. Watts, volts, and milliamps
   d. Amperes, volts, and ohms

3. A column of water 1 ft in height will exert
   a. 0.43 psi
   b. 1 BTU
   c. 2.31 inches Hg
   d. 7.48 pounds

4. A flow rate of 2 ft^3/sec is the same as:
   a. 15 gal/sec
   b. 1000 gpm
   c. 5.0 mgd
   d. 25 gal/sec

5. A lift station flow meter indicates that pump #1 flow rate is 400 gpm. The operator determines the following field data:

   Wet Well Diameter = 6 feet
   Inflow Rate (pump off) = 2 ft/min
   Pump #1 Drawdown (pump on) = 3 ft/2min

   From this data, the operator can conclude that:
   a. The actual flow rate is 740 gpm
   b. The meter is recording the flow accurately
   c. The flow rate based on test data is 630 gpm
   d. The flow meter recording is 50% higher than actual flow

6. Using dye tests, an operator measures the time of travel between manhole station 1 + 50 and 4 + 50 as 90 seconds. What is the velocity (ft/sec) in the sewer line?
   a. 1 ft/sec
   b. 2 ft/sec
   c. 3.3 ft/sec
   d. 5 ft/sec

7. The flow measuring device with a steel plate having a calculated size hole between flanges is:
   a. Orifice plate
   b. Offset
   c. Transducer
   d. Weir

CHAPTER EIGHT

Wastewater Quality Control

8.1.0 Operators must be able to recognize hydrogen sulfide (H_2S) by its rotten egg smell and must be able to describe the factors that lead to the generation of H_2S in the collection system, including flow rates, wastewater quality, system demand, and lift station operation.

8.2.0 Operators must be able to explain the use of aeration in the collection system, specifically for corrosion control and reduction of H_2S levels.

8.3.0 Operators must be able to describe the use of chlorine and hydrogen peroxide to reduce or eliminate odors caused by bacteria.

8.4.0 Operators must be able to list and describe the properties and dangers of chemicals commonly used to control hydrogen sulfide (H_2S) in collections systems, including:

8.4.1 chlorine
8.4.2 lime
8.4.3 sodium hydroxide
8.4.4 hydrogen peroxide
8.4.5 air (oxygen O_2)

8.5.0 For each of the chemicals listed above, operators must be able to describe how excessive dosages may affect both collection systems and treatment plants.

8.6.0 Given chemical strength, wastewater quality, and parameters to be controlled, operators must be able to calculate proper chemical feed rates for each of the chemical ins 8.4.0. Operators must be able to define dosage, demand, and concentration.

8.7.0 Operators must be able to control insects and rodents around collection systems. Operators must be able to list effective methods for controlling with herbicides, insecticides, rodenticides, and outline effective procedures for minimizing these hazards.

8.8.0 Operators must be able to describe the purpose and use of masking agents, and state their limitations with regard to collections systems.

8.9.0 Operators must be able to identify by visual inspection symptoms of grease build-up, root intrusion, and corrosion, and specify effective control strategies for each.

8.10.0 Operators must be able to identify and describe the operation of various types of screening systems, including mechanically and manually cleaned bar screens and manually cleaned bar racks.

8.11.0 For manually cleaned bar screens, operators must be able to propose, implement, and state the importance of a cleaning schedule which minimizes downstream head los.

8.12.0 For mechanically cleaned screens and rack, operators must be able to describe all manual and automatic control sequences. They must be able to recognize and interpret the visual symptoms of malfunctions, specifically abnormally high or low head conditions in the flow channel.

8.13.0 Operators must recognize and describe the operating principles of typical grit-removal systems, including both mechanically and manually cleaned, and aerated or conventional, grit chambers.

8.14.0 Operators must be able to define grit, explain its origins in the waste stream, and state the importance of its removal.

8.15.0 Operators must be able to describe the corrosive dangers of high and low velocity flows in a collection system. Operators must be able to use flow equalization systems to prevent scouring or deposits caused by high or low velocity flows.

8.16.0 Given influent rates and probable weather conditions, operators must be able to determine whether flow rates are likely to exceed pumping capacity, and describe the use of a flow equalization basin should pumping capacity be exceeded. Operators must be able to describe processes for returning stored flow to the process stream after total flow levels return to normal.

8.17.0 Operators must be able to calculate t a lift stations = s flow equalization capacity in gallons and the percentage of average daily flow this represents.

8.18.0 Operators must be able to describe the function of the lift station within the wastewater collection system, specifying how collection system components are affected by abnormal conditions and outline corrective actions.

8.19.0 Operators must be able to use the lift station monitoring devices to determine normal and abnormal conditions and maintain the correct operating parameters.

STUDY SUGGESTIONS FOR CHAPTER EIGHT
Wastewater Quality Control

1. See O & M Wastewater Collection Systems, Vol. pp. 36.-42, for information on flow measurement. Pages 163-171 discuss chemical safety and identification of hazardous materials, including Material Safety Data Sheets. For information on the use of chemical for pipeline cleaning and maintenance, see pp. 340-353. For a description of the problems caused by sand, grit and debris, see Table 6.1 on p. 269.

REVIEW QUESTIONS FOR CHAPTER EIGHT
Wastewater Quality Control

1. What problems are created by the presence of hydrogen sulfide in collection systems?

a. Odor and corrosion
b. Solid deposits
c. Flow quantity reduction
d. Changes in wastewater color

2. Hydrogen peroxide controls sulfide generation by:
   a. Keeping wastewater aerobic
   b. Changing the color of the wastewater
   c. Covering the odor
   d. Cleaning the pipe

3. A _____ channel is a weir which is commonly installed in grit removal channels. It controls velocity by varying the channel depth according in changes in flow quantity.
   a. Proportional weir
   b. A “notch” weir
   c. Rectangular weir
   d. Parabolic weir

4. The odor commonly associated with hydrogen sulfide gas is:
   a. Similar to petroleum odor
   b. Similar to methane odor
   c. Rotten egg odor
   d. Similar to ammonia

CHAPTER NINE

Environmental Surveillance, Recordkeeping, and Reporting

9.1.0 Operators should be able to demonstrate sampling and testing techniques for the following physical and chemical characteristics:

9.1.1 temperature
9.1.2 suspended solids
9.1.3 grease
9.1.4 flammable solvents
9.1.5 floating oil
9.1.6 pH
9.1.7 hydrogen sulfide (H_2S)
9.1.8 methane

9.2.0 For each of the characteristics listed above, operators must know when and how to perform the following types of sampling:

9.2.1 composite sampling
9.2.2 flow proportioning
9.2.3 grab sampling

9.3.0 Operators must be able to define and distinguish between the following composite sampling methods: continuous, periodic, and flow proportioned.

9.4.0 Operators must be able to describe the “chain of custody” for sample collection, storage, handling, and analysis.

9.5.0 Operators must be able to select sampling locations that are representative of the waste stream and of the specific parameter being tested. Operators must be able to determine representative sampling times and frequencies, based on the following factors:

- 9.5.1 detention time (from source to sample point)
- 9.5.2 time of day
- 9.5.3 flow rate
- 9.5.4 sample type (for example, grab or composite)

9.6.0 Operators must be able to correctly handle, preserve, label, and store samples. Label information includes:

- 9.6.1 name of sampler
- 9.6.2 sample location
- 9.6.3 date and time of sample
- 9.6.4 preservative added
- 9.6.5 test(s) to be performed.

9.7.0 Operators must be able to describe in general terms the environmental impact of spill of both “normal” and “abnormal” sewage. Further, they must know appropriate procedures for reporting and remediating such spills.

9.8.0 Operators must list federal, state and local agencies that can assist them in profiling characteristics of receiving streams and in estimating the environmental impact of collection system discharge on a particular receiving stream.

9.9.0 Operators, especially superintendents and owners, must be able to list their legal obligation for proper operation of the collection system and for prompt, truthful reporting of information required or requested by regulatory agencies.

9.10.0 Operators must state the period specified by law for the retention of all collection facility logs and records.

9.11.0 Operators must identify and contact by mail and by telephone the regulatory agencies and specific plant inspectors responsible for NPDES oversight of their facilities.

9.12.0 Operators must explain their job to the public and project a positive public image.

STUDY SUGGESTIONS FOR CHAPTER NINE

Environmental Surveillance, Recordkeeping, and Reporting

1. See O & M of Wastewater Collection Systems, Vol. 1, pp. 105-109 and 272-273 for information on recordkeeping.

2. Also refer to O & M of Wastewater Collection Systems, Vol. 2, for general information on records, work requests, and reports.

STUDY QUESTIONS FOR CHAPTER NINE

Environmental Surveillance, Recordkeeping, and Reporting

1. All of the following testing parameters require that a means of sample preservation be used *except*:
   a. Oil and grease
   b. Metals analysis
   c. Suspended solids
   d. Temperature

2. A collection of individual samples collected at regular intervals within a 24-hour span is called:
   a. Grab sample
   b. Daily aliquot
   c. Composite sample
   d. Standard solution

ANSWERS TO REVIEW QUESTIONS

CHAPTER ONE

1. D
2. A
3. C
4. B
5. C
6. B
7. B
8. C
9. B
10. B
11. D
12. C
13. A
14. B
15. D
16. C
17. D
18. C

CHAPTER THREE

1. A
2. B
3. D
4. C
5. C
6. A
7. C
8. D
9. B
10. D
11. A
12. D
13. A
14. B

CHAPTER TWO

1. C
2. A
3. C
4. A
5. D
6. D
7. B
8. C
9. A
10. A
11. D
12. A
13. A
14. D
15. D
16. D
17. C
18. A
19. D
20. A
21. D
22. D
23. C

CHAPTER FOUR

1. C
2. A
3. A
4. D
5. C
6. B
7. C
8. B

CHAPTER FIVE

1. A
2. C
3. A

4. D
5. B

CHAPTER SIX

1. C
2. C
3. D

CHAPTER SEVEN

1. A
2. D
3. A
4. A
5. A
6. C
7. A

CHAPTER EIGHT

1. A
2. A
3. A
4. C

CHAPTER NINE

1. D
2. C