

THE

NORTH CAROLINA

COLLECTION SYSTEM OPERATOR'S

'NEEDS TO KNOW'

GRADES 1 THROUGH 4

2004 Edition

ACKNOWLEDGMENTS

This document was prepared by the Training and Certification Unit of the North Carolina Department of Environment, Health and Natural Resources, Division of Environmental Management, under the direction of the Water Pollution Control System Operators Certification Commission, in cooperation with the North Carolina Section of the American Water Works Association (AWWA) and the Water Environment Association (WEA). Special thanks to The Liaison Committee for Collection System Personnel of AWWA/WEA for their assistance in developing this document.

TABLE OF CONTENTS

<u>Page(s)</u>	<u>Section</u>
1	Wastewater Collection Systems
1 - 2	Concepts and Terminology
2 - 3	Testing Collection Systems
4	Organization For System Maintenance
4 - 5	Job Site Pre-Planning
5	Sewer Main Inspection
6	Service Taps, Types of Service, and Clean-outs
7 - 8	Sewer Materials, Construction, and Repairs
8	Root Control and Preventive Maintenance Programs
9	Sewer Cleaning Techniques
10 - 11	Sewer Rehabilitation
11 - 12	Manhole Construction and Repair
12 - 13	Hydraulic Design
14 - 16	Lift Stations
16 - 17	Lift Station Maintenance
18 - 21	Pump Theory and Electrical Basics
21 - 22	Math
22 - 23	Public Relations
24	Interviewing
24	Maps
24	Records
25	Supervision
25	Employee Relations
25	Employee Records
26	Laws and Regulations
27 - 36	Safety Section
27 - 28	Basic Traffic Control
28 - 31	Confined Spaces
31	Job Site Safety
32	Personnel Protective Equipment
33 - 34	Related Health Risks
34 - 35	Safety Equipment
35 - 36	Shoring and Underground Construction Safety
37	Mathematics Conversion Factors
38 - 41	Summary of Collection System Laws and Regulations

REFERENCES

Kerri, Kenneth D. *et al.* Operation And Maintenance of Wastewater Collection Systems Third Edition, 1987, Vols. I and II. California State University, Sacramento.

Manual on Uniform Traffic Control Devices for Streets & Highways U.S. Department of Transportation, Federal Highway Administration, 1988 edition.

WASTEWATER COLLECTION SYSTEMS

Reference - Operation and Maintenance of Wastewater Collection Systems Vol. I and II

1. I Define *wastewater*.
2. I What is a *wastewater collection system*?
3. I Explain the purpose of wastewater collection systems.
4. I What is meant by the *operation and maintenance* of a wastewater collection system?
5. I Explain the responsibilities of a *collection system operator*.
6. II Explain how flow varies in a collection system and why flow variation is important.
7. III Name the main parts of a collection system.
8. III List the rigid and flexible pipes commonly used in collection system installations.
9. IV Describe the information needed to properly install a sewer main.
10. IV Describe the equipment that is needed too properly install a sewer main.
11. IV Explain what an *easement* is and how it affects the maintenance of collection systems.

CONCEPTS AND TERMINOLOGY

Reference - Operation and Maintenance of Wastewater Collection Systems Vol. I and II

1. I Define each of the following terms as it relates to collection systems:
 - A) Invert;
 - B) Size;
 - C) Grade;
 - D) Depth;
 - E) Force Main;
 - F) Gravity System;
 - G) Inverted siphon;
 - H) Velocity;
 - I) Corrosion.
2. I List the four types of sewer pipe materials.
3. I Name the types of hazardous atmospheres that are found in sewers.

- | <u>ITEM</u> | <u>GRADE</u> | |
|-------------|--------------|--|
| 4. | II | Explain the difference between <i>inflow</i> , <i>infiltration</i> and <i>exfiltration</i> . |
| 5. | II | Explain how hydrogen sulfide is generated in a collection system. |
| 6. | II | Explain each of the following terms as it relates to collection systems: <ul style="list-style-type: none"> A) Air blower; B) AC and DC current; C) Amperage; D) Asphyxiation; E) Backfill compaction; F) Bacteria; G) Bar rack; H) By-pass; I) Cavitation; J) Hydraulic cleaning; K) Lateral; L) Material Safety Data Sheet (MSDS). |
| 7. | III | Define each of the following terms as it relates to collection systems: <ul style="list-style-type: none"> A) Alignment; B) Bedding; C) Blockage; D) Cleanout; E) Concentric manhole cone; F) Eccentric manhole cone; G) Manhole; H) Septic; I) Drop manhole. |
| 8. | III | Explain the term <i>scouring (self-cleaning) velocity</i> . |
| 9. | IV | Explain the difference between <i>sewer</i> , <i>sewage</i> and <i>sewerage</i> . |
| 10. | IV | Explain the difference between <i>easement</i> and <i>right-of-way</i> . |
| 11. | IV | Explain air movement in a collection system. |

TESTING COLLECTION SYSTEMS FOR ACCEPTANCE

Reference - Operation and Maintenance of Wastewater Collection Systems, Vol. II

1. II Explain the proper procedure for inspecting newly installed collection lines.
2. II Is all excavated material suitable for backfill? Explain.

ITEM GRADE

3. II Explain the purpose of "as built" plans.
4. II Explain how backfill is tested.
5. II Define each of the following terms:
 - A) Low pressure air test;
 - B) Infiltration test;
 - C) Exfiltration test;
 - D) Vacuum test;
 - E) Mandrel test;
 - F) Smoke test.
6. III Explain the reasons for inspecting and testing collection systems.
7. III Explain how to conduct each of the following tests:
 - A) Low pressure air test;
 - B) Infiltration test;
 - C) Exfiltration test;
 - D) Vacuum test;
 - E) Mandrel test;
 - F) Smoke test.
8. III Explain the difference between *permanent easement* and *construction easement*.
9. III Explain the maintenance problems that can be caused by improper construction and installation of a collection system.
10. IV Be able to interpret the results from each of the following tests:
 - A) Low pressure air test;
 - B) Infiltration test;
 - C) Exfiltration test;
 - D) Vacuum test;
 - E) Mandrel test;
 - F) Smoke test.
11. IV Should acceptance of a collection system be based only on the tests noted above? Why?
12. IV Explain the limitations of TV inspections.

ORGANIZATION FOR SYSTEM MAINTENANCE

Reference - Operation & Maintenance of Wastewater Collection Systems, Vol. II.

1. II List records and reports that need to be kept on file and why each one is important.
2. II Identify the problems a wastewater collection agency must deal with on a regular basis.
3. II Explain the purpose and reasons wastewater collection agencies are needed.
4. II Explain why maps of a collection system need to be kept updated.
5. III List the classes of personnel and equipment needed to perform the work of a collection system maintenance organization.
6. III List the work activities that are needed to operate a collection system.
7. III Prepare a listing of crews needed (from the work activities you listed in Item #6 above) and develop an organizational chart.
8. III List the job responsibilities for each position on the organizational chart created in Item #7.
9. III Explain why a priority list should be developed for scheduling work by preventive maintenance crews.
10. III Explain the function of the lift station unit in a wastewater collection agency.

JOB SITE PRE-PLANNING

Reference - Shoring School Practical

1. I Given appropriate data, be able to calculate the legal ditch widths for various soil types and depths.
2. I List the needed shoring equipment for various jobs.
3. I Explain why compliance with regulations requires forethought and planning.
4. I Explain why it may be necessary to alter work practices in order to comply with safety rules.
5. I Explain why the use of trench boxes will require additional equipment on the job site which will complicate management of the job site.
6. I Explain why pavement removal, traffic control, staffing, equipment, existing utilities and the type of repair have to be considered in selecting shoring systems.

<u>ITEM</u>	<u>GRADE</u>	
7.	I	Explain the provisions of the 'utility location' law.
8.	I	Why is there a need for 'as-built' plans in job site pre-planning? Explain.
9.	I	Explain the differences that the original construction techniques can make in the selection of proper shoring for making repairs.
10.	I	Explain why planning and training are necessary to reduce the effects of not knowing the exact extent or location of a problem when performing repair work.

SEWER MAIN INSPECTION

Reference - Operation & Maintenance of Wastewater Collection Systems Vol. I

1. I Define *lamping*.
2. I Explain *dye testing*.
3. I List problems that can be determined by performing a dye test.
4. I Explain why it is important to inspect new pipe line construction.
5. II Why is it important to notify the area residents when a smoke test is being performed? Explain.
6. II Explain how to perform a smoke test and what can be learned from this procedure.
7. II List the problems that can be detected when a sewer line is inspected with closed-circuit television.
8. III List the components required for TVing a sewer line.
9. III Describe how to set up and TV a sewer line.
10. III List the information usually recorded on a TV log sheet.
11. III Explain the reason and need for the following tests:
 - A) Low pressure air test of sewer main;
 - B) Deflection test;
 - C) Manhole exfiltration (or vacuum) test.

SERVICE TAPS, TYPES OF SERVICE, AND CLEAN-OUTS

Reference - Operation & Maintenance of Wastewater Collection Systems Vol. I

1. I List the pipe materials that you might encounter when connecting a tap to a sewer main.
2. I What is the minimum pipe diameter required for a residential service line?
3. I Define the following terms:
 - A) Service tap;
 - B) Clean-out.
4. I Define a *backwater valve* and its purpose.
5. I Explain the procedure for opening a service connection which has become blocked between the property line and the sewer main.
6. II Describe each of the three approved methods for installing a service tap after the main line is exposed.
7. II Explain where cleanouts are required on a commercial building's sewer line.
8. II Describe how to install a typical in-line cleanout after an existing line is exposed.
9. II Explain the differences in the responsibilities of a private plumber and the utility crew at a service tap.

SEWER MATERIALS, CONSTRUCTION, AND REPAIRS

Reference - Operation & Maintenance of Wastewater Collection Systems, Vol. I.

1. I List the materials commonly used for:
 - A) Sewer pipe;
 - B) Manholes;
 - C) Frames and covers;
 - D) Pipe fittings;
 - E) Pipe repair couplings.
2. I List the problems which may occur if pipe/manhole joints are not watertight.
3. I List the materials that are used to make joints watertight in newly constructed:
 - A) Manholes;
 - B) Pipe;
 - C) Pipe/manhole connections.
4. I Define each of the following:
 - A) Trench excavation;
 - B) Pipe bedding materials;
 - C) Trench backfill;
 - D) Trench shoring.
5. I Describe the procedures used to pinpoint locations of broken sewer mains.
6. I How can operators in trenches be protected from cave-ins? Explain.
7. I Explain why it is necessary to locate all nearby utilities before beginning a repair or new construction.
8. II Explain the proper use of sewer line cleaning tools.
9. II Explain the proper procedure for determining the depth of a sewer line that is being repaired.
10. II List problems which can occur if sewers are not constructed in straight (true) alignments.
11. II List the materials necessary to repair a collapsed section of sewer pipe.
12. II Describe the procedure to make a tap for a residential service in each of the following:
 - A) An existing sewer main;
 - B) An existing manhole;
 - C) An existing wye or tee in a sewer main.

ITEM GRADE

13. II Describe how a sewer main can be *sliplined* and list the advantages and disadvantages of sliplining.
14. II List the major equipment that would be required for an excavation operation.
15. II Define *competent person*.
16. II Explain the need for proper bedding and backfilling of a pipe installation. Explain when you would use select backfill.
17. II Explain the repair procedure you would use to repair a pipe segment where a bell has become crushed or collapsed.
18. III Describe the purpose and procedure for setting up a by-pass pumping operation.
19. III Explain the repair procedures you would use to repair a sewer main which has collapsed under a building.
20. III Explain the measures you would take to repair a line in order to provide relief for customers which are regularly impacted by overflows during rainfall events.
21. III Explain the reasons for grouting and sealing sewers.

ROOT CONTROL AND PREVENTIVE MAINTENANCE PROGRAMS

Reference - Operation & Maintenance of Wastewater Collection Systems, Vol. I.

1. II Define *preventive maintenance*.
2. II Explain the purpose for having a preventive maintenance program.
3. II List the equipment that would be used in opening blockages caused by roots.
4. II Describe the advantages and limitations of rodding equipment.
5. II Describe the advantages and limitations of a high velocity cleaner.
6. II Describe how roots enter a sewer line and how rodding effects the growth of these roots.
7. III List the objectives of a preventive maintenance program.
8. III Describe how chemical treatment of root problems in a sewer line works.
9. III What safety precautions should be used when chemically treating roots? Explain.

SEWER CLEANING TECHNIQUES

Reference - Operation & Maintenance of Wastewater Collection Systems, Vol.I.

1. I Explain the use of hand rods in a cleaning operation.
2. I Explain how a power rodder works.
3. I Explain how a high velocity cleaner works.
4. I List the problems that are normally found in a sewer line that cause blockages.
5. II List four types of hydraulic cleaning methods.
6. II What factors should be considered in selecting a tool to clear back-ups? Explain.
7. II What are the sources of grease that is discharged into the collection system?
8. II Describe how hydrogen sulfide is formed in sewers.
9. II Define *balling*.
10. II Explain the advantages and limitations of each of the following cleaning techniques:
 - A) High velocity cleaner;
 - B) Power rodder;
 - C) Bucket machine.
11. II Given the following problems, list the line cleaning solution that you would use for each:
 - A) Emergency stoppages:
 - 1) Manhole overflowing;
 - 2) Flooding dwelling;
 - B) Grease;
 - C) Roots;
 - D) Sand, grit and debris;
 - E) Odor.
12. II Explain the situations when the collection system operator should notify the receiving wastewater treatment plant operator of actions being taken in the collection system.
13. III Explain how the *bucket machine* operates.
14. III List situations where using chemicals would be effective.
15. III List potential methods of chemical control of sulfide.

SEWER REHABILITATION

Reference - Operation and Maintenance of Wastewater Collection Systems, Vol. II

1. II Explain how each of the following are affected by sewer rehabilitation:
 - A) Increased capacity;
 - B) Reduced infiltration and/or inflow;
 - C) Correction of structural deficiencies;
 - D) Correction of malfunctions;
 - E) Extension of life of sewers;
 - F) Reduction in overflows.

2. II Explain why each of the following causes collection systems to need rehabilitation:
 - A) Old materials;
 - B) Vibrations;
 - C) Settling.

3. II Define *inflow* and *infiltration*.

4. II Describe the sources of inflow and infiltration.

5. II Describe each of the following basic sewer system rehabilitation techniques:
 - A) Joint sealing and testing;
 - B) Manhole sealing;
 - C) Manhole rehabilitation;
 - D) Sliplining;
 - E) In-place linings;
 - F) Point repairs;
 - G) Total line replacement.

6. II Explain how each of the following can be sources of inflow and infiltration into sewers:
 - A) Manholes;
 - B) Bad joints;
 - C) Service lines;
 - D) Storm sewer cross connections;
 - E) Illegal connections.

7. III Explain how each of the following steps are performed in a Sanitary Sewer Evaluation Survey (SSES):
 - A) Inventory system;
 - B) Smoke testing;
 - C) Dye water testing;
 - D) Flow isolation;
 - E) Closed circuit TV inspection;

- | <u>ITEM</u> | <u>GRADE</u> | |
|-------------|--------------|---|
| | | F) Flow monitoring. |
| 8. | III | Discuss what Public law 92-500 means to sewer rehabilitation. |
| 9. | III | Explain how each of the following are utilized in flow monitoring: <ul style="list-style-type: none"> A) Selection of sites; B) Rainfall monitoring; C) Ground water level gauges; D) Data gathering; E) Equipment maintenance. |
| 10. | III | Describe each of the following methods of sewer rehabilitation and give the advantages and disadvantages of each method: <ul style="list-style-type: none"> A) Manhole rehab; B) Sliplining; C) Point repairs; D) Line replacement; E) Liner insertion; F) Grouting; G) Service repairs. |
| 11. | IV | Discuss the features of a <i>flow hydrograph</i> and explain the components. |
| 12. | IV | Explain how each of the following factors will affect a collection system during rainfall events: <ul style="list-style-type: none"> A) Intensity; B) Duration; C) Ground water levels. |
| 13. | IV | Discuss the economics of sewer rehabilitation. |

MANHOLE CONSTRUCTION AND REPAIR

Reference - Operation & Maintenance of Wastewater Collection Systems, Vol. I.

1. I Define *manhole*.
2. I What is the minimum size of a manhole opening?
3. I Where are manholes required to be installed?
4. I List the materials normally used in manhole construction.
5. I What safety precautions should be taken before entering a manhole?
6. II Describe the items that should be checked when inspecting a manhole.

ITEM GRADE

7. II Describe how to install an *outside drop connection*.
8. II List the problems you may encounter when a manhole is inspected visually.
9. II Define *manhole infiltration*.
10. II Describe methods used to seal manhole joints.
11. II Describe situations where you would recommend the installation of *inside drops*.
12. II Describe the methods you can use to adjust the rim elevation of a manhole in advance of a street paving operation.
13. II Describe the methods you can use to eliminate inflow through a perforated manhole cover.
14. III Explain how to eliminate infiltration occurring in the barrel section of a manhole.
15. III Explain how to eliminate flow problems in the bottom section of a manhole that does not have a formed invert.
16. III Explain how to eliminate I/I from the cone section of a manhole.
17. III What is the purpose of the vent stack in manholes located in a flood plain?

HYDRAULIC DESIGN

Reference - Operation & Maintenance of Wastewater Collection Systems, Vol. I.

1. II Define the following terms:
 - A) Building sewer;
 - B) Lateral or branch sewers;
 - C) Main sewers;
 - D) Trunk sewers;
 - E) Interceptor sewers;
 - F) Gravity sewers.
2. II Be able to calculate the distance between 2 manholes when given specific station information.
3. II Describe the factors that affect the flow capacity of a sewer line.
4. III Be able to calculate the percent slope of a line segment when given specific information.
5. III Explain why a minimum water velocity of 2.0 feet per second is often specified for sewer construction.

- | ITEM | GRADE | |
|------|-------|--|
| 6. | III | List the typical per capita residential flows. What is a typical range used for design purposes? |
| 7. | III | Be able to calculate the velocity of flow in a sewer when provided with specific data. |
| 8. | III | Why is it important to make field calculations of sewer flow velocities? Explain. |
| 9. | III | List two commonly used methods for measuring velocities in the field. |
| 10. | III | Define the following terms: <ul style="list-style-type: none"> A) Scouring velocity; B) Peak flow; C) Average daily flow; D) Drainage basin; E) Velocity. |
| 11. | III | What causes friction losses in wastewater collection systems? Why? Explain. |
| 12. | III | Define <i>inverted siphon</i> and explain its purpose. |
| 13. | III | Define <i>air jumper</i> and explain its purpose. |
| 14. | III | Define <i>slope of sewer</i> and explain why the slope is important. |
| 15. | III | Explain the type of information you can obtain from <i>sewer cut sheets</i> and how the information can be used in sewer construction. |
| 16. | III | Explain what <i>grade stakes</i> are and how they are useful in sewer construction work. |
| 17. | III | What problems can develop in a sewer because of sudden changes in the direction and velocity of flow of the wastewater? |
| 18. | III | Explain how you can use a fixed-beam laser for grade control in sewer construction. |
| 19. | IV | List the factors that must be considered when a sewer line is designed. |
| 20. | IV | Give the formula needed to calculate the amount of flow through a pipe. |
| 21. | IV | List the principal components of a low pressure pump system. |
| 22. | IV | List four factors which affect the flow capacity of sewers. |
| 23. | IV | Define <i>hydraulic blockage</i> . |
| 24. | IV | Explain how to correct a hydraulic blockage condition. |

LIFT STATIONS

Reference - Operation and Maintenance of Wastewater Collection Systems Vol. I

1. II What is the purpose of a lift station?
2. II What are the types of lift stations?
3. II What is the most important requirement of a lift station?
4. II Explain problems that are encountered with each of the following at a typical lift station:
 - A) Power;
 - B) Control systems;
 - C) Pumping systems;
 - D) Structures.
5. II Explain the difference between *dry well* and *wet well* lift stations.
6. II Describe the typical problems encountered with the operation of a lift station.
7. II Why is it important to have a starting sequence established when power is restored to a lift station?
8. II Explain the relationship between *psi* and *feet of head*.
9. II Describe the purpose of bar screens and comminutors in a lift station.
10. II Given diagrams, identify the following components of a lift station:
 - A) Influent pipe;
 - B) Discharge pipe;
 - C) Wet well;
 - D) Check valve;
 - E) Pump;
 - F) Motor;
 - G) Isolation valves.
11. II Explain the purpose of a sump pump in a dry well.
12. II Explain what happens when a seal fails on a submersible pump.
13. II Discuss each of the following types of level controls available for lift stations and the advantages and disadvantages of each type:
 - A) Floats;
 - B) Bubbler;
 - C) Ultrasonic;

ITEM GRADE

D) Electrodes.

14. II Explain why ventilation is required in a dry well.
15. II Explain the purpose of having an emergency standby generator.
16. II Why should lift stations be equipped with at least two pumps? Explain.
17. II Explain the importance of O/M manuals for a lift station.
18. II Explain the need for, and how to set up, a preventive maintenance program for a lift station.
19. II Describe the hazards that may be encountered when entering a lift station.
20. II Define *packing* and *mechanical seals* and explain the difference between the two.
21. II What is the critical period after lift station failure and why is it important?
22. II What items should be inspected on a routine visit to a lift station?
23. II What items or factors influence the frequency of lift station visits?
24. II Discuss the importance of record keeping for lift station maintenance.
25. II Why should lift stations have a sign-in log? Explain.
26. II Explain the purpose of forced-draft ventilation in a lift station.
27. III Define *friction loss* in piping and describe the factors that cause it.
28. III In lift stations, why is the suction pipe generally larger than the discharge pipe?
29. III Define *cavitation* and describe its effects on a pump.
30. III Discuss the effect of long detention times and frequent pump cycles in wet wells.
31. III Describe the purpose of *fillets* in the bottom of a wet well.
32. III Define *water hammer* and explain ways to control it.
33. III What is the purpose of a dehumidifier in a dry well? Explain.
34. III Describe each of the following types of flow metering:
 - A) Magnetic;
 - B) Doppler;
 - C) Ultrasonic;
 - D) Parshall flume.
35. III Define *telemetry* and explain its use with lift stations.

36. III Explain and differentiate between each of the following head terms used with pumps:
- A) Suction head;
 - B) Discharge head;
 - C) Total static head;
 - D) Total dynamic head.
37. III What factors influence the location of a lift station? Why? Explain.
38. IV Describe how *SCADA* systems and *remote telemetry* are used with lift stations.

LIFT STATION MAINTENANCE

Reference - Operation and Maintenance of Wastewater Collection Systems Vol. II

1. I Why must unqualified personnel not attempt electrical equipment maintenance? Explain.
2. II Describe proper equipment maintenance procedures for each of the following:
- A) Pumps;
 - B) Seals;
 - C) Bar screens;
 - D) Controls;
 - E) Valves;
 - F) Alarms.
3. II Why is it important to have records of lift station maintenance?
4. II Why is it important to have written records of lift station repairs?
5. II Explain the need for a lock-out/tag-out procedure.
6. II List information typically found on the nameplate of a pump motor.
7. II Explain the need to shut-off, lock-out and tag-out electrical equipment properly before working on it.
8. II What is the purpose of lubrication?
9. II Define the following terms:
- A) Alternating current;
 - B) Direct current;
 - C) Voltage;
 - D) Amps;

ITEM GRADE

E) Kilowatt.

10. II List six of the most important rules for pump maintenance.
11. II Explain the purpose of the stuffing box in a pump.
12. II Explain why a pump should never be allowed to run dry.
13. II List five problems that may develop in a pump as a result of improper packing or improper packing maintenance.
14. III Identify items to be inspected when responding to a night-time lift station alarm.
15. III Describe how to establish a maintenance program and frequency schedule for lift stations.
16. III What factors must be considered in preparation of a lift station maintenance program?
17. III Why must lift station maintenance schedules be reevaluated annually?
18. III Explain the significance of local conditions to lift station maintenance.
19. III List the common causes of motor malfunction.
20. III Define *centrifugal force* and explain its importance in regards to pumps.
21. III Define *impeller* and explain how one works.
22. III Explain the purpose of bearings and the causes of bearing failure.
23. III What meters and testers are used to maintain, repair and troubleshoot electrical circuits and equipment? Explain the use of each meter and tester.
24. III Explain the need to avoid any down-sloping toward the pump in *suction pumping*.
25. III Explain *cavitation* and its impact on pumps.
26. III Explain the use of *pneumatic ejectors*.
27. III Explain the advantages and disadvantages of mechanical seals in pumps.
28. III Explain the need for proper alignment of a pump and motor.
29. III Explain why it is very important to prevent scoring or grooving of a pump shaft and how this can be prevented.
30. IV Describe the various types of level control systems used in lift stations. Describe the operation and maintenance of these control systems.

PUMP THEORY AND ELECTRICAL BASICS

References - Operation and Maintenance of Wastewater Collection Systems, Vol. II

1. II What is the purpose of a pump?
2. II Given diagrams, be able to identify each of the components for the listed types of pumps:
 - A) Centrifugal pump:
 - 1) Pump suction;
 - 2) Inspection hole cover;
 - 3) Impeller;
 - 4) Casing drain plug;
 - 5) Discharge pipe;
 - 6) Lantern ring;
 - 7) Packing;
 - 8) Packing gland;
 - 9) Gland seal adjustment collar;
 - 10) Shaft;
 - 11) Pump bearings;
 - 12) Mechanical seals;
 - 13) Grease fittings;
 - 14) Relief plug.
 - B) Positive displacement pump - plunger type:
 - 1) Crank shaft;
 - 2) Piston;
 - 3) Plunger;
 - 4) Ball valve.
 - C) Positive displacement pump - diaphragm type:
 - 1) Shaft;
 - 2) Gears;
 - 3) Diaphragm;
 - 4) Ball valve.
3. II Describe the procedures for starting up and shutting down a centrifugal and positive displacement pump.
4. II What is the purpose of a shaft coupling?
5. II Describe the effect that improper (too loose or too tight) pump packing would have on the operation and efficiency of a pump.
6. II Define voltage and explain the two types of current:
 - A) Direct current;
 - B) Alternating Current.

ITEM GRADE

7. II Explain the purpose of alternating the operation of two or more pumps.
8. II Describe typical applications for each type of pump and list the advantages and disadvantages of each application.
9. II Explain the difference between a *conductor* and an *insulator*.
10. II Explain the use of a voltage tester for electrical troubleshooting.
11. II Explain the use of an ammeter for electrical troubleshooting.
12. II Explain the purpose and use of a *megger*.
13. II Define *fuse*, describe the different types of fuses and explain their uses.
14. II Describe the uses of *circuit breakers*.
15. II Define *ampere* and *ohm* and explain their significance in relation to pumps.
16. II Explain the term *ground* as it relates to electricity.
17. II Define *electric motors* and describe the use of the various types in collection system operations.
18. II Given a drawing of an electric motor, be able to identify the following parts:
 - A) Stator;
 - B) Rotor;
 - C) Shaft;
 - D) Bearings;
 - E) Lifting lug;
 - F) Seal;
 - G) Terminal Box;
 - H) Fan.
19. II Describe the information that can be found on a motor nameplate.
20. II Explain the necessity for lock-out/tag-out in electrical safety.
21. II Define the term "head" as it relates to pumping.
22. II Explain the factors which affect the efficiency of a centrifugal pump.
23. II Explain the procedure for installing a 3-phase electric motor.
24. III Describe the effect that throttling of the suction and discharge valves would have on a centrifugal and a positive displacement pump.

- | <u>ITEM</u> | <u>GRADE</u> |
|-------------|--|
| 25. | III Explain (define) each of the following:
<ul style="list-style-type: none"> A) Suction head (lift); B) Friction head; C) Discharge head; D) Total pump capacity; E) Total dynamic head; F) Water horsepower; G) Brake horsepower; H) Motor horsepower. |
| 26. | III Identify the problems that are associated with the condition which occurs when either the suction or discharge head exceeds the pump capacity. |
| 27. | III Describe how each of the following affect the capacity of a centrifugal pump:
<ul style="list-style-type: none"> A) Size of the suction and discharge ports; B) Speed; C) Total dynamic head; D) Wear on the impeller. |
| 28. | III Describe how each of the following affect the capacity of a positive displacement pump:
<ul style="list-style-type: none"> A) Size of the piston; B) Length of the stroke; C) Speed. |
| 29. | III Describe how each of the following affect shaft couplings:
<ul style="list-style-type: none"> A) Pump cycling; B) Shaft misalignment; C) Worn bearings; D) Lubrication. |
| 30. | III Outline the advantages and disadvantages of variable speed pump systems. |
| 31. | III Describe how a <i>water hammer</i> is created and how it affects pumps. |
| 32. | III Describe <i>cavitation</i> and how it affects a centrifugal pump. |
| 33. | III Describe the difference between single and three phase alternating current and explain some of the various uses. |
| 34. | III Explain how to use the formula E=IR . |
| 35. | III Define <i>horsepower</i> and explain the formula for the horsepower output of a motor. |
| 36. | III Describe <i>overload heaters</i> and explain what determines their sizes. |

<u>ITEM</u>	<u>GRADE</u>	
37.	III	Describe a <i>motor starter</i> and explain what determines their size.
38.	III	Explain the correct sequence of events that should be taken when putting out an electrical motor fire.
39.	IV	Given a pump manufacturer's pump curve for a given impeller size and speed, be able to determine each of the following: <ul style="list-style-type: none"> A) Pump capacity ; B) Head (ft); C) Pump efficiency; D) Brake horsepower.

MATH

Reference - Operation and Maintenance of Wastewater Collection Systems, Vol. II, Appendix

1. I Perform basic mathematical calculations including volume calculations, pumping rate calculations and trench width calculations.
2. II Determine the average of a group of numbers.
3. II Add, subtract, multiply and divide fractions.
4. II Convert fractions to decimals and decimals to fractions.
5. II Convert fractions to percent and percent to fractions.
6. II Describe the use of squares and square root.
7. II Explain the principle of various scales on drawings.
8. II Define the area formula for a circle, rectangle and a right triangle.
9. II Explain the relationship between feet of water and pressure in psi.
10. III Describe velocity and explain its use in determining flow rate.
11. III Explain how to compute volumes for a box and a cylinder.
12. III Use area and velocity to determine flow rate by use of $Q=AV$.
13. III Use the temperature conversion formulas to convert from Centigrade to Fahrenheit and Fahrenheit to Centigrade.
14. III Explain what a *sewer cut sheet* is and how it is used to determine pipe elevation.
15. III Be able to use *slope* to determine pipe elevation.

<u>ITEM</u>	<u>GRADE</u>	
16.	IV	Explain <i>water</i> and <i>brake horsepower</i> and use the horsepower formula to compute horsepower requirements.
17.	IV	Explain <i>pump efficiency</i> and demonstrate its use.
18.	IV	Be able to use the electrical formula Power = Volts x Amps.
19.	IV	Be able to use <i>concentrations</i> (mg/l or ppm) to determine chemical feed rate and compute chemical cost.
20.	IV	Given appropriate data, and using the electricity and horsepower formulas, be able to calculate power costs.

PUBLIC RELATIONS

Reference - Operation and Maintenance of Wastewater Collection Systems, Vol. II

1. I Explain the importance of a proper public relations program.
2. I Explain the need for maintaining good public relations as part of ensuring public support.
3. I Explain the importance of maintaining good public relations with each of the following groups:
 - A) Regulatory agencies;
 - B) City councils;
 - C) Civic groups;
 - D) Industries;
 - E) Environmental groups;
 - F) Governing agencies;
 - G) Local Health Department.
4. I Explain the role of each of the following as factors influencing public relations:
 - A) Attitude;
 - B) Manner;
 - C) Appearance;
 - D) Conduct;
 - E) Spirit;
 - F) Quality and quantity of work;
 - G) Responsibility;
 - H) Knowledge of work;
 - I) Morale and pride;
 - J) Confidence;
 - K) Interest;
 - L) Honesty.

- | <u>ITEM</u> | <u>GRADE</u> | |
|-------------|--------------|--|
| 5. | I | <p>Explain the role of the following in maintaining good public relations:</p> <ul style="list-style-type: none"> A) Good housekeeping; B) Odor control; C) Insect control; D) Information booklets, pamphlets, brochures, etc.; E) Handling complaints; |
| 6. | I | Explain the importance of having a designated spokesperson to deal with the press. |
| 7. | I | Explain who is responsible for hiring collection system operators. |
| 8. | I | What is the source of the funding used for collection system operators? |
| 9. | I | Explain the public's point of view of collection system workers who litter. |
| 10. | I | Explain the importance of collection system operators maintaining a clean truck and wearing clean uniforms. |
| 11. | I | Explain why certain inappropriate remarks made to the public can be considered sexual harassment. |
| 12. | I/II | Describe the 'public image' aspect of collection system operations specifically as it pertains to public relations - i.e. the appearance of personnel and equipment, individual attitudes, job-site layout, littering and 'professionalism'. |
| 13. | II | Explain what should and should not be included in news releases. |
| 14. | II | <p>Explain the role of the following in ensuring good public relations:</p> <ul style="list-style-type: none"> A) News releases; B) Photographs; C) Advertisements; D) Bulletins and newsletters; E) Activities reports; F) Information booklets, pamphlets, brochures, etc.; G) Operating reports and records. |
| 15. | III | Explain the benefits and costs of notification of the public in regards to the performing of repairs or other preventive maintenance (PM) activities. |
| 16. | IV | Explain the importance and disadvantages of having a media relations policy. |
| 17. | IV | Explain the issues involved with having collection system operators on or in private property. |

INTERVIEWING

1. IV Explain why it is important to ask the right questions during an interview and explain the consequences of asking the wrong or improper questions.
2. IV Explain the importance of each of the following:
 - A) Equal Employment Opportunity (EEO);
 - B) American Disabilities Act (ADA);
 - C) Privacy Act;
 - D) Requirements for the advertising and publication of job vacancies;
 - E) Job descriptions.
3. IV Explain the legal issues involved with testing in pre-employment selection.
4. IV Explain the techniques involved with employee counseling and the impacts of an improperly conducted interview.

MAPS

1. II Describe how to locate a street and an address on a city map.
2. III Explain the types of information required on collection system maps.
3. III What are the uses of collection system maps?
4. III What are the different types of maps that are used in collection system mapping?
5. III Explain why collection system maps should be updated.
6. III Describe how to read and interpret drawings of a wastewater collection system.

RECORDS

1. II Describe the information that is needed to prepare a work order.
2. III Explain the need for a work order system.
3. III Explain the importance of filling out a work order completely.
4. III Explain how records are used in developing or using a preventive maintenance (PM) program.
5. IV Describe the different types of records needed on a collection system.

ITEM GRADE

6. IV Explain the importance of records in legal actions.

SUPERVISION

1. I Explain why supervisors should deal with most customer complaints.
2. II Explain the different supervisory roles performed at the different levels of supervision.
3. III Explain the principles of administration and the ability to accomplish the goals of the organization.
4. IV Explain the different levels of an organization necessary to effectively supervise a collection system operation - both operationally and staff wise.

EMPLOYEE RELATIONS

1. IV What is a grievance procedure? Explain.
2. IV Explain the benefits of a formal grievance procedure.
3. IV Explain the role that a supervisor plays in a grievance procedure.
4. IV Explain both the benefits and problems associated with each of the following:
 - A) "Open-door" policies;
 - B) Feed-back policies for complaints and/or compliments;
 - C) Safety committees;
 - D) Group planning activities;
 - E) "Empowerment".
5. IV Explain what North Carolina State law says about collective bargaining.
6. IV Explain the importance of training in effective employee relations.

EMPLOYEE RECORDS

1. III Explain the role of the first line supervisor in performing employee evaluations.
2. III What should be discussed with an employee before, during and after an evaluation.
3. IV Describe the different types of employee records and explain the significance of each type.
4. IV Explain the uses and requirements of the different types of employee evaluations.

LAWS AND REGULATIONS

NCAC Title 15A, Chapter 8
NCAC Title 15A 2H .0200
NCGS 143B-300
NCGS 90A - 35

1. I-IV Describe the circumstances which may cause a certified operator's certification to be revoked or suspended.
2. I-IV Identify the functions of the Water Pollution Control System Operators Certification Commission (WPCSOCC).
3. I-IV Explain the requirement for a certified operator in responsible charge (ORC) for each wastewater collection system in North Carolina.
4. I-IV Identify the North Carolina governmental agency which has permitting authority for wastewater collection systems.
5. I-IV Describe the current State regulatory procedure with respect to violations of the regulations and identify penalties which can be imposed for these violations.
6. I-IV Identify the North Carolina regulation which sets forth the requirements and procedures for application and issuance of collection system permits.
7. I-IV Identify the minimum design requirements for pumping stations and sewer systems and sewer system extensions as outlined in 15A NCAC 2H .0219.

SAFETY SECTION

BASIC TRAFFIC CONTROL

References - *Operation & Maintenance of Wastewater Collection Systems, Vol.I.* *Manual on Uniform Traffic Control Devices for Streets & Highways*

1. I Describe the sequence of events for the installation and removal of required traffic control devices at a job-site.
2. I Explain the use of each of the following types of traffic control devices used in work zone traffic control:
 - A) Signs;
 - B) Channel devices;
 - C) Lighting devices;
 - D) Pavement marking.
3. I Explain the use of each of the following types of signs in traffic control:
 - A) Detour;
 - B) Road Closed;
 - C) Men Working;
 - D) One Lane;
 - E) Construction Work Ahead;
 - F) Obey flagman.
4. I Explain the color significance of warning signs.
5. I What are the standard sizes for warning signs?
6. I List the three types of *channeling devices*.
7. I Explain the proper flagger procedure.
8. I Explain the proper use of yellow flashers.
9. II List the conditions which require the use of flaggers.
10. II Explain why each of the following questions must be addressed when determining how traffic control should be accomplished at a job-site:
 - A) Is traffic moving at a low rate of speed (0-35) or high rate of speed (40-55)?
 - B) Is street two or one lane?
 - C) Is it undivided four lane?
 - D) Is it multiple lane one way?
 - E) Are walkways affected?
 - F) Will lane closure be required?
 - G) Will more than one lane be closed?
 - H) Will traffic control be required during peak traffic periods or at night?

- | <u>ITEM</u> | <u>GRADE</u> | |
|-------------|--------------|---|
| 11. | II | Define each of the following work areas in a traffic control zone and describe the traffic control for each of the areas:

<ul style="list-style-type: none"> A) Advanced warning area; B) Transition area; C) Buffer area; D) Work area; E) Termination area. |
| 12. | II | Explain how speed limits affect the placement of advance Construction Ahead signs. |
| 13. | III | List some of the protective measures which can be taken to provide safe passageways for pedestrian work areas. |
| 14. | III | Be able to determine the minimum channelization taper length needed for a given speed limit. |
| 15. | III | Describe a legal cone (delineator) and explain their use in work area traffic control. |
| 16. | IV | List the conditions that excavations must meet when steel plates or similar devices are used to bridge a trench. |
| 17. | IV | What are the conditions which necessitate Type "A" and Type "B" flashing warning lights/barricades? |

CONFINED SPACES

REFERENCES - Operation & Maintenance of Wastewater Collection Systems, Vols. I and II

1. I Describe the potential hazards and appropriate safety precautions that a wastewater collection system operator should be aware of with respect to :
 - A) Gases;
 - B) Poisonous substances;
 - C) Suffocation;
 - D) Explosions;
 - E) Confined spaces;
 - F) Blood-borne pathogens.
2. I Describe the physiological effects of an atmosphere containing very little oxygen on the respiratory system, nerves, blood, etc. Describe the effects of an atmosphere which contains substantial amounts of hydrogen sulfide on the same body systems.
3. I Identify the types of equipment which should be used for protection against atmospheric hazards.
4. I Describe how to test for harmful gases and the lack of oxygen in manholes and other confined spaces prior to entering the space and explain the order in which an operator should test for these gases.

- | <u>ITEM</u> | <u>GRADE</u> | |
|-------------|--------------|---|
| 5. | I | Describe why the following procedures are necessary when harmful gases exist in work areas:

A) Purging to remove toxic or flammable gases;
B) Use of self-contained air packs in hazardous atmospheric conditions. |
| 6. | I | What percent oxygen concentration range is necessary in order to have safe working conditions? Explain. |
| 7. | I | Define each of the following terms:

A) Confined space.
B) Permit-required confined space. |
| 8. | I | State the purpose of each of the following items of safety equipment and explain how it works:

A) Portable fresh air blower;
B) Atmospheric testing equipment;
C) Self-contained breathing apparatus;
D) Respirator/Inhalator;
E) First aid kit;
F) Barricades, traffic cones and warning signs;
G) Fire fighting equipment;
H) Explosion-proof portable lights;
I) Safety harnesses, lifelines and retrieval systems;
J) Protective clothing. |
| 9. | I | Explain the reason for each of the following precautions when working in below-ground structures:

A) Placing warning devices, barricades or guard rails around manholes;
B) Placing trucks and equipment between working area and traffic;
C) Removing manhole covers with hoists or hooks;
D) Prohibiting smoking in any underground structure;
E) Testing for oxygen deficiency and dangerous gases;
F) Requiring each worker entering a manhole to wear a harness, lifeline and retrieval system;
G) Stationing an attendant at the entrance to a manhole while a third worker is in the manhole;
H) Ventilating and purging the underground structure with fresh air;
I) Using non sparking tools, shoes with rubber soles, and safety lights;
J) Permitting no open flames in or near the structure. |
| 10. | I | Describe how to test for an oxygen deficient atmosphere in a confined space. |

<u>ITEM</u>	<u>GRADE</u>	
11.	I	Explain why each of the following conditions cause oxygen deficiency in wastewater collection systems: A) Poor ventilation; B) Displacement of air by another gas; C) Absorption, consumption or biochemical depletion of air by decomposition of organic matter in sewers, manholes and covered tanks; D) Burning and welding.
12.	I	Describe procedures which must be followed if an oxygen-deficient atmosphere exists.
13.	I	Explain the difference between a <i>respirator</i> and a <i>self-contained breathing apparatus (SCBA)</i> .
14.	I	Define the term <i>LEL (Lower Explosive Limit)</i> and explain its significance and how it varies.
15.	I	Identify the hazardous locations in wastewater collection systems which encourage the accumulation of noxious gases and oxygen-deficient atmospheres.
16.	I	List the three ingredients necessary for a fire.
17.	I	Why is noise considered a safety hazard? Explain.
18.	I	Explain the importance of proper lighting as a safety measure.
19.	I	What actions must be taken when electrical equipment is repaired or installed in a wastewater collection system?
20.	I	What emergency phone numbers should always be kept posted in a conspicuous place?
21.	I	What are the employer's responsibilities for providing necessary safety equipment? How and why should employees be informed that the safety equipment is for their benefit?
22.	I	Describe the requirements of the "Right To Know" regulations.
23.	I	What agency administers the OSHA program in North Carolina?
24.	II	Explain why flammable compounds should not be discharged into a collection system.
25.	II	Explain why ventilation of a manhole is essential and describe the proper use and placement of a blower when it is being used to ventilate a manhole.
26.	II	Describe the safety requirements needed with respect to belts, coupling guards, electrical disconnects and lock-out procedures.
27.	II	Explain the importance of informing collection system employees about safety laws and describe methods for encouraging compliance with them.
28.	III	Why is it important to make a detailed report showing exactly how an accident occurred?

<u>ITEM</u>	<u>GRADE</u>	
29.	IV	Identify the records required for the purposes of Workmen's Compensation.
30.	IV	Identify the records required by OSHA.
31.	IV	Describe how to organize and implement a good safety training program. What are some of the main issues that should be addressed?

JOB SITE SAFETY

Reference - Operation and Maintenance of Wastewater Collection Systems, Vol. II

1. I Explain how orderliness increases work speed.
2. I Describe how to secure signs and barricades.
3. I Explain the benefits of keeping the cab of the work truck clean.
4. I Explain what is meant by 'good housekeeping' on the job site.
5. I Describe the basic sanitation requirements that need to be maintained on a job site.
6. I Describe the proper use of each of the hand tools found on a service truck.
7. I Explain who should and should not be allowed on a job site.
8. I Why should picks never be left in manhole covers?
9. I Define *mushroom* and explain the precautions that should be taken in dealing with *mushrooms*.
10. I Explain the proper way to get tools to an individual working in the bottom of a manhole.
11. I Explain the correct procedure for dealing with tools with split or cracked handles.
12. I Explain the proper procedure for handling damaged ladders.
13. I Describe the precautions that should be taken when working on snow and ice.
14. I When is 'horse-play' acceptable on the job? Why?
15. I Describe the elements of proper lifting.
16. I Explain why it is not permissible to allow a passenger to ride on a piece of heavy equipment.

PERSONNEL PROTECTIVE EQUIPMENT (PPE)

*Reference - 29 CFR Part 1910
29 CFR Part 1926*

1. I Why and when is personnel protective equipment (PPE) necessary?
2. I Describe when you would need to wear each of the following PPE items:
 - A) Goggles;
 - B) Face shield;
 - C) Both face shields and goggles.
3. I Explain why a cartridge respirator is not appropriate for low oxygen atmospheres.
4. I What does SCBA stand for?
5. I Is a dust mask a respirator? Why? Explain.
6. I Explain the proper care and maintenance of a respirator.
7. I Explain the proper way to wear a hard hat and describe when a hard hat should be worn.
8. I What is *hearing protection* and when should it be worn?
9. I Explain why cotton balls are inappropriate ear protection.
10. I Explain the basic requirements of a respirator protection plan.
11. I Explain when protective foot wear should be worn.
12. I What type of protection does proper clothing provide?
13. I Explain the vest and hard hat requirements for working in traffic, in ditches, at night and around equipment.
14. I Describe the personnel protective equipment required when performing each of the following:
 - A. Confined-space entry;
 - B. Pipe cutting for the various types of piping;
 - C. Tamp and jack hammer operation.
15. I Explain why local OSHA requirements are the minimum workplace standards and employer safety policies can be more stringent than the OSHA requirements.

RELATED HEALTH RISKS

1. I Explain the need for safety in wastewater collection systems operations.
2. I Describe the hazards of infection and explain how to minimize them.
3. I State the purpose of following basic rules of good personal hygiene.
4. I Explain each of the following basic rules of good personal hygiene as it applies to wastewater collection system operators:
 - A) Keep hands and fingers away from eyes, ears, nose and mouth;
 - B) Wear rubber gloves;
 - C) Wash hands before eating and smoking;
 - D) Do not store personal clothes with work clothes. Also, wash work clothes separately from family clothes;
 - E) Give cuts and scratches first aid immediately;
 - F) Take a shower after work;
 - G) Keep current all adult vaccinations such as tetanus, diphtheria etc.;
 - H) Provide waterless hand cleaners at the job site;
 - I) Do NOT smoke or chew tobacco while working directly with wastewater;
 - J) Keep work shoes at work. Clean and dry shoes between uses.
5. I Explain why each of the following precautions is important to a collection system operator:
 - A) Do not lift more than can be handled comfortably;
 - B) Establish a solid footing and good balance before lifting;
 - C) Get as close to the load as possible when lifting or carrying;
 - D) Keep the back straight, gripping the object firmly, and using the legs to provide lift;
 - E) Never carry a load that is too large to see over or around.
6. I Describe hazards commonly encountered in collection systems with respect to falling and explain methods for minimizing them.
7. I Describe special hazards existing in collection systems with respect to drowning and explain how to minimize them.
8. I Explain how keeping a job site neat and orderly affects each of the following:
 - A) Public relations;
 - B) Positive image;
 - C) Impression of competence;
 - D) Pride and pleasant working conditions;
 - E) Safety.
9. I Why should potable water sources be clearly marked? Explain.
10. I Why should the location of MSDS, fire extinguishers and first aid be clearly known?

- | <u>ITEM</u> | <u>GRADE</u> | |
|-------------|--------------|---|
| 11. | I | Describe each of the basic good housekeeping measures listed below, explain the reason for each and describe why they encourage safety:

A) Have a routine cleaning program;
B) Remove trash and loose debris;
C) Repair loose boards, holes, splinters and protruding nails;
D) Keep walkways free of oil, grease and sludge;
E) Keep combustible wastes in metal air-tight containers and remove from the job site daily;
F) Prompt cleanup of spills. |
| 12. | I | Identify electrocution hazards in wastewater collection systems and explain how to minimize them. |
| 13. | I | Identify the poisonous snakes and insects (water moccasins, black widow and brown recluse spiders, fire ants, wasps, etc.) that may be encountered in and around wastewater collection systems and describe the first aid actions that will be needed in the event of a bite or sting. |
| 14. | II | Describe the actions that should be taken and reports which should be prepared following an accident. |
| 15. | II | Explain why safety and the protection of the public's investment are reasons for good housekeeping. |
| 16. | II | Why is it especially important for wastewater collection system operators to have knowledge of first aid? |

SAFETY EQUIPMENT

1. I Explain what a gas monitor/atmospheric meter is used to determine and when one should be used.
2. I Describe the gases that are being monitored when a gas monitor/atmospheric meter is being used.
3. I When is a tripod necessary? Why?
4. I Explain the essential elements of a respiratory protection plan.
5. I What is a respirator and when is one used?
6. I Describe the special equipment needed for confined-space entry.
7. I When is rescue equipment needed on the job? Why?
8. I Describe the types of safety equipment that must be on all trucks regardless of the function of the truck.
9. I Why are explosion-proof lights and radios required in confined spaces?
10. I What does "TWA" mean on a gas monitor?
11. I Ventilation blowers are used for a period of time before entry into a confined space. What factors effect the pre-entry run time of the blowers?

ITEM GRADE

- 12. I Who is responsible for the pumps used to de-water construction excavations? Why?
- 13. I Describe the safety equipment that must be provided by the employer and the employee.

SHORING AND UNDERGROUND CONSTRUCTION SAFETY

Reference - 29 CFR Part 1926

- 1. I Explain the need for underground construction safety.
- 2. I Explain the General Conditions of 29 CFR Part 1926.650-652 Subpart P.
- 3. I Explain the legal requirement that states that utilities must be given 48 hours notice before digging occurs near their underground installations.
- 4. I Explain why poles and sidewalks beside excavations must be removed or supported.
- 5. I Explain how imposed loads, like buildings and equipment, increase the hazard of cave-ins.
- 6. I Explain the need for protecting existing utilities.
- 7. I Explain why there is a need for easy and rapid escape from excavations.
- 8. I Describe the requirements for ladders and ramps for exits from excavations.
- 9. I Explain why a safety vest must be worn while working in traffic.
- 10. I Describe the requirements for providing protection from falling loads.
- 11. I Under what conditions can you stay in a truck being loaded? Explain.
- 12. I Explain what makes an excavation a confined space.
- 13. I Explain why all excavations five feet and deeper, unless in stable rock, shall be protected from cave-ins before employee entry.
- 14. I Define *competent person*.
- 15. I Explain the four areas of specific knowledge or ability needed to be considered a *competent person*.
- 16. I Explain who designates the *competent person* on a work crew.
- 17. I Describe the *pinch points* on hydraulic shoring.
- 18. I Explain how hydraulic shoring uses water and a lubricant as the hydraulic fluid.
- 19. I Explain how the amount of support required in shoring is based on soil type and the classification as found in Appendix A of the regulations.
- 20. I Explain why the maximum depth a piece of shoring equipment can be used at is controlled by the

<u>ITEM</u>	<u>GRADE</u>	
		soil type, the manufacturer's data and OSHA regulations.
21.	I	Explain why the <i>competent person's</i> authority to determine the safety system for excavation is limited to excavations of twenty feet or less.
22.	I	Explain Appendix D of the regulations - Aluminum Hydraulic Shoring, Typical Installations.
23.	I	Explain why the <i>competent person</i> must require the removal of standing water from a ditch before allowing employees to enter the ditch.
24.	I	Describe the dewatering operation of a ditch and explain the responsibility of the <i>competent person</i> .
25.	I	Explain why the <i>competent person</i> must, by definition, have the authority to order any employee to exit a ditch immediately.
26.	I	Explain why the <i>competent person</i> is responsible for ensuring that all safety requirements are being met at a work site.
27.	I	Why must drinking water be supplied at work sites, in a labeled container, at all times?
28.	I	Why must trash and liter be put into a waste container and not allowed to be loose in the cab of a truck?
29.	I	Explain why all construction requires a written safety program.
30.	I	Why must material safety data sheets (MSDS) be located on each truck?
31.	I	Explain why one hour of Right-To-Know training is required each year.
32.	I	Who is the person most responsible for your safety ? Why?
33.	I	List the various types of shoring equipment used in collection system construction.
34.	I	Explain why it is important for collection system operators to view audio visuals in order to understand that cave-ins are serious causing injury and death to over 100 people each year.
35.	I	Explain why cities can now be fined for disregarding safety laws. Explain why the costs of injuries are great and why there are personal liabilities for those who disregard the laws.
36.	I	Describe the proper installation and removal of the various types of shoring equipment.
37.	I	Why should a collection system operator never enter a trench until the <i>competent person</i> says that the trench is safe for entry?
38.	I	Explain how to limit your exposure to danger in the work place by not spending more time than necessary in hazardous places such as ditches, traffic areas, confined spaces and near heavy equipment.
39.	I	Explain why water is the number one hazard to ditch stability.

ITEM 40. GRADE I

Explain what should be expected during an OSHA inspection and explain your rights and your employer's rights during the inspection.

MATHEMATICS

REFERENCE - Operation Of Wastewater Treatment Plants Vol. I, Appendix

CONVERSION FACTORS

LENGTH	=	CONVERSION FACTOR
12 inches	=	1 foot 12 in/ft
3 feet	=	1 yard 3 ft/yd
5280 feet	=	1 mile 5280 ft/mile
AREA	=	CONVERSION FACTOR
9 square feet (ft ²)	=	1 square yard (yd ²) 9 ft ² /yd ²
27 cubic feet (ft ³)	=	1 cubic yard (yd ³) 27 ft ³ /yd ³
VOLUME	=	CONVERSION FACTOR
7.48 gallons	=	1 cubic foot (ft ³) 7.48 gal/ft ³
1000 milliliters	=	1 liter 1000 ml/L
3.785 liters	=	1 gallon 3.785 L/gal
WEIGHT	=	CONVERSION FACTOR
454 grams	=	1 pound 454 gm/lb
16 ounces	=	1 pound 16 oz/lb
2000 pounds	=	1 ton 2000 lb/ton
POWER	=	CONVERSION FACTOR
0.746 kilowatts	=	1 horsepower 0.746 kw/HP
DENSITY	=	CONVERSION FACTOR
8.34 pounds	=	1 gallon 8.34 lbs/gal
62.4 pounds	=	1 cubic foot (ft ³) 62.4 lbs/ft ³
PRESSURE	=	CONVERSION FACTOR
2.31 foot water	=	1 psi 2.31 ft water/psi
0.433 psi	=	1 foot water 0.433 psi/ft water
FLOW	=	CONVERSION FACTOR
694 gpm	=	1 MGD 694 gpm/MGD
1.55 cfs	=	1 MGD 1.55 cfs/MGD
MULTIPLY	BY	TO OBTAIN
cubic feet	7.48	gallons
cubic feet per second	0.646	MGD
gallons	8.34	pounds of water
gallons	3.785	liters
horsepower	0.746	kilowatts
inches of mercury	1.133	feet of water
MGD	1.55	cubic feet per second
pounds	454	grams
psi	2.31	feet of water
feet of water	0.434	psi
gpm	1440	gpd
MGD	694	gpm

SUMMARY OF COLLECTION SYSTEM LAWS AND REGULATIONS

(NOTE: The following are summations of the laws and regulations that apply to most wastewater collection operators and are presented as they existed at the time of the printing of this edition of the Needs To Know manual and are subject to modification.)

- Operators of Wastewater Collection Systems are certified by the Water Pollution Control System Operators Certification Commission (WPCSOCC). The Certification Commission may revoke the certificate of any operator who practices fraud or deception; or if the commission finds that reasonable care, judgment or the application of his knowledge or ability was not used in the performance of his duties, or if the operator is incompetent or unable to perform their duties, or if the operator supplied false information to obtain or maintain certification, or cheated on a certification examination.
- A collection system, upon classification, will be required to designate an Operator in Responsible Charge (ORC) and a Back-up Operator in Responsible Charge. The ORC must hold a valid collection system operator's certificate at a level equal to or higher than the collection system classification. The Back-up ORC must hold a valid collection system operator's certificate at a level that is no less than one grade than the classification of the system.
- The North Carolina Regulation that regulates collection system permits is Title 15A NCAC 2H .0200.
- The Division of Water Quality (DWQ) is the agency which has permitting authority for wastewater collection systems and wastewater treatment facilities.
- No person shall construct or operate any sewer system, treatment works or disposal system prior to applying for and receiving a permit from the Division Water Quality.
- For violations of the regulations, the Environmental Management Commission may assess a penalty of up to \$25,000 per day, per violation, for every day that the violation continues.
- All pumping stations must be designed and constructed based upon at least minimum standards which include:
 1. No by-pass or overflow lines.
 2. Multiple pumps (minimum of 2) capable of pumping at a rate of 2.5 times the average daily flow rate with any one pump out of service. Pump-on/Pump-off elevations shall be set such that 2-8 pumping cycles per hour may be achieved in the pump station at average flow. The need for odor and corrosion control must be evaluated if extended detention times are necessary due to phased development.

3. At least one of the following shall be required:
 - a. Dual source or standby power supply on site or;
 - b. Telemetry systems with sufficient numbers of standby generators and personnel for distribution or;
 - c. Approval by the Director that the pump station:
 1. Serves a private water distribution system which has automatic shut-off at power failure and no elevated water storage tanks, and;
 2. Has sufficient storage capacity that no potential for overflow exists, and;
 3. Is connected to facilities that can tolerate septic wastewater due to prolonged detention; or
 - d. Where the waters that would be impacted by a power failure are classified as C, the applicant may be allowed to show a history of power reliability that would demonstrate that an alternative power source or other reliability measures would not be needed.
4. Screened vents for all wet wells.
5. High water audio and visual alarms.
6. Protection from a 100 year flood.
7. Restricted access to the site and equipment.
8. All-weather roadway to the site.

- All sewer systems and sewer system extensions must be designed and constructed based upon at least minimum standards which include:
 1. Wastewater flow rate at design loading should result in the sewer flowing approximately half full;
 2. A velocity of two feet per second;
 3. Construction and operation shall not result in water pollution;
 4. Infiltration rate limited to 100 gallons per day per inch of pipe diameter per mile of pipe;
 5. Construction and operation consistent with all applicable local ordinances;
 6. For public gravity sewers, a minimum eight-inch diameter pipe and for private gravity sewers, a minimum six-inch diameter pipe;

7. Minimum separations:

- | | |
|--|----------------------|
| a. Storm sewers (vertical); | 12 inches |
| b. Water mains (vertical - water over sewer);
or (horizontal); | 18 inches
10 feet |
| c. in benched trenches (vertical); | 18 inches |
| d. Any private or public water supply source including any WS-I waters
or Class I or Class II impounded reservoirs used as a source of drinking
water; | 100 feet |
| e. Waters classified WS -II, WS-III, B, SA, ORW, HQW, OR SB; | 50 feet |
| f. Any other stream, lake or impoundment; | 10 feet |
| g. Any building foundation; | 5 feet |
| h. Any basement; | 10 feet |
| i. Top slope of embankment or cuts of 2 feet or more vertical height; | 10 feet |
| j. Drainage systems: | |
| 1. Interceptor drains; | 5 feet |
| 2. Ground water lowering and surface drainage ditches; | 10 feet |
| k. A swimming pool; | 10 feet |
| l. ferrous sewer pipe with joints equivalent to water main standards, shall be used where these
minimum separations cannot be maintained. The minimum separation shall however not be
less than 25 feet from a private well or 50 feet from a public water supply; | |

8. Three feet minimum cover shall be provided for all sewers unless ferrous material pipe is specified;
9. The maximum separation between manholes shall be 425 feet unless written documentation is submitted which shows that the owner/authority has the capability to perform routine cleaning and maintenance on the sewer at the specified manhole separations;
10. Drop manholes shall be provided where invert separations exceed 2.5 feet;
11. Manholes shall be designed for 100-year flood protection;
12. An air relief valve shall be provided at all high points along force mains.

- Bypass or overflow from pump stations or manholes that would allow wastewater to be diverted to surface

waters, dry ditches or to the land surface are prohibited.

- Any failure of a pumping station or collection system resulting in a by-pass without treatment of all or any portion of the wastewater shall report by telephone to either the central office or appropriate regional office of the Department of Environment and Natural Resources as soon as possible but **no later than 24 hours after the occurrence or on the next working day** following the occurrence or first knowledge of the occurrence.
- Each utility owner having underground utilities shall record a notarized document, containing the name of the utility owner and the title, address, and telephone number of its representatives designated to receive the written or oral notice of intent to excavate, with the Register of Deeds of each county in which the utility owner owns or operates underground facilities.
- Each utility owner having underground utilities located in a proposed excavation area shall be notified, either orally or in writing, not less than two nor more than 10 working days prior to starting the excavation. Excavations are exempted from the notification in the case of an emergency involving danger to life, health, or property requiring immediate correction, or in order to continue the operation of a major industrial plant, or in order to assure the continuity of utility services, if notice is given to the utility owner as soon as is reasonably possible.