

Needs To Know

For

A, B, & C Distribution

System Operators

**Prepared by the Board of Education and Examiners of the NCAWWA/WEA in
Cooperation with the North Carolina Water Treatment Facility Operators Certification
Board and the North Carolina Division of Environmental Health, Department of
Environment and Natural Resources**

02/14/2008

References

1. *Water Transmission and Distribution* textbook, AWWA (2nd and 3rd Editions)
2. “Rules Governing Public Water Systems,” North Carolina Administrative Code, Title 15A, Subchapter 18C - March 2001.
3. Rules Governing Water Treatment Facility Operators”, North Carolina Administrative Code, Title 15A, Subchapter 18D - August 2000.

How To Use This Outline

The outline is not a list of facts; therefore, it cannot be studied by itself. The entire manual should then be read and particular attention given to the highlighted sections. (Note: The sections highlighted are a guide to what is being taught in the class.) The individual is responsible for knowing this material for the examination.

If the operator is deficient in basic math skills, it is recommended courses be taken in the community college system, or elsewhere, to correct the deficiency.

The operator should not expect to study and learn the material necessary to be a distribution system operator or pass the certification examinations in a short period of time, such as the annual school. The annual school is only intended as a review. Distribution system techniques continually change and continuous study is required even after certification. Study of the outlined material and on the job training is recommended. The manuals are designed as a self-teaching guide and can be studied at the operator’s own study rate.

Items shown in ***Bold Italics*** refer to items that are modified in the 3rd Edition. A few items were deleted in the 3rd Edition and others were simply placed in different order in the book. Study of either Edition will prepare you for the classes and later examination.

This document has been updated and changes are noted as follows: ☒ = topic added, ☒ = topic deleted.

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	2. Circular prestressed-concrete tanks	190	229-230		X	X
	3. Hydraulically applied concrete-lined reservoirs	190	231		X	X
	C. Locations of distribution storage systems	192-194	231-234			
	1. Elevated storage	192-194	231-234			X
	a. Relationship to system hydraulics	192	231-232			X
	1. Location near the pumping station	192	231			X
	2. Location beyond the service area	192	231			X
	3. Location in a primary service area	192	231-232			X
	4. Several smaller storage units on the system	192	231			X
	b. Minimizing pumping and transmission costs	193	232-233			X
	c. Aesthetic concerns	194	233			X
	2. Ground-level storage	194	233-234			X
	D. Water storage facility equipment	195-204	234-242			
	1. Elevated storage tanks	195-202	234-235			X
	a. Inlet and outlet pipes	195-196	235			X
	b. Overflow pipe	196	235			X
	c. Drain connection	196	235-236			X

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	d. Monitoring devices	197	236			X
	e. Valving	197	236			X
	f. Air vents	197	236-237			X
	g. Access hatches	197-198	237			X
	h. Ladders	198-199	237			X
	1. Exterior ladders	199	237			X
	2. Interior ladders	199	237			X
	3. Climbing safety devices	199	237			X
	i. Coatings	200	238-239			X
	1. Interior coatings	200	238-239			X
	2. Exterior coatings	200	239			X
	3. Coating standards	200	239			X
	4. Inspecting the work of a painting contractor	200	239			X
	j. Cathodic protection	201-202	239-240			X
	k. Obstruction lighting	202	240			X
	2. Ground-level storage facilities	202-204	240-242			X
	a. Inlet and outlet pipes	203	241			X
	b. Overflow pipe, vents, and hatches	203	241			X
	c. Drains	203	242			X
	d. Corrosion protection	203-204	242			X
	E. Operation and maintenance of water storage facilities	204-208	242-246			
	1. Cold-weather operation	204-205	242-243		X	X
	2. Basic maintenance	205-207	243-245		X	X
	a. Elevated tanks	205	243		X	X
	b. Ground-level tanks	205	243-244		X	X
	c. Disinfection	205-206	244-245		X	X
	1. Disinfecting the entire volume of the tank	206	244		X	X
	2. Coating interior surfaces with chlorine solution	206	244		X	X
	3. Testing for bacteriological safety	207	244-245		X	X
	3. Inspection	207-208	246		X	X
	a. Structural damage	207	246		X	X
	b. Accessory equipment	207-208	246		X	X
	c. Signs of vandalism or forced entry	208	246		X	X

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	4. Records	208	246		X	X
	F. Water storage facility safety	208-209	247		X	X
	1. Dangers of working in a confined space	209	247		X	X
	2. Checking of safety devices	209	247		X	X
	3. Worker personal safety equipment	209	247		X	X
<i>System Opr</i>	Distribution system operation and maintenance	211-249	23-75			
	A. Distribution system inspection <i>Maintaining Water Quality</i>	211-216	23-26	X	X	X
	1. Water quality sampling <i>Routine Monitoring</i>	211	24	X	X	X
	a. Bacteriological quality <i>Development of a Sampling Plan</i>	211-212	24-25	X	X	X
	b. Chemical quality <i>Development of a Sampling Plan</i>	212	24-25	X	X	X
	c. Aesthetic quality <i>Development of a Sampling Plan</i>	212	24-25	X	X	X
	2. Pressure and flow tests	212-214	53-54	X	X	X
	a. Maintaining adequate pressure <i>Maintaining Flow & Pres.</i>	212-213	53-54	X	X	X
	b. Checking pressure	213	54	X	X	X
	c. Checking the loss of head	214	55	X	X	X
	d. Checking flow	214	55-56	X	X	X
	3. Routine inspection	214-216	56	X	X	X
	B. Flushing and cleaning	216-225	32-41	X	X	X
	1. Water system flushing <i>Flushing Programs</i>	216-218	32-36	X	X	X
	a. The need for system flushing <i>Flushing Programs</i>	216	32	X	X	X
	b. Flushing programs <i>Flushing Procedures</i>	216-217	32	X	X	X
	c. Flushing procedures	217-218	32-36	X	X	X
	2. Chlorine treatment	219	41	X	X	X
	3. Water main cleaning	219-225	36-37			
	a. Main-cleaning considerations	219-220	36-37		✘	X
	b. Main-cleaning preparations	220-221	37		✘	X
	c. Air purging	221	37		✘	X
	d. Swabbing	221-222	37-38		✘	X
	e. Pigging	222-224	38-40		✘	X
	1. Bare pigs	222	39		✘	X
	2. Cleaning pigs	222	39		✘	X
	3. Scraping pigs	223	39		✘	X

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	g. Power-driven cleaning	224	41		✗	X
	h. Final cleaning procedures	225	41		✗	X
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	1. Locating leaks	227-228	56-57		X	X
	a. Unaccounted-for-water	227	56-57		X	X
	b. Large leaks	227	57		X	X
	c. Small leaks	227-228	57		X	X
	2. Leak detection <i>Leak Detection Methods</i>	228-233	58-62		X	X
	a. Listening surveys	228-232	58-62		X	X
	1. Leak detection equipment	228-229	58-60		X	X
	2. Leak detection procedures	229-232	60-61		X	X
	3. Factors affecting leak detection	232	61-62		X	X
	b. Water audits	232-233	62-63		X	X
	3. Emergency repairs	233-239	63-68	X	X	X
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	b. Locating the leak	235-236	65-66	X	X	X
	c. Excavation	236-237	66-67	X	X	X
	d. Leak repair	237-238	67-68	X	X	X
	e. Restoration	239	68	X	X	X
	f. Record keeping	239	68	X	X	X
	E. Water system corrosion <i>Source Water Treatment</i>	239-248	45-49			
	1. Internal electrochemical corrosion <i>Source Water Treatment</i>	241	45-49			X
	a. Reduction in pipe capacity	241	46			X
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	1. Exposed meters	253	249	X	X	X
	2. Meter boxes	253-254	249-250	X	X	X
	3. Meters located in buildings	255-256	250-252	X	X	X
	B. Service line sizes, materials, and equipment	256-263	252-258			
	1. Service line size	256-257	252-253	X	X	X
	2. Types of service line pipe and tubing	257-258	253-254	X	X	X
	a. Lead pipe	257	253	X	X	X
	b. Galvanized iron pipe	257	253	X	X	X
	c. Copper tubing	258	253-254	X	X	X
	d. Plastic tubing	258	254	X	X	X
	3. Adapters and connectors	258	254-258	X	X	X
	4. Corporation stops	259-260	255	X	X	X
	5. Curb stops and boxes	260-263	255-258	X	X	X
	a. Arch-pattern stops and boxes	261	255	X	X	X
	b. Minneapolis-style stops and boxes	261-262	255-257	X	X	X
	c. Advantages and disadvantages	262-263	257-258	X	X	X
	C. Water service taps	263-269	258-268			
	1. Direct insertion	264-265	259-261	X	X	X
	2. Service clamps <i>Saddles</i>	266	261-262	X	X	X
	3. Small drilling machines	267-269	262-263	X	X	X
	4. Self-contained taps	269	263	X	X	X
	5. Tap location	269	263-264	X	X	X
	D. Leaks and breaks	269-270	264-268	X	X	X
	E. Thawing	270-271	265-266		X	X
	1. Electrical thawing	270	265		X	X
	2. Hot-water thawing	271	265-266		X	X
	F. Service line responsibility	272	266-267	X	X	X
	G. Service line records	272-273	267	X	X	X

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	a. Piston meters	276	270-271	X	X	X
	b. Nutating-disk meters	276	270-271	X	X	X
	2. Large-customer meters	278-280	272-274	X	X	X
	a. Compound meters	278-279	272-273	X	X	X
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	c. Detector-check meters	280	274	X	X	X
	3. Meter selection	280-282	274-275	X	X	X
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	b. Commercial meters	281-282	275	X	X	X
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	1. General considerations	282-283	276	X	X	X
	2. Manifold installations	283-284	277-279	X	X	X
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	4. Indoor installations	285-286	279-281	X	X	X
	5. Outdoor installations	286-289	281-283	X	X	X
	a. Small-meter installation	287-288	281-282	X	X	X
	b. Large-meter installation	288-289	282-283	X	X	X
	C. Meter reading	290-294	283-288			
	1. Meter registers	290	283-284	X	X	X
	2. Direct readout	290-291	284-285	X	X	X
	a. Reading meters located in homes	291	284-285	X	X	X
	b. Reading meters located outside	291	285	X	X	X
	c. Procedures for houses where occupants are not home	291	284-285	X	X	X
	3. Remote reading devices	291-293	285-287	X	X	X
	a. Remote registration	291-293	285-286	X	X	X
	b. Plug-in type readers	293	286-287	X	X	X
	c. Electronic meter reading	293	287	X	X	X
	4. Automatic meter reading	294	287	X	X	X
	D. Meter testing, maintenance, and repair	294-299	289-293			
	1. Testing new meters	295	289	X	X	X

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	4. Maintenance and repair	297-298	292	✗	X	X
	5. Record keeping for meters	298-299	292-293	X	X	X
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	E. Mainline metering	300-305	293-300			
	1. Uses of mainline meters	300	293	✗	X	X
	2. Types of mainline meters	300-305	293-299	✗	X	X
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	2. Multijet meters	301	294	✗	X	X
	3. Propeller meters	301	295	✗	X	X
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	c. Venturi meters	303	295-297		X	X
	d. Orifice meters	303	297		X	X
	e. Magnetic meters	304-305	297-299		X	X
	f. Ultrasonic meters	305	299		X	X
	H. Metering safety		299	X	X	X

	<i>Backflow Prevention and Cross-connection control</i>	315-354	301-335			
	A. Cross-connection Terminology	315-316	301-302	X	X	X
	1. Backflow	315	301-302	X	X	X
	a. Backpressure	315	302	X	X	X
	b. Backsiphonage	315	302	X	X	X
	c. Cross-connections	316	302	X	X	X
*	B. <i>Where cross-connections occur</i>	316		X	X	X
*	B. <i>Cross-connection Locations</i>		302	X	X	X
	C. Types of cross-connections	316-325	302-310	X	X	X
	1. Actual cross-connections	316-318	302-304	X	X	X
	2. Potential cross-connections	318	304	X	X	X
	3. Cross-connection examples	319-325	304-310	X	X	X
	a. Backflow due to backpressure	321	306-307	X	X	X

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	b. Backflow due to backsiphonage	322-324	308-310	X	X	X
	D. Public health significance of cross-connections	325-329	310-315	X	X	X
<i>Has</i>	1. Diseases attributable to cross-connections	326-328	See chapter references listed below.	X	X	X
<i>Been</i>	a. Dysentery	326-327	“	X	X	X
<i>Refor-</i>	b. Gastroenteritis	327	“	X	X	X
<i>Matted</i>	c. Hepatitis	327	“	X	X	X
*	d. Salmonella	328	“	X	X	X
*	e. Food contamination	328	“	X	X	X
*	2. Chemical contamination attributable to cross-connections	328-329	“	X	X	X
*	a. Fertilizer poisoning	328-329	“	X	X	X
*	b. Endrin contamination	329	“	X	X	X
*	c. Boiler-chemical contamination	329	“	X	X	X
<i>Rename</i>	1. Contaminants associated with cross-connections	“	313-314	X	X	X
<i>Section</i>	<i>a. Chemical contaminants</i>	“	313-314	X	X	X
*	<i>1. Pesticides</i>	“	313	X	X	X
*	<i>2. Metals</i>	“	314	X	X	X
*	<i>3. Organic compounds</i>	“	314	X	X	X
*	<i>4. Nitrates and nitrites</i>	“	314	X	X	X
*	<i>b. Biological contaminants</i>	See above chapter references	314-315	X	X	X
	E. Backflow control methods and devices	329-340	315-325		X	X
	1. Air gaps	330-331	315-316		X	X
	2. Reduced-pressure-zone backflow preventers	331-334	316-320		X	X
	3. Double check-valve assemblies	334-336	320-321		X	X
	4. Vacuum breakers	336-337	321-323		X	X
	5. Barometric loops	337-338	323-324		X	X
	6. Other methods and devices	339	324-325		X	X
	7. Level of protection	339	325		X	X
	F. Cross-connection control programs	340-352	325-333		X	X
	1. Developing a cross-connection control program	345-352	325-333		X	X
	a. Program content	346-347	330		X	X
	b. Procedures	347-351	330-332		X	X

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c. Backflow-prevention devices	351-352	332-333		X	X
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1. Water customer reports	352-353	333		X	X
2. Utility or agency operating records	353	333		X	X
3. Testing and repair personnel reports	353-354	334		X	X

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A. Types of pumps	357-369	337-349		X	X
1. Velocity pumps	357-369	337-340		X	X
a. Velocity pump designs and characteristics	358-362	338-340		X	X
1. Radial-flow designs	358-360	338-340		X	X
--Single stage	360	338-340		X	X
--Multistage	360	340		X	X
2. Axial-flow pumps	360-362	340-341		X	X
3. Mixed-flow designs	362	341		X	X
b. Centrifugal pumps	363-365	341-343		X	X
1. Advantages	364	342		X	X
2. Disadvantages	364	343		X	X
c. Vertical turbine pumps	365-367	344-45		X	X
1. Deep-well pumps	366	345		X	X
2. Submersible pumps	366	346		X	X
3. Booster pumps	366	347		X	X
d. Jet pumps	367-369	347		X	X
2. Positive-displacement pumps	369	348-349		X	X
a. Reciprocating pumps	369	348-349		X	X
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B. Operation of centrifugal pumps	369-376	350-355		X	X
1. Pump starting and stopping	371-374	350-353		X	X
a. Pump starting	371-372	351		X	X
b. Pump stopping	372-373	351-352		X	X
c. Flow control	374	353		X	X
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	c. Vibration	375	354		X	X
	d. Speed	375	354		X	X
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	C. Centrifugal pump maintenance	376-393	355-371			X
	1. Mechanical details of centrifugal pumps	376-385	355-363			X
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	b. Single-suction pumps	377-378	355-356			X
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	k. Bearings	383-384	363			X
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	c. Ohms	398	374			X
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	b. Repulsion-induction motors	402	376			X
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	b. Fuses and circuit breakers	410	384			X
	c. Overcurrent relays	410	384-385			X
	d. Lightning surge arresters	410	385			X
	e. Voltage relays	411	385			X
	f. Frequency relays	411	385			X
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	1. Service prior to operation	421-422	394-395			X
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