# WATER SYSTEMS OPERATION AND MAINTENANCE VIDEO TRAINING SERIES

### COURSE OUTLINE

|    |                                     | Page                  |  | Page        |
|----|-------------------------------------|-----------------------|--|-------------|
| 1. | Wellhead Protection by Ken Kerri    | 1                     | <ol><li>Inspecting a Pump Station<br/>by Ken Kerri</li></ol> | 123         |
| 2. | Hypochlorination<br>by Ken Kerri    | 35                    | Distribution Systems     by Ken Kerri                        | 163         |
| 3. | Water Storage Tanks<br>by Ken Kerri | 65                    | 7. Approaches to Compliance With St by Kurt Ohlinger         | andards 225 |
| 4. | •                                   | mpling and Testing 95 | Water Words  | 235         |
|    | by Ken Kerri                        |                       | Subject Index  | 247         |

## **SUBJECT INDEX**

| Α   | Clear wells, 71, 72, 75                       |
|---|---|
| •   | Coliform tests, lab tests, 53                 |
| Abnormal operation, hypochlorinators, 52                      | Column pipe, pumps, 27, 144                   |
| Acid treatment, wells, 19                                     | Community involvement, wellhead protection, 6 |
| Adverse conditions, wells, 15                                 | Compliance, sampling and testing, 100, 103    |
| Air gap separation, 134, 137, 207, 210                        | Compliance with standards                     |
| Altitude-control valves, 79                                   | awareness of regulatory changes, 233          |
| Amperometric titration, chlorine, 45                          | causes of non-compliance, 233                 |
| Application points, disinfection, 44                          | consolidate systems, 233                      |
| Approaches, compliance, 233                                   | consult with DHS/LPA, 233                     |
| Aquifers, 10  | decision tree, 230                            |
| Arithmetic, chlorination, 58–63                               | explore approaches, 233                       |
| Auxiliary power, 149  | hiring a consultant, 234                      |
| Awareness, cross-connection hazards, 212                      | history of standards, 229                     |
| Awareness of regulatory changes, 233                          | identify the problem, 230                     |
| <b>3</b> , <b>3</b> ,   | new source, 234                               |
| В   | treatment/engineered blending, 234            |
| В   | Composite samples, 103                        |
| Poels preserve 424 422 204 205                                | Compound meters, 176                          |
| Back pressure, 131, 132, 204, 205                             | Concrete storage facility maintenance, 87     |
| Backflow, 204, 205, 209 Backflow prevention devices, 134, 207 | Connections, pipes and services, 194          |
| •   | Consolidate systems, 233                      |
| Backsiphonage, 131, 133, 204, 206                             | Consult with DHS/LPA, 233                     |
| Bacteriological analysis, lab tests, 53                       | Containers, sampling, 106                     |
| Blending, compliance, 234                                     | Control of cross connections, 131             |
| Blowoffs, surveillance, 170 Breakpoint chlorination, 55, 56   | Controls, electrical                          |
| breakpoint chiorination, 55, 56                               | Also see Electrical supply and controls       |
| _   | Corrective storage tank maintenance, 84       |
| C   | Corrosion control, storage tanks, 86          |
|   | Corrosion, well screens, 16, 17               |
| CT values, 54, 110  | Cross-connection control                      |
| Casing maintenance, wells, 17                                 | air gap separation, 207, 210                  |
| Cathodic protection, 86, 88                                   | awareness, hazards, 212                       |
| Causes of non-compliance, 233                                 | backflow prevention devices, 207              |
| Centrifugal pumps, 24, 142                                    | chemicals used by consumers, 212              |
| Chemicals used by consumers, 212                              | hazards, 212–215                              |
| CHEMTREC (800) 424-9300, 58                                   | importance, 204                               |
| Chlorination arithmetic, 58–63                                | industries, 212                               |
| Chlorine residual curve, 108                                  | maintenance procedures, 215                   |
| Chlorine residual, lab tests, 53                              | program responsibilities, 204                 |
| Chlorine residual testing                                     | responsibilities, program, 204                |
| CT values, 110  | testing procedures, 215                       |
| chlorine residual curve, 108                                  | water supplier program, 207                   |
| critical factors, 108   | Cross connections                             |
| Chlorine residuals  | backflow prevention devices, 134              |
| amperometric titration, 45                                    | control, 131                                  |
| DPD colorimetric method, 45                                   | hazardous chemicals, 134                      |
| measurement, 44   | hazards, 134–142                              |
| types, 44   | industries, 139                               |
| Chlorine treatment, wells, 20                                 | maintenance and testing procedures, 142       |
| Circuit breaker trips, pumps, 161                             | program responsibilities, 131                 |
| Circuit testing instruments, 155                              | water supplier control program, 134           |
| Cleaning storage tanks, 87, 89                                | Customer services, surveillance, 170          |

### 248 Water Systems

| D                                       | E   |
|---|---|
| DHS, consult with, 233                  | Electrical circuits, 155                      |
| Data, geologic and hydrologic, 15       | Electrical control definitions, 155           |
| Decision tree, compliance, 230          | Electrical supply and controls                |
| Decline in yield, wells, 22             | auxiliary power, 149                          |
| Deep well pumps, 23, 142                | electricity, 149                              |
| Deep well turbine pumps, 24, 143        | equipment, 151                                |
| Definitions, electrical control, 155    | instrumentation, 155                          |
| Depth sampling, 104                     | motor starters, 149                           |
| Devices, sampling and testing, 104      | pump controls, 151                            |
| Disinfection                            | purpose, 149                                  |
| factors influencing, 41–44              | Electricity, supply, 149                      |
| process, 44                             | Electronic meters, 176                        |
| purpose, 41                             | Elevated tanks, 71, 72, 75                    |
| Disinfection, distribution systems, 199 | Emergency maintenance, storage tanks, 89      |
| Disinfection, factors influencing       | Emergency plan, hypochlorinators, 54          |
| inorganic matter, 42                    | Engineered, compliance, 234                   |
| microorganisms, 43                      | Equipment, electrical supply, 151             |
| organic matter, 42                      | Excessive noise, pumps, 34                    |
| pH, 41                                  | Explore approaches, compliance, 233           |
| points of application, 44               | Explosive charges, wells, 21                  |
| reducing agents, 43                     |   |
| temperature, 42                         | F   |
| turbidity, 42                           | •   |
| Disinfection, field                     | Field disinfection, distribution systems, 199 |
| disinfection of mains, 199              | First-draw sampling, 106                      |
| need, 199                               | Flushing, distribution systems, 201           |
| Disinfection of mains, 199              | Frequent starting, pumps, 160                 |
| Disinfection, storage tanks, 89–92      | Fuses blow, pumps, 34, 161                    |
| Displacement meters, 176                |   |
| Distribution system pumps               | G   |
| inspection procedures, 129              | •   |
| preventive maintenance procedures, 129  | GIS (geographic information system), 216, 219 |
| purpose, 129                            | Geographic information system (GIS), 216, 219 |
| Distribution system sampling, 102       | Geologic data, 15                             |
| Distribution systems                    | Goals of plant operation, 101                 |
| cross-connection control, 204           | Grab samples, 103                             |
| disinfection, 199                       | Ground-level reservoirs, 71, 73, 75           |
| field disinfection, 199                 | Grounds, storage tanks, 87                    |
| flushing, 201<br>maps, 215              | Groundwater                                   |
| meters, 175                             | aquifers, 10                                  |
| O & M, 168                              | hydrologic cycle, 10, 11                      |
| pipe flushing, 201                      | importance, 9                                 |
| pipes, 188                              | pollution, 13–15                              |
| records, 215                            | water cycle, 10, 11                           |
| records and maps, 215                   | Guide, pump troubleshooting, 159–161          |
| surveillance, 168                       |   |
| system O & M, 168                       | Н   |
| system pipes, 188                       | ••  |
| system surveillance, 168                | Hazardous chemicals, cross connections, 134   |
| system valves, 171                      | Hazards, cross connections, 134–142, 212–215  |
| valves, 171                             | High-velocity jetting, wells, 17, 18          |
| Downhole video inspection, wells, 22    | Hiring a consultant, 234                      |
| DPD colorimetric method, chlorine, 45   | History of standards, 229                     |
| Drinking water laws, 229                | Hydrologic cycle, 10, 11                      |
| Drinking water regulations, 101         | Hydrologic data, 15                           |
| Drinking water standards, 229           | Hydropneumatic tanks, 71, 74, 75              |

| Hypochlorination safety program CHEMTREC (800) 424-9300, 58 cooperation, 55 hypochlorite safety, 55 operator safety training, 55 Hypochlorinators abnormal operation, 52 emergency plan, 54 installation, 47 maintenance, 53 normal operation, 51 records, 58 safety program, 55–58 shutdown, 51 start-up, 47, 51 system failure, 53 | Maintenance and testing, cross connections, 142 Maintenance, hypochlorinators, 53 Maintenance, pipes, 188 Maintenance procedures, cross connections, 215 Maintenance, storage tanks cathodic protection, 86, 88 cleaning tanks, 87, 89 concrete storage facilities, 87 corrective maintenance, 84 corrosion control, 86 emergency maintenance, 89 grounds, 87 inspection, 87, 89 painting, 84 preventive maintenance, 84 safety, 85 |
|--|---|
| troubleshooting, 52, 53, 54  | Maps, distribution systems, 215   |
| Hypochlorite safety, 55  | Measurement, chlorine residuals, 44   |
| 1  | Measuring for compliance, 103 sampling frequencies, 104 sampling methods, 104   |
| Incrustation, well screens, 16, 17   | sampling points, 104<br>Meters  |
| Industries, cross connections, 139, 212 Inorganic matter, disinfection, 42   | compound meters, 176  |
| In-plant sampling, 102   | displacement meters, 176  |
| Inspection   | electronic meters, 176  |
| pumps, 129   | proportional meters, 179  |
| storage systems, 76<br>storage tanks, 87, 89   | purpose, 175<br>selection, 175  |
| Installation, hypochlorinators, 47   | types, 175–179  |
| Instrumentation, electrical supply, 155  | velocity-type meters, 176   |
| Instruments, circuit testing, 155  | Microorganisms, disinfection, 43  |
| 1  | Mike's tip, 92<br>Monitoring data sheets, 115–121   |
| J  | Monitoring requirements, compliance, 112  |
| (NO LISTINGS)  | Motor starters, 149   |
|  | Motors, pumps, 32, 146  |
| K  | N   |
| (NO LICTINGS)  | N   |
| (NO LISTINGS)  | National Primary Drinking Water Standards, 231, 232   |
| L  | New source, compliance, 234<br>Noise, pumps, 161  |
| LPA, consult with, 233 Laboratory procedures, sampling and testing, 106  | Non-compliance, causes, 233 Normal operation, hypochlorinators, 51  |
| Laboratory tests   | Normal operation, hypochlorinators, or  |
| bacteriological analysis (coliform tests), 53 chlorine residual, 53  | 0   |
| Lead and Copper Rule, 110<br>Leaks   | O & M, distribution systems, 168  |
| locating, 188  | Oil lubricated pumps, 26, 29, 145, 147 Operation, storage tanks   |
| repairing, 194   | pumps, 80   |
| Locating leaks, 188  | sampling, 82  |
| Locating pipes, 191  | storage level controls, 80  |
| Lockout warning tag, 158 Lubricating oils, pumps, 32   | storage levels, 79  |
| Lubricating ons, purips, 52  | storage tanks, 77<br>troubleshooting, 82, 83  |
| M  | Operator safety training, 55  |
|  | Organic matter, disinfection, 42  |
| Main, disinfection, 199  | Overdraft, aquifer, 12  |
| Mains, surveillance, 170   | Overload relays trip, pumps, 161  |
| Maintaining pressure in system, 130  | Overpumping, wells, 15  |

### 250 Water Systems

| P   | Repairs, wells, 17                                      |
|---|---|
|   | Representative sampling, 102                            |
| Painting, storage tanks, 84                       | Responsibilities, cross connections, 204                |
| Performance, wells, 15                            | Right-angle gear drive pumps, 27, 30, 31, 144, 148, 149 |
| pH, disinfection, 41                              |   |
| Pipe connections, 194                             | S   |
| Pipe flushing, 201                                | •   |
| Pipe maintenance, 188                             | SDWA (Safe Drinking Water Act), 101                     |
| Pipes, distribution systems, 188                  | SDWA (Safe Drinking Water Act), disinfection, 41        |
| Also see System pipes                             | Safe Drinking Water Act (SDWA), 101                     |
| Points of application, disinfection, 44           | Safe Drinking Water Act (SDWA), disinfection, 41        |
| Pollution, groundwater, 13–15                     | Safety program, hypochlorinators, 55–58                 |
| Polyphosphates, wells, 21                         | Safety, storage tanks, 92                               |
| Porosity, 10                                      | Salt water intrusion, 13, 14                            |
| Power, pumps, 161                                 | Samples, preservation, 106, 107                         |
| Preservation of samples, 106, 107                 | Sampling  |
| Pressure in system, 130                           | composite samples, 103                                  |
| Pressure tanks, 71, 74, 75                        | containers, 106   |
| Preventive maintenance                            | depth, 104  |
| pumps, 129  | devices, 104  |
| storage tanks, 84                                 | distribution system, 102                                |
| wells, 17   | first-draw 106  |
| Process of disinfection, 44                       | frequencies, 104  |
| Program responsibilities, cross connections, 204  | grab samples, 103                                       |
| Proportional meters, 179                          | importance, 101   |
| Pump controls, 151                                | in-plant, 102   |
| Pump inspection, 129                              | methods, 104  |
| Pump preventive maintenance procedures, 129       | points, 104   |
| Pumps, storage tank operation, 80                 | preservation, 106, 107                                  |
| Pumps, well                                       | representative, 102                                     |
| centrifugal pumps, 142                            | source water, 102                                       |
| column pipe, 144                                  | surface, 104  |
| deep well pumps, 142                              | techniques, 104   |
| deep well turbine pumps, 143                      | water tap, 106  |
| motors, 146                                       | Sampling and testing                                    |
| oil lubricated pumps, 145, 147                    | chlorine residual testing, 108                          |
| purpose, 142                                      | compliance, 100, 103                                    |
| right-angle gear drive pumps, 144, 148, 149       | devices, 104  |
| service guidelines, 144                           | importance, 100   |
| shallow well pumps, 142                           | laboratory procedures, 106                              |
| submersible pumps, 143, 146                       | Lead and Copper Rule, 110                               |
| turbine-type pumps, 142<br>volute-type pumps, 142 | measuring for compliance, 103                           |
| water lubricated pumps, 145, 147                  | monitoring requirements, 112                            |
| water lubilicated pullips, 145, 147               | sampling, 101, 102                                      |
| Q   | techniques, 104   |
| · · ·   | testing for compliance, 100                             |
| (NO LISTINGS)                                     | types of samples, 103                                   |
| (NO EIGTHNOG)                                     | Sampling containers, 106 Sampling devices, 104          |
| R   | Sampling devices, 104 Sampling, storage tanks, 82       |
| IX.   | Sampling techniques, 104                                |
| Records   | Sand in well, 9   |
| distribution systems, 215                         | Screen maintenance, wells, 17                           |
| hypochlorinators, 58                              | Selecting a pump, 31                                    |
| storage tanks, 92                                 | Selection of meters, 175                                |
| Records and maps, distribution systems            | Service connections, 194                                |
| importance, 215                                   | Service guidelines, pumps, 31, 144                      |
| maps, 215   | Shallow well pumps, 23, 142                             |
| types of records, 220                             | Shutdown, hypochlorinators, 51                          |
| Reducing agents, disinfection, 43                 | Shutting off, pumps, 160                                |
| Repairing leaks, 194                              | Source water sampling, 102                              |
| Repairing pulled services, 194                    | Specific yield, 10                                      |
| . • • • • • • • • • • • • • • • • • • •           |   |

| Standards, compliance, 229                   | pipe connections, 194                         |
|--|---|
| Standards for drinking water quality, 100    | pipe maintenance, 188                         |
| Standpipes, 71, 73, 75                       | repairing leaks, 194                          |
| Starting, pumps, 160                         | repairing pulled services, 194                |
| Start-up, hypochlorinators, 47, 51           | service connections, 194                      |
| Storage facilities, purpose, 70              | System surveillance, 168                      |
| Storage facilities, surveillance, 168        | System valves, distribution systems, 171      |
| Storage facilities, types                    |   |
| clear wells, 71, 72, 75                      | T   |
| elevated tanks, 71, 72, 75                   | •   |
| ground-level reservoirs, 71, 73, 75          | Techniques, sampling and testing, 104         |
| hydropneumatic tanks, 71, 74, 75             | Telemetering, surveillance, 171               |
| pressure tanks, 71, 74, 75                   | Temperature, disinfection, 42                 |
| standpipes, 71, 73, 75                       | Testing for compliance, 100                   |
| surge tanks, 71, 74, 76                      | Testing procedures, cross connections, 215    |
| Storage system inspection, 76                | Treatment, compliance, 234                    |
| Storage system surveillance, 76              | Troubleshooting, hypochlorinators, 52, 53, 54 |
| Storage tank level controls, 80              | Troubleshooting, pumps                        |
| Storage tank levels, 79                      | circuit breaker trips, 161                    |
| Storage tanks, disinfection, 89–92           | delivery, 34                                  |
| Storage tanks, maintenance                   | excessive noise, 34                           |
| cathodic protection, 86, 88                  | frequent starting, 160                        |
| cleaning tanks, 87, 89                       | fuses blow, 34, 161                           |
| concrete storage facilities, 87              | guide, 159–161                                |
| corrective maintenance, 84                   | need, 32, 159                                 |
| corrosion control, 86                        | noise, 161                                    |
| emergency maintenance, 89                    | overload relays trip, 161                     |
| grounds, 87                                  | power, 34, 161                                |
| inspection, 87, 89                           | shutting off, 33, 160                         |
| painting, 84                                 | starting, 33, 160                             |
| preventive maintenance, 84                   | Troubleshooting, storage tanks, 82, 83        |
| safety, 85                                   | color, 83                                     |
| Storage tanks, operation                     | positive coliform results, 83                 |
| pumps, 80                                    | tastes and odors, 83                          |
| sampling, 82                                 | turbidity, 83                                 |
| storage level controls, 80                   | Troubleshooting, wells, 22                    |
| storage levels, 79                           | Turbidity, disinfection, 42                   |
| storage tanks, 77<br>troubleshooting, 82, 83 | Turbine-type pumps, 24, 142                   |
| Storage tanks, records, 92                   | Types of meters, 175–179                      |
| Storage tanks, safety, 92                    | Types of samples, 103                         |
| Submersible pumps, 143, 146                  | Types, pumps, 24, 25                          |
| Subsidence, 12                               |   |
| Surface sampling, 104                        | U   |
| Surge tanks, 71, 74, 76                      |   |
| Surging, wells, 17                           | (NO LISTINGS)                                 |
| Surveillance, distribution systems, 168      |   |
| blowoffs, 170                                | V   |
| customer services, 170                       |   |
| mains, 170                                   | Valves and blowoffs, surveillance, 170        |
| purpose, 168                                 | Valves, distribution systems, 171             |
| storage facilities, 168                      | Vandalism                                     |
| telemetering, 171                            | storage systems, 77                           |
| valves and blowoffs, 170                     | surveillance, 170                             |
| vandalism, 170                               | Velocity-type meters, 176                     |
| Surveillance, storage systems, 76            | Video hypochlorination problem, 63            |
| System failure, hypochlorinators, 53         | Volute-type pumps, 24, 142                    |
| System O & M, distribution systems, 168      |   |
| System pipes, distribution systems           | W   |
| connections, pipes and services, 194         |   |
| locating leaks, 188                          | Water cycle, 10, 11                           |
| locating pipes, 191                          | Water distribution systems                    |
| maintenance, pipes, 188                      | Also see Distribution systems                 |

### 252 Water Systems

| , | Water lubricated pumps, 26, 29, 145, 147 Water quality changes, wells, 22 Water quality monitoring, wells, 22 Water supplier program, cross connections, 207 Water tap sampling, 106 Well casing vent, 7 Well maintenance and rehabilitation acid treatment, 19 adverse conditions, 15 casing maintenance, 17   | Well pumps Wellhead p commun purpose sand in v well cas well pum |
|---|---|--|
|   | chlorine treatment, 20 clogging of screen, 15, 16 collapse of screen, 15, 16 corrosion, 16, 17 decline in yield, 22   | (NO LISTIN   |
|   | downhole video inspection, 22 explosive charges, 21 high-velocity jetting, 17, 18 importance, 15  | Yield, declir  |
|   | incrustation, 16, 17 overpumping, 15 performance, 15 polyphosphates, 21 preventive maintenance, 17 repairs, 17 screen maintenance, 17 surging, 17 troubleshooting, 22 water quality changes, 22 water quality monitoring, 22 yield, decline, 22 Well pumps  | (NO LISTIN   |
|   | centrifugal pumps, 24, 142 column pipe, 27, 144 deep well pumps, 23, 142 deep well turbine pumps, 24, 143 lubricating oils, 32 motors, 32, 146 oil lubricated pumps, 26, 29, 145, 147 purpose, 22, 142 right-angle gear drive pumps, 27, 30, 31, 144, 148, 149 selecting a pump, 31 service guidelines, 31, 144 shallow well pumps, 23, 142 submersible pumps, 143, 146 troubleshooting, 32–34 turbine-type pumps, 24, 142 types, 24, 25 volute-type pumps, 24, 142 water lubricated pumps, 26, 29, 145, 147 well pumps, 22 |  |

Well pumps, 8, 22
Wellhead protection
community involvement and support, 6
purpose, 6
sand in well, 9
well casing vent, 7
well pumps, 8
Working around electrical units, 157

X

(NO LISTINGS)

Y

Yield, decline, wells, 22

Z

(NO LISTINGS)