Need-to-Know Criteria

Maintenance Technologists School Class III

February 2011

Suggested Reference Materials

All of the below listed reference manuals are available through the NC AWWA-WEA Book Store

Go to: http://www.ncsafewater.org/

- Either of one (1) of these three (3) California State University (CSUS), Sacramento (SAC) Foundation, Office of Water Programs
  - Operation of Wastewater Treatment Plants, Volume II (WW SAC)
  - Industrial Waste Treatment, Volume II (Ind W SAC)
  - Water Treatment Plant Operation, Volume II (W SAC)
  
  These manuals are also available through the NC AWWA-WEA Bookstore.
- Pumps and Pumping (PP) / Arasmith Consulting
- Electrical Fundamentals for Water and Wastewater (EFWW) / Arasmith Consulting
- Industrial Maintenance, 3rd Edition, by Denis Green & Jonathon F. Gosse (Ind. Maint.)
- Need to Reference / Code of Federal Regulations(CFR), Title 29, Part 1910 Occupational Safety and Health Standards Available at: www.osha.gov; click on Standards

Students will Need-to-Know the Criteria for Maintenance Technologists Class 1, 2 & 3

Materials, Tools and Lubrication

1. Required Advanced Material Selection – Adhesives, Anti-seize compounds, Coatings/Paints, Epoxy, Fastening Devices, Gaskets, Locking Compounds, Metals, O-rings, Plastics, Sealants, Shims, Solvents

2. Required Advanced Knowledge of Materials – Application Procedures, Corrosion Control, Material Compatibility, Material Safety Data Sheets


4. Required Advanced Knowledge of Ancillary Crafts – Welding/Cutting Equipment
5. Required Advanced Use of Precision Tools – Alignment, Caliper, Dial Indicator, Laser, Micrometer
6. Required Advanced Knowledge of Tools – Accuracy, Non Sparking, Precision, Sharpening, Tool Storage
7. Required Advanced Use of Lubricants – Grease, Oil, Water


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**Pumps**

1. Management of Pump Repair
2. Management of Pump Preventive Maintenance
3. Pump Troubleshooting
4. Determining Pump Condition with Pump Hydraulics
5. Air binding: Removal of Air
6. Cavitation: Avoidance
7. Operating against a Closed Valve: Closed/Partially Opened
   a. How does pump respond?
8. Pump Curves: Reading and Uses
   a. System Head Curve
   b. System Static Head
   c. Effects of Pump Diameter change on Pump Curve
9. Pump Efficiency; Read and Calculate
10. Pump Hydraulics/Head: Horsepower, NPSH, TDH, Static Head Capacity
11. Reverse Rotation/Non Reverse Rotation: Differences and Uses
    a. Non-Reversing Ratchet: How it Works
12. Water Hammer: Surge Control and ARV’s
    a. Well Vents
    b. Control Valves
13. Control Systems: Types and Uses
    a. Level Control Types
14. Knowledge of pump components
15. Impellers: Types, Installation and Removal
1. Direction of Rotation
2. Impeller Types: Open, Semi-Open, Closed

16. Lantern Ring:
   a. Location and Purpose

17. Mechanical Seal:
   a. Function

18. Packing/Packing Gland:
   a. Function and Location
   b. Types and Materials

19. Shaft Sleeve:
   a. Function and Location
   b. Material Types

20. Slinger Ring:
   a. Function and Location

21. Stuffing Box: Installation and Removal

22. Flush/Seal Water:
   a. Function

23. Suction/Discharge piping:

24. Volute:
   a. Function and Types

25. Wear Plate/Wear Rings:
   a. Function, Location, Materials

26. Back Flows:
   a. Prevention Devices

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**Rotating Components**

1. Bearing Types and Applications

2. (Mostly applications as Types appear to have been covered some in I and II – Match the load and type of force with proper bearing
   Ball, Needle, Radial, Roller, Spherical, Tapered, Thrust, Babbitt, Sleeve, linear

3. Self Aligning non friction

4. Bearing materials
   a. Babbitt
   b. PTFE
   c. Nylon
   d. Bronze Impregnated
   e. Ceramic – Rolling element

5. Bearing identification and nomenclature
   a. Numbering
6. Bearing protection
   a. Housings
   b. Seals
   c. Shields
   d. Storage
7. Shafts
8. Specifications for use
   a. Metal
   b. Clearance / Tolerance
   c. Journals
   d. Roundness
9. Rotating Assemblies – Fans, Blowers, Pumps
   a. Single stage vs. Multiple stage
   b. Alignment, and Vibration standards
   c. Key Factors
      i. Heat
      ii. RPM
      iii. Material Moved
      iv. Temperature

Motors and Drives
1. Motors – Characteristics and uses
   a. Key Terms
      i. Impedance, Induction, Capacitance
   b. Single Phase
   c. Capacitor Start / Capacitor Run
   d. Split Phase
   e. Permanent Split Capacitor
   f. Capacitor Start / Induction Run
2. Start Capacitors/Run Capacitors
3. Centrifugal Start Switches
4. Polyphase AC (3 Phase)
5. 3 Phase Induction Motor
6. Wye configuration
7. Delta configuration
8. Wye/Delta configuration
9. Part Winding start
10. Wound Rotor
11. DC Motors
    a. Electrical Properties
b. Permanent Magnet
c. Fields
d. Armature

12. Convert Hp to KVA and KVA to Hp
13. Mechanical Drives

14. Belt Types and Applications
   a. V-Belts
   b. Link Belt
c. Timing Belt
d. Flat Belt
e. Slip and Creep

15. Alignment & Tension
   a. Straight Edge v. String alignment v Laser
   b. Calculating proper tension
c. Ft lbs of force deflection per span (ctr to ctr of shaft)

16. Chain Sprockets and application
   a. Single Hub
   b. Double Hub
c. Inspection of Sprocket condition
d. Identification of sprockets (nomenclature)

17. Gear Types
   a. External vs. Internal
   b. Spur, Helical, Bevel, Worm, Mitre

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**Pipes and Valves**

1. Utilizing the proper operations, lubrication and maintenance procedures to maintain the following valves
   a. Gate
   b. Plug
c. Butterfly
d. Globe
e. Check-Ball-Flapper
f. Pinch
g. Sluice
h. Shear
   i. Diaphragm
   j. Pressure Relief

2. Maintain the pipes, fitting and connections associated with plant piping systems
   a. Pipes
      i. Ductile Iron, Cast Iron
ii. Clay  
iii. Iron pipe  
iv. PVC – Schedule 40 and 80  
v. Steel  
vi. Copper  
vii. Concrete  
viii. Stainless Steel  
b. Fittings  
  i. Elbows  
  ii. Tees  
  iii. Wyes  
  iv.Reducers  
v. Sleeves  
vii. Adapters  
viii. Unions  
c. Connections  
  i. Flanges  
  ii. Mechanical Joint  
  iii. Bell & Spigot  
v. Uni-flange  
v. PVC Cement  
v. Solder  
vii. Threaded  
viii. Welded  

3. Utilizing the proper procedures and techniques to inspect and maintain tanks and reservoirs  
   a. Steel  
   b. Concrete  
   c. Elevated  
   d. Above Ground  
   e. Below Ground  
   f. Cathode Protection  

4. Utilizing the proper procedures and techniques to inspect and maintain backflow preventers  
   a. Air Gap  
   b. Pressure Vacuum Breaker  
   c. Double Check Valve Assembly  
   d. Reduced Pressure Principle Assembly  

5. Inspect, adjust or replace valve packing when applicable  

6. Lubricate valve gearing and rising stems  

7. Lap or replace valve body seats as required  

8. Adjust the gland on a plug valve  

9. Adjust clearances on sluice gates  

10. Select proper valve for a specific application  

11. Select the correct piping material for a specific application
12. Inspect, replace (cut if applicable) gaskets for various valves and piping systems

13. Select the appropriate sealant for threaded pipe connections

14. Utilizing the proper tooling chase existing or cut new threads for piping systems

15. Utilizing the proper maintenance procedures to glue PVC pipe and fittings using the correct cleaner, primer and glue

16. Utilizing the proper maintenance procedures to remove/install pipe hangers and restraints on piping systems

17. Utilizing the proper maintenance procedures and techniques to remove obstructions preventing flow through piping and valves

18. Utilizing the proper maintenance procedures to test and set lift and reseat pressure on a pressure relief valve

19. Utilize the proper procedures to inspect and maintain the different types of tanks and reservoirs

20. Utilize the proper procedures to inspect and maintain a cathode protection system

21. Utilize the proper procedures to recognize, inspect, maintain and test the different types of backflow preventers

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**Safety Practices**

1. Advanced Overview of Industrial Safety Standards
   a. Commercial Drivers License (CDL)
   b. Equipment Operator Certification
   c. Safety Practices

2. Follow Advanced Safety Procedures
   a. Chemical Handling
   b. Confined Space Entry
   c. Cross Connection Control
   d. Electrical Hazards
   e. Explosion proof lighting
   f. Extension cords
   g. Fire Safety
   h. Laboratory Safety
   i. Lock-out / Tag-out
   j. Traffic Control / Work zone safety
3. Advanced Knowledge of Safety Procedures
   a. Amperage
   b. Arc Flash
   c. Certification requirements
   d. Combustible gas devices
   e. Emergency Response Plans
   f. Fall/retrieval equipment
   g. Fuel Tanks / Cans
   h. Grounding
   i. Job safety analysis
   j. Lighting protection
   k. Material Safety Data Sheets
   l. Personal Protective Equipment
   m. Rescue procedures
   n. Resistance
   o. Right to Know Law
   p. Ventilation
   q. Voltage
   r. Wattage
   s. Wire Sizing
   t. Working over water
Pressure Vessels and Blowers

Advanced knowledge of compressors, blowers, boilers and associated devices.

1. Required Advance knowledge of Boilers
   a. Definition / MAWP (Maximum Allowable Working Pressure)
   b. Definition / BHP (Boiler Horse Power)
   c. Safety Valve Fitting
   d. Low Pressure Boiler / MAWP up to 15 psi
   e. High Pressure Boiler / MAWP 15 psi & over 6 BHP
   f. Firebox / Round Top, Flat Sides
   g. Safety Valves
   h. Definitions / Boiler Fittings & Accessories
   i. Feed water Valves
   j. Water Column
   k. Condensate Return Tanks
   l. Low Water Cutoff & Testing
   m. Feed water Regulators
   n. Bottom Blow down Valves
   o. Feed water Pumps
   p. Boiler Startup & Shutdown Procedures
   q. Boiler Water Treatment, Internal, External
   r. Types of Fans
   s. Steam Traps

2. Required Advance knowledge of Compressors / Blowers
   a. Compressor Maintenance
   b. Chiller Water Systems
   c. Pneumatic Systems
   d. Definition – Air Compressor
   e. Definition – Pneumatic Systems
   f. Compressor Types / Piston (Reciprocating, Single & Multi Stage), Vane, Centrifugal, Screw
   g. Relief Valve
   h. Inter & After Cooler
   i. Compressed Air Dryers
   j. Oil & Moister Separator
   k. Compressor Unloader
   l. The Control of Hazardous Energy (lockout/tag out)

Electrical Devices and Concepts

Advanced knowledge of electrical theory, electrical apparatus types, devices and operation
1. Required Advance Knowledge of Electrical Devices
   a. Ammeter
   b. Conduit - National Electrical Code
   c. Ground Fault Circuit Interrupters (GFCI)
   d. Internal Motor Heating Coils
   e. Leak Detection (Insulation)
   f. Magnetic Starters
   g. Motor Control
   h. Phase Protection Monitoring
   i. Vibration Monitoring
   j. Voltmeter
   k. Watt Hour Meter
   l. Megger

2. Identify Electrical Devices
   a. Soft Start (reduced voltage starter)
   b. Variable Frequency Drives

3. Maintain Electrical Devices
   a. Capacitors
   b. Circuit Breakers
   c. Fuses
   d. Heaters/Overload Protection
   e. Knife Switches
   f. Relays
   g. Switch Gears
   h. Transformers
   i. Wound Rotors
   j. Characterize electric motor operation and condition

4. Required Advanced Knowledge of Electrical Concepts
   a. Amperage
   b. Grounding
   c. Load Demand
   d. Resistance, Voltage
   e. Wattage
   f. Wire Sizing
   g. Electrical Line Diagrams
   h. Electrical Math
   i. Ladder Logic Diagrams

5. Required Advanced Knowledge of Regulations / Standards
   a. National Fire Protection
   b. National Electrical Code

**Instrumentation**

The focus of Class 3 is **CALIBRATION AND MAINTENANCE OF INSTRUMENTS**
1. The level of instruction and testing is that of **ADVANCED MAINTENANCE SKILLS** with emphasis on
   a. **INSPECTION** of Instrumentation and Control Systems
   b. **MANAGEMENT** of the duties required to maintain Instrumentation and Control Systems
   c. **PREDICTIVE MAINTENANCE** aspects of Instrumentation (to include **ANALYSIS** of results)

   The NTK topics for Class 3 below are in addition to the topics identified from Class 1 and Class 2
   Instrumentation NTK. Reference sources follow each topic where applicable.

2. Understand maintenance procedures (including proper care, cleaning and operational verification) of the
   following Instruments
   a. Air velocity Transmitter
   b. Chart Recorder
   c. Chlorine concentration Analyzer
   d. Chlorine gas Detector
   e. Conductivity Analyzer
   f. Dissolved Oxygen Analyzer
   g. Oxidation Reduction Potential Analyzer
   h. Particle Count Analyzer
   i. pH Analyzer
   j. Streaming Current Analyzer
   k. Temperature Transmitter
   l. Flow Totalizer

3. Be able to identify the following Terms associated with Calibration of Instrumentation
   a. Calibration
   b. Accuracy
   c. Precision (or Repeatability)
   d. Sensitivity
   e. Linearity
   f. Span (or Range)
   g. Standard (or Reference)
h. Standardize

i. Calibration Sheet or Documentation

j. Alarm Set-Points

k. Analog

l. Digital

4. Understand general Calibration procedures for the following categories of instrumentation
   a. Pressure transducers
   b. Temperature transducers
   c. Flow meters
   d. Level meters
   e. pH and ORP analyzers
   f. Chemical Concentration Analyzers
   g. Gas Monitors (detectors)
   h. Paced Metering Pumps

5. Identify Troubleshooting techniques for Instrumentation and Control Systems

Need-to-Know the Math Criteria for Maintenance Technologists Class 1, 2 & 3

**Formula / Conversion Table Below**

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**Math**

Advanced Knowledge of Math

1. Required Advance knowledge of Shop Geometry
   a. Use of a Protractor
      i. Angles (Measure or Make)
      ii. Adding and subtracting angles
   b. Circles
      i. Circumferences
      ii. Radius
      iii. Diameter
      iv. Chord
      v. Arc
c. Triangles
   i. Right
   ii. Acute
   iii. Obtuse
d. Regular Polygons
   i. 3 – Triangle
   ii. 4 – Square
   iii. 5 – Pentagon
   iv. 6 – Hexagon
   v. 7 – Heptagon
   vi. 8 – Octagon
   vii. 9 – Nonagon
   viii. 10 – Decagon
e. Dividing a Line
f. Erecting a Perpendicular Line
g. Areas of Geometric Shapes
   h. Triangle \( A = \frac{1}{2}bh \)
i. Rectangle \( A = ab \)
j. Square \( a = b^2 \)
k. Parallelogram \( A = ah \)
l. Circle: \( \pi r^2 \)

2. \( 1 \text{ Hp} = 33,000 \text{ ft.-lbs./min.} \)
   a. WHp – Water Horsepower
      \[ \text{WHp} = \frac{\text{TDH} \times Q \times d}{33,000 \text{ ft-lbs./min.}/\text{Hp}} \]
   b. BHp – Brake Horsepower
      \[ \text{BHp} = \frac{\text{WHp}}{0.70} (70\% \text{ Efficiency}) \]
   c. EHp – Electrical Horsepower
      \[ \text{BHp} = \frac{\text{BHp}}{0.90} (90\% \text{ Efficiency}) \]

3. \( 1 \text{ Hp} = 746 \text{ Watts} \)
4. \( 1 \text{ Kw} = 1000 \text{ Watts} \)
5. Watts Law \( P = V \times A \)
6. 1 ft. of Water = 0.433 psi
7. Station Efficiency = \( \frac{\text{Water Hp}}{\text{Electrical Hp}} \)
8. Pump Efficiency = \( \frac{\text{Water Hp}}{\text{Brake Hp}} \)
9. Feet of Head = \( \text{psi} \times 0.422 \text{ ft./psi} \)
10. Feet of Water = \( \frac{\text{inches of Hg} \times 13.55}{12''/\text{ft.}} \)
11. The Specific Gravity of Mercury is 13.55
12. Velocity Head \( V^2/2g \)
   a. \( V = \) Velocity in feet per second
   b. \( g = \) the acceleration due to gravity – 32.2 ft./sec. \(^2\)
13. Determine water depth w/pipe 0.433 psi./ft.

14. Flow & Velocity  \( Q = VA \) \( V = \frac{Q}{A} \)
   a. \( V \) = Velocity cfs (cubic feet second)
   b. \( Q \) = Flow ft./sec. (feet per second)
   c. \( A \) = Cross Sectional Area
   d. 1 cfs = 448 GPM

15. TDH Calculations
   a. Suction Conditions  \( TDH = \frac{\text{Discharge psi} - \text{Suction psi}}{0.433 \text{ psi/ft}} \)
   b. Suction Lift w/ Vacuum Gauge  \( TDH = \frac{\text{Discharge psi}}{0.433 \text{ psi/ft}} + \text{Suction Vacuum inches of Hg x 1.13 in/ft} \)
   c. Suction Lift  \( TDH = \frac{\text{Discharge psi}}{0.433 \text{ psi/ft}} + \text{Suction Lift in feet} \)

16. \( E=IR \) \( I=E/R \) \( R=E/I \)
   a. Power = Current x Voltage so \( P = I \times V \) or \( I = \frac{P}{V} \) or \( V = \frac{P}{I} \)

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**Drawings**

1. Operation and Maintenance Manuals
   a. Types of Drawings in Manual
   b. How they are used
      i. Reactive maintenance
      ii. Preventive Maintenance
      iii. Predictive maintenance

2. Standard operation procedures
   a. Who should write
   b. How organized
   c. How much detail needs to be included
   d. What is the benefit

3. Electrical and Instrumentation Drawings
   a. Programmable Logic Controllers
      i. Definition
      ii. Uses
   b. Ladder Logic
      i. Definition
      ii. Examples
      iii. How to interpret

4. Geographic Information System (GIS)
   a. Uses
   b. Examples
   c. How to interpret

5. Schematics
   a. Types
b. Examples
c. How to interpret

6. Graphing
   a. SCADA Trending
      i. Uses
      ii. How to interpret
   b. Vibration analysis
      i. Predictive maintenance

7. Construction Drawings
   a. As-built Drawings/Blueprints
      i. Definition
      ii. Purpose
      iii. How to ensure accuracy
      iv. Examples of typical shortcomings

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**Maintenance Management**

1. Required Advance Administrative / Maintenance Management
   a. Corrective Maintenance
   b. Employee Training
   c. Planning Scheduling (prioritizing)
   d. Predictive Maintenance
   e. Preventive Maintenance
   f. Record Keeping
   g. Work Order
   h. Writing Reports

2. Required Advance Knowledge of Administrative / Maintenance Management
   a. Computer Maintenance Management Systems
   b. Reporting Requirements
   c. Spreadsheet Software
   d. Word Processing Software

3. Required Advance Knowledge of Ancillary Crafts
   a. Computers
b. Herbicides and Pesticides

4. Maintain System Advance Security
   a. Fences
   b. Lighting and Locks
   c. Chemical Delivery
   d. Surveillance

5. Protect System Advance Security
   a. Data Security
   b. Vehicle Security

6. Restrict System Advance Security
   a. Computer Access
   b. System Access

7. Vulnerability Assessments of System Security
   a. Perform / Update

8. Required Advance Knowledge of System Security
   a. Communication System
   b. Homeland Security
   c. Security Awareness

9. Required Advance Regulations and Standards
   a. Comply with requirements
      b. Implement Requirements
      c. Record Requirements
      d. Report Requirement

10. Required Advanced Knowledge of Regulations and Standards
   a. CHEMTREC
   b. Department of Homeland Security
   c. Department of Transportation
   d. Environmental Protection Agency 40 CFR
   e. National Incident Management System
f. National Sanitation Foundation  
g. Occupation Safety & Health Administration  
h. Office of Hazardous Materials Safety  
i. State / Provincial Regulations  

**Formula / Conversion Table**

\[ \text{Amps} = \frac{\text{Volts}}{\text{Ohms}} \]

Area of Circle = \((0.785)(\text{Diameter}^2)\) or \((\pi)(\text{Radius}^2)\)

Area of Cone (lateral area) = \((\pi)(\text{Radius})\sqrt{\text{Radius}^2 + \text{Height}^2}\)

Area of Cone (total surface area) = \((\pi)(\text{Radius})(\text{Radius} + \sqrt{\text{Radius}^2 + \text{Height}^2})\)

Area of Cylinder (total outside surface area) = \[\pi\text{Radius}\text{Height} + \pi\text{Diameter}\text{Height}\]

Area of Rectangle = \((\text{Length})(\text{Width})\)

Area of a Right Triangle = \(\frac{\text{Base}\times\text{Height}}{2}\)

Average (arithmetic mean) = \(\frac{\text{Sum of All Terms}}{\text{Number of Terms}}\)

Circumference of Circle = \((\pi)(\text{Diameter})\)

Degrees Celsius = \((\text{Degrees Fahrenheit} - 32)\left(\frac{5}{9}\right)\) or \(\frac{\left(\text{F} - 32\right)}{1.8}\)

Degrees Fahrenheit = \([(\text{Degrees Celsius})\left(\frac{9}{5}\right) + 32]\) or \([(\text{Degrees Celsius})\times(1.8) + 32]\)

Electromotive Force (E.M.F), volts = \((\text{Current, amps})\times(\text{Resistance, ohms})\) or \(E = IR\)

Filter Backwash Rate, GPM/sq ft = \(\frac{\text{Flow, gpm}}{\text{Filter Area, sq ft}}\)

Flow Rate, cfs = \((\text{Area, sq ft})\times(\text{Velocity, ft/sec})\) or \(Q = AV\) where: \(Q = \text{flow rate}, A = \text{area}, V = \text{velocity}\)

Force, pounds = \((\text{Pressure, psi})\times(\text{Area, sq in})\)

Horsepower, Brake (bhp) = \(\frac{(\text{Flow, gpm})(\text{Head, ft})}{(3,960)(\text{Decimal Pump Efficiency})}\)
Horsepower, Motor (mhp) = \frac{(Flow, gpm)(Head, ft)}{(3,960) (Decimal Pump Efficiency) (Decimal Motor Efficiency)}

Horsepower, Water (whp) = \frac{(Flow, gpm)(Head, ft)}{3,960}

Leakage, gpd = \frac{Volume, gallons}{Time, days}

Reduction in Flow, % = \frac{(Original Flow - Reduced Flow)(100\%)}{Original Flow}

Slope, % = \frac{Drop or Rise}{Distance} \times 100

Specific Gravity = \frac{Specific Weight of Substance, lbs/gal}{Specific Weight of Water, lbs/gal}

Velocity, ft/sec = \frac{Flow Rate, cu ft/sec}{Area, sq ft} or \frac{Distance, ft}{Time, sec}

Volume of Cone = \frac{1}{3} (0.785) (Diameter^2) (Height)

Volume of Cylinder = (0.785) (Diameter^2) (Height)

Volume of Rectangular Tank = (Length) (Width) (Height)

Watts (DC circuit) = (Volts) (Amps)

Watts (AC circuit) = (Volts) (Amps) (Power Factor)

Wire-to-Water Efficiency, % = \frac{Water Horsepower, HP}{Power Input, HP or Motor HP} \times 100

Wire-to-Water Efficiency, % = \frac{(Flow, gpm)(Total Dynamic Head, ft)(0.746 \text{ kw}/\text{hp})(100)}{(3,960) (Electrical Demand, kilowatts)}

Conversion Factors:

1 acre = 43,560 square feet  
1 acre foot = 326,000 gallons  
1 cubic foot = 7.48 gallons  
1 cubic foot = 62.4 pounds  
1 cubic foot per second = 0.646 MGD  
1 foot = 0.305 meters  
1 foot of water = 0.433 psi  
1 gallon = 3.79 liters
1 gallon = 8.34 pounds
1 grain per gallon = 17.1 mg/L
1 horsepower = 0.746 kW or 746 watts or 33,000 ft. lbs./min.
1 million gallons per day = 694 gallons per minute
1 million gallons per day = 1.55 cubic feet per second
1 mile = 5,280 feet
1 pound = 0.454 kilograms
1 pound per square inch = 2.31 feet of water
1 ton = 2,000 pounds
1% = 10,000 mg/L
Π or pi = 3.14

Abbreviations:
cfs cubic feet per second
ft feet
g grams
gpd gallons per day
gpg grains per gallon
gpm gallons per minute
in inches
kW kilowatt
lbs pounds
mg/L milligrams per liter
MGD million gallons per day
mL milliliter
psi pounds per square inch
Q flow