

Meter – Types, Installation and Flow Measurements for Water and Wastewater

Hawai'i Rural Water Association

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Water Meters

Why is water measurement important?

Produce Revenue to cover expenses

Means to charge each customer
equitably!

1 Prevent the waste of water

2 Leak detection ... unaccountable water/non-revenue

3 Minimize load on the wastewater facility and
measure for billing purposes.

Meter reading ... revenue generating



Meters

➤ Good metering is necessary for
tracking non-revenue water



Water Meters

All of the water produced by a utility does NOT reach
its intended destination!

Some of the water that does arrive at its intended
destination is NEVER paid for

- Because of inaccurate meters...
- Because some locations are unmetered...
- Because of theft
- Leaks

Lost Revenue M₃

Meter Failures

Meter Inaccuracies

➤ Undetected Leaks

➤ Theft





Determining Meter Size

- **Factors to consider when selecting the right size meter:**
 - Expected customer demand
 - Pressure conditions
 - Friction losses in service line, meter and customer plumbing
 - Range of flow rates
 - Allowable pressure losses

Meter Selection

- **While selecting meters, look for:**
 - the ability to measure and register your anticipated flow levels
 - The ability to meet required capacity with minimum head loss
 - **Durability**
 - **Ruggedness**
 - **Precision of workmanship**
 - **Ease of repair**
 - **Availability of spare parts**

Meter Selection

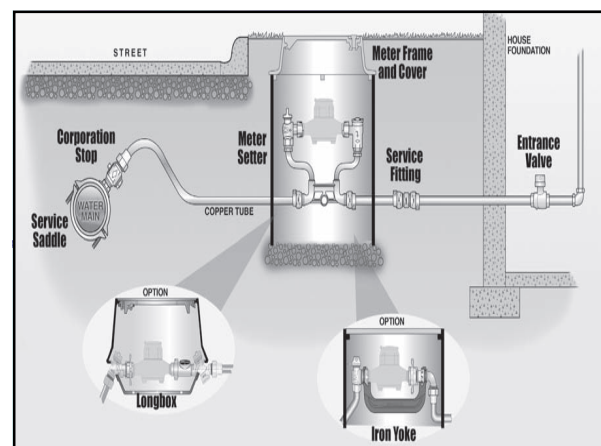
- **While selecting meters, look for:**
 - **Freedom from irritating noise**
 - **A reasonable price**
 - **A manufacturer with a good reputation in**
 - Quality products
 - Availability of replacement meters and spare parts
 - Delivery times
 - Warranties

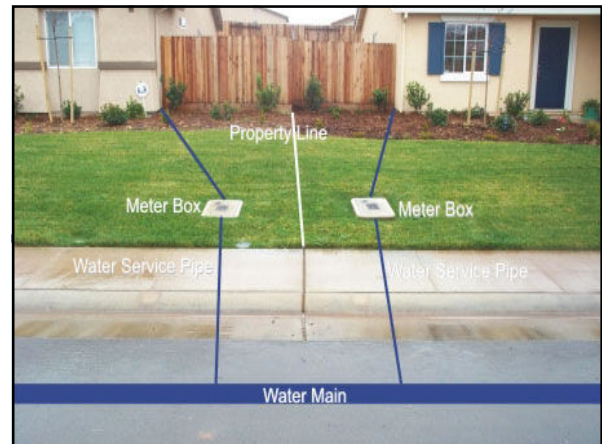
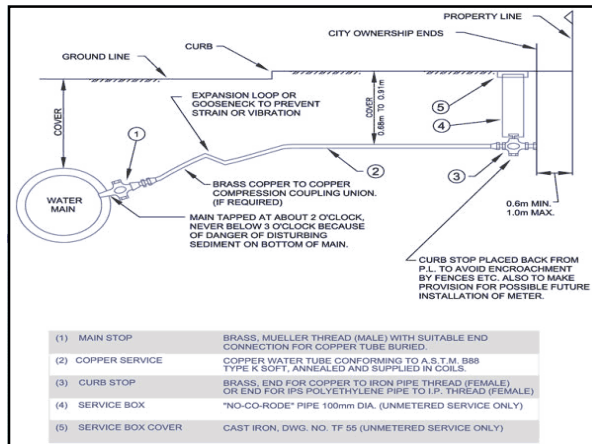
Meter Installation Recommendations

- **Location should be accessible**



- Install as close to property line as possible
- Lid of meter box should be flush with ground
- Follow manufacturers installation requirements or water agency codes
- Use proper tools and fittings
- **Public safety --- Operator safety**





Meter Selection

- When choosing which type of meter your system needs, keep in mind that:
 - Displacement meters are not designed for continuous high flow.
 - Velocity meters are not good at recording low flows.
 - Know your cost factors: Positive displacements vs. compound

Commonly Used Meters

In small water distribution systems

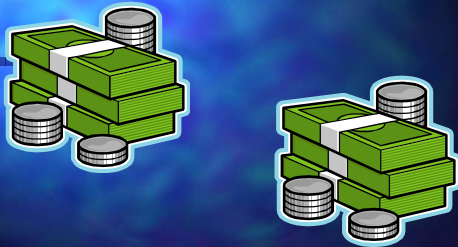
- Positive displacement
- Compound
- Velocity or turbine

In larger water distribution systems

- Proportional
- Venturi
- Orifice
- Pitometers
- Magnetic
- Sonic
- Detector check

Why is accuracy important?

- Revenue, Revenue, Revenue!!!



The Small Flow Water Meter



5/8" --- 1"

Small Flow Water Meter Brands

- Neptune
- Sensus
- Badger
- Master Meter
- Precision
- ABB
- Hersey
- All meters should conform to AWWA C700 Standard

Today's Small Flow Water Meter

- Computer Aided design
- Bronze outer case
- Some plastic or composite internal parts
- Less pressure loss with better design
- Visual Read
- Touch Read
- (AMR) Automatic Meter Read

Small Meter Operation

- Water flows through the meter's strainer into the measuring chamber.
- The water flowing into the measuring chamber drives the piston
- The piston is balanced in the measuring chamber and oscillates around a central hub
- A drive magnet transmits the motion of the piston to a driven magnet located inside the sealed register
- The driven magnet is connected to the gear train in the register that is displayed on the register dial face.

Positive Displacement Meters

This type of meter works by measuring and registering the number of times the meter chamber, whose volume is known, is filled and emptied.

➤ ADVANTAGES

- Wide variations
- No straight piping

➤ DISADVANTAGES

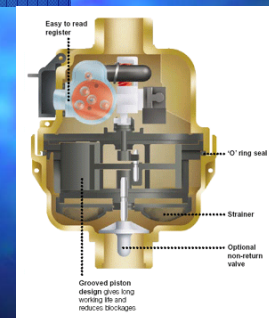
- Low flows not detected in sizes over 2"
- High headloss at high flows
- Foreign matter or corrosion

Piston Meters

The meter can be installed in any position: horizontally, vertically or on inclined pipelines, maintaining optimum performance with no loss of accuracy.



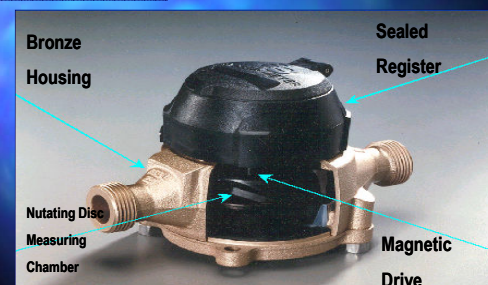
Piston Meters



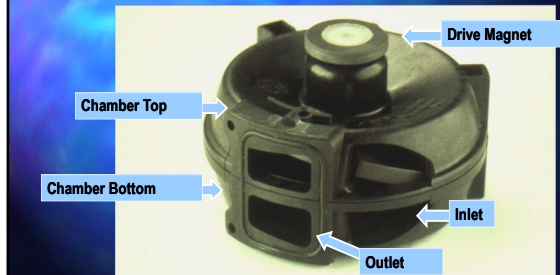
Nutating Disc Meters

1. Measures water in discrete volumes
2. Basically, fills a cup, measures it and then pours it out

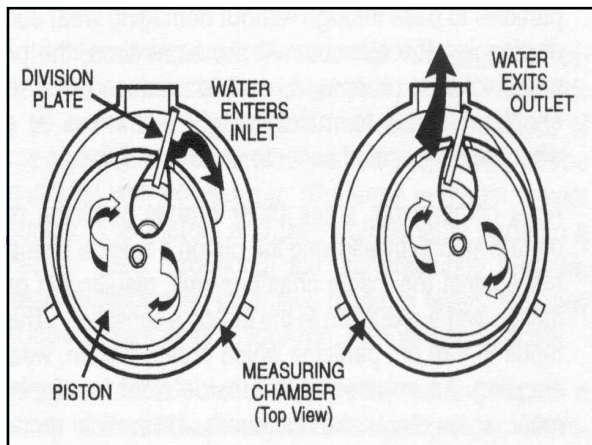
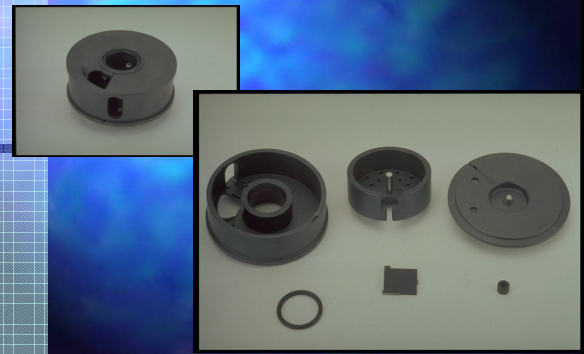
Nutating Disc Meters



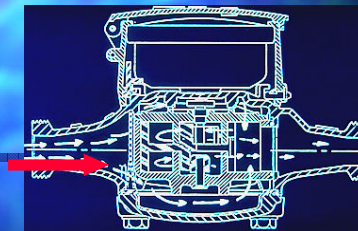
Chamber Assembly



Oscillating Piston Meters



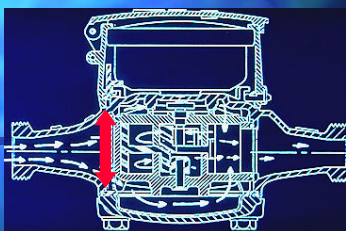
Oscillating Piston Meters



Precise water measurement

- Dual port measuring chamber

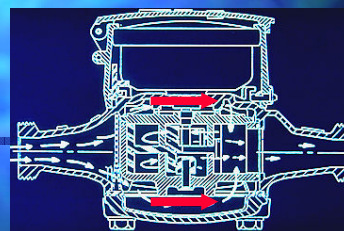
Oscillating Piston Meters



Precise water measurement

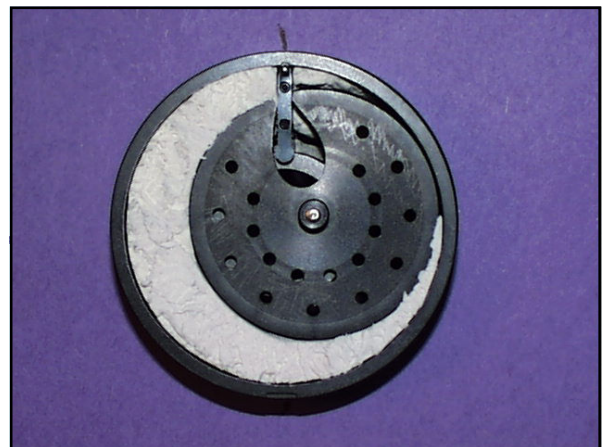
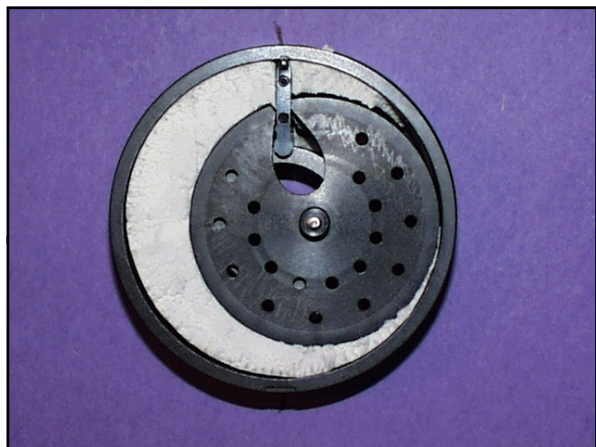
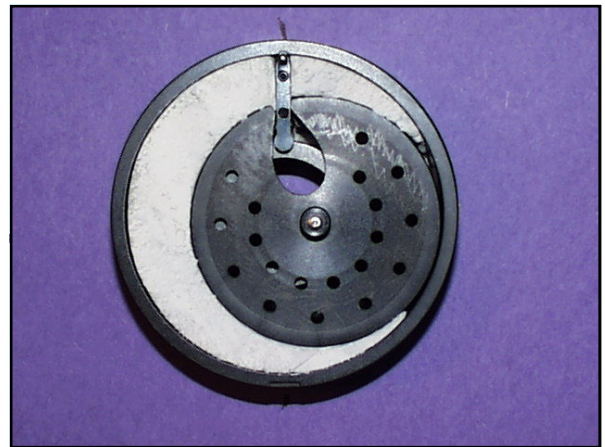
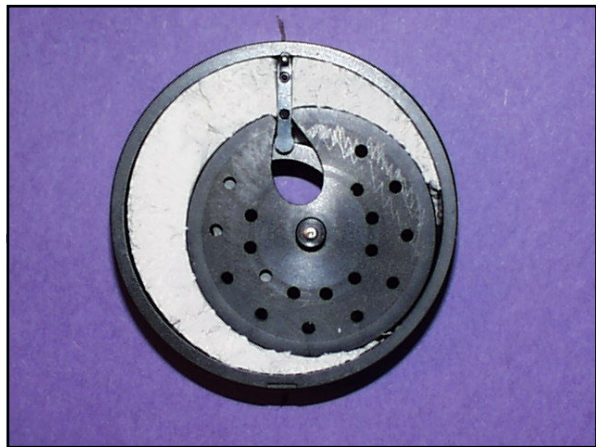
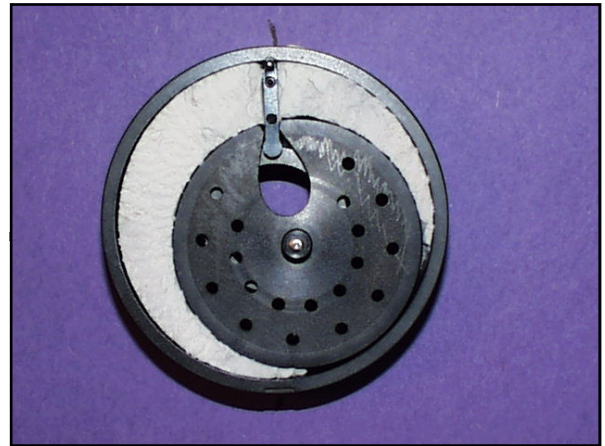
- Dual port measuring chamber

Oscillating Piston Meters



Precise water measurement

- Dual port measuring chamber

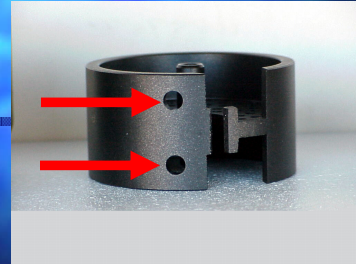


Oscillating Piston Meters



Precise water measurement
 • Dual port measuring chamber

Holed Oscillating Piston Meters



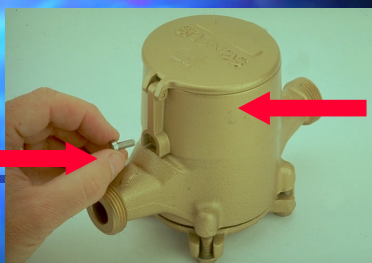
Trouble Shooting Small Meters

When a meter is removed from service and brought to the shop, it is always advisable to run an accuracy test prior to disassembly,

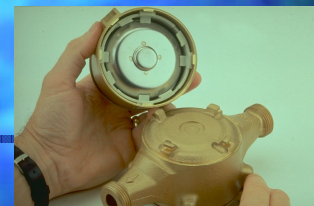
- Always note in particular the low flow test results ($\frac{1}{4}$ GPM for 5/8" size meter). Inaccuracy will normally show up first at low flows in older meters.
- Excessive wear in meters may be caused by pipe chips, chemical deposits, other foreign material.

Small Meter Repair

- Most small water meter registers carry a 25-year warranty.
- If your register is malfunctioning and it is within the warranty period, talk with your meter distributor and they should replace it, no charge.
- Most encoder registers carry a 10-year warranty



Superior register design
 • Protective Bonnet
 • Tamper resistant Security Screw



Superior register design
 • Upgradeable and easy maintenance

Meter Positions



Water Meter Testing

To avoid a loss of revenue for your utility, meters must either be field tested or brought in periodically for testing and repair.

Whether a water utility tests its own meters or has someone else do it depends on the staff size, time available, facilities and the size of the meter

Water Meter Testing and Repair

When a meter is removed from service and taken to the repair shop, what is the first thing that should be done?

- * Test the meter.

If you cannot run a test on the meter right away, what should you do?

- * Cap one end and run water into it.

Why?

- * The water keeps the deposits soft and makes dismantling easier

Meter Test Bench



Meter Testing

Three basic elements to meter testing

- Running a number of different rates of flow over the operating range of the meter to determine overall efficiency
- Passing known quantities of water through the meter at various test rates to provide a reasonable determination of meter registration
- Meeting accuracy limits on different rates for acceptable use

Small Water Meters

There are literally millions of displacement meters in service in the U.S.

These meters are a sizable investment for the utilities.

However, their real value cannot be realized unless they function properly.

All modern meters contain magnetic couplings, sealed registers and synthetic chambers.

The success of these materials and designs have eliminated the need for many meter repairs as compared to 30-40 years ago.

Water Meter Testing or Replacement

- How often should meters be tested or should the utility consider replacement?

➤ AWWA RECOMMENDATION

➤ 5/8" – 1"	Meter	Every 10 years
➤ 2"	Meter	Every 4 years
➤ 3"	Meter	Every 3 years
➤ 4"	Meter	Every 2 years
➤ 6" & Larger	Meter	Every Year

Accuracy

- Residential meters should have an accuracy of between 98.5 to 101.5% or $100\% \pm 1.5\%$.
- Larger meters can have a wider accuracy range, but normally not more than $\pm 4\%$.

Summary

- Water meters are subject to wear and deterioration Major causes?
- The rate of wear and deterioration is directly related to how much the meter is used and the quality of water.
- Over time, all meter efficiency decreases
- The larger the meter, the more often it should be tested.

Conclusion

- Due to modern meter engineering and design, material costs, many utilities have limited their scope of repairs
- Although cost-effect repairs may now be limited and unpractical, testing of water meters should continue to assure equity among customers and to assure minimal revenue loss

...



Let the meter work for you!

Meter Installation



- "Dual" plumbed system
- Purple piping, fittings or meter indicate recycled water system used only for irrigation

Types of Large Meters



Large Water Meters

- Typically, the largest 10 percent of the meters in your system measures 40-60 percent of the systems consumption.
- Especially true in large cities

Compound Meters



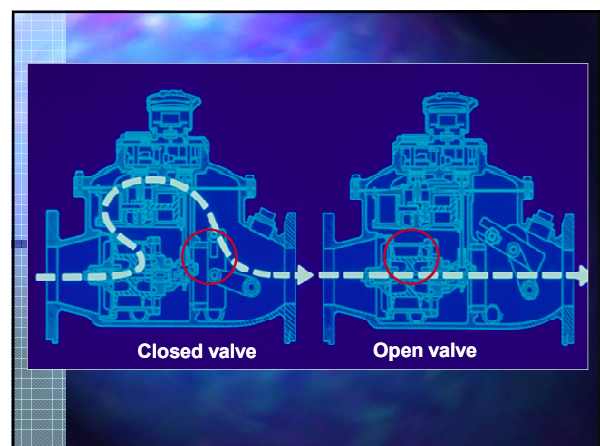
Compound Meters

Used where demand varies

- Schools
- Hospitals
- Hotels office complex
- Office complexes
- Modular home estates

Compound Meters

- Automatic valve enables high flows to be metered through the turbine side of the compound meter
- Low flows measure through displacement side of the compound meter
- One or two registers depends on design
- Accurate over a wide range
- Slight loss in accuracy or registering at the changeover point between the two meters



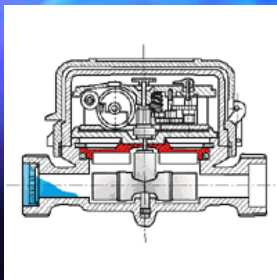
Velocity Meters

- Turbine
- Propeller
- Multi-jet
- Venturi
- Magnetic
- Ultrasonic
- Orifice

High Velocity Meters

- Operate on the principle that water passing through a known cross-sectional area with a measured velocity can be equated into a volume of flow. Velocity meters are good for high flow applications. Usually use in 3" or larger lines
- **ADVANTAGES**
 - Used for large flows
 - Low headloss
- **DISADVANTAGES**
 - Inaccurate at low flows

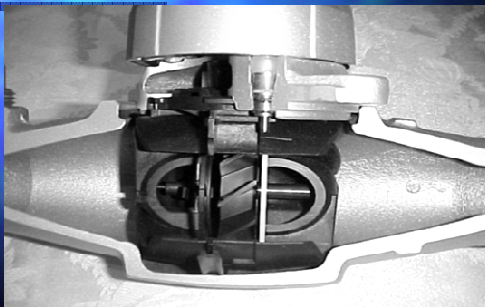
Turbine Meters



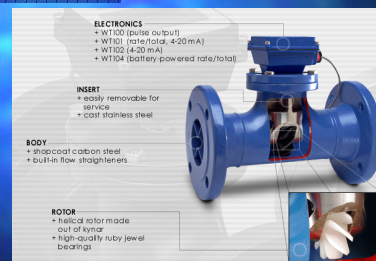
Turbine Meters

- Have a rotating element (rotor or bladed wheel) in the chamber that turns with the flow of water
- Volume of water recorded on the register is almost in direct proportion to the number of revolutions made by the rotor
- Flow is measured by the number of revolutions by the rotor
- Low friction loss
- Size to the flow
- Suitable for higher flow: industrial, utility and agricultural applications
- 2" up to 20"

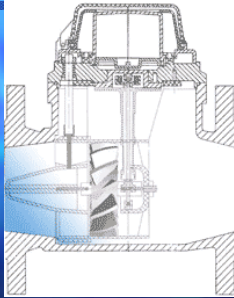
MIXED-FLOW TURBINE METERS



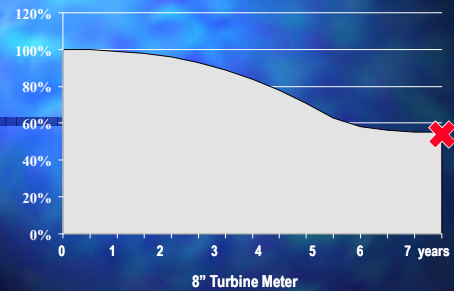
AXIAL-FLOW TURBINE METERS



AXIAL-FLOW TURBINE METERS



Accuracy over Time



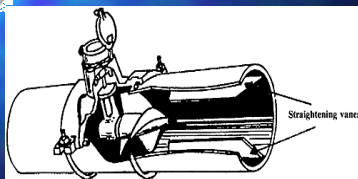
Propeller Meters

- Like turbine meters, propeller is turned by the flow of water, movement transmitted to a register
- Larger propeller meter, the propeller may be smaller in diameter in relation to the internal diameter of the pipe
- Primarily used for in-line measure where flows do not change abruptly
- Can be built within a section of pipe
- Can be saddle mounted
- Friction loss generally less than a turbine meter

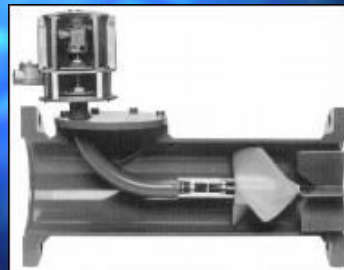
Propeller Meters

- Have a fan-shaped rotor that spins with the flow of water. A recorder is attached to the rotor to register the readings.
- Used primarily for main line flow measurements
- Wear out faster
- Debris will jam prop

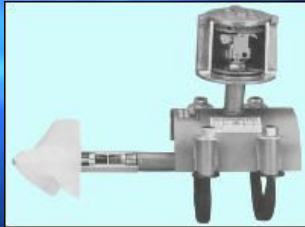
PROPELLER METERS



Propeller Meter



Cut-in Propeller Meters



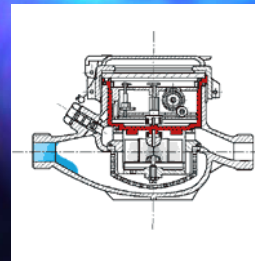
Cut-in Propeller Meters



Multi-jet Meters

- Multi-blade rotor mounted on a vertical spindle inside a cylindrical measuring chamber
- Water flows through several tangential openings and around the circumference, leaving the measuring chamber through another set of tangential openings placed at a different level in the measuring chamber
- Flow is measured proportional to the speed of the rotor.

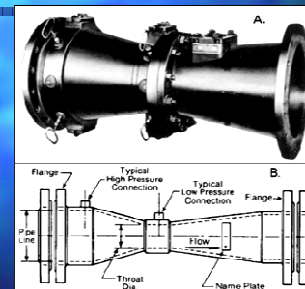
Multi-jet Meters



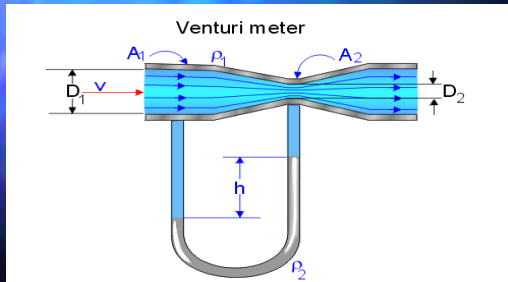
VENTURI METERS

- Have a section that has a smaller diameter than the pipe on the upstream side.
- Based on a principle of hydraulics, as water flows through the pipe, its velocity is increased as it flows through a reduced cross-section area.
- Difference in pressure before water enters the smaller diameter section and at the smaller diameter "throat" is measured. The change in pressure is proportional to the square of velocity.
- Flow rate can be determined by measuring the difference in pressure.
- Venturi meters are suitable for large pipelines and do not require much maintenance.
- Low friction loss

VENTURI METERS

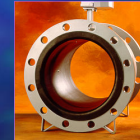


VENTURI METERS



Magnetic Meters

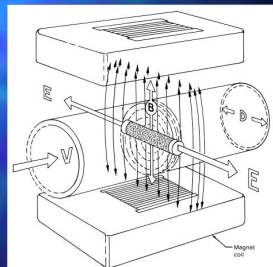
- Commonly called "Mag meters"
- Measure flow by means of magnetic field
- Water passing through the field induces a small electric-current flow
- Proportional to the water flow
- Current is converted to measure of water flow
- Uses
 - Dirty waters
 - Wastewater
 - Corrosive liquids



How Does It Work?

Faraday's Law

"A conductor moving through a magnetic field will induce an electromotive force proportional to the velocity of the conductor"



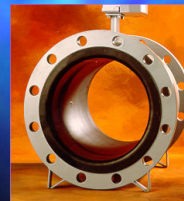
Technology Strengths

Feature:

- Completely open Flow Tube design

Benefits:

- No Pressure Loss = less pumping energy required
- No Moving Parts = no wear, no maintenance.
- No "Water Hammer" Issue



Technology Strengths

Feature:

- High Accuracy: +/- 0.25 or 0.5% 99.75% to 100.25%



Benefits:

- Exceeds AWWA accuracy standards for conventional meter technologies.
- Turbine Meters: +/- 1.5% 98.5% to 101.5%
- Propeller Meters: +/- 2.0% 98.0% to 102%

Technology Strengths

Feature:

Wide flow range 0.1 to 39.4 ft/sec flow velocity for all sizes

Typical Examples:

METER SIZE: 8"	FLOW RANGE
MAG METER	20 to 5,975 GPM
TURBINE METER	20 to 3,500 GPM
PROPELLER METER	100 to 1,500 GPM
COMBO METER	1-1/4 TO 4,500 GPM

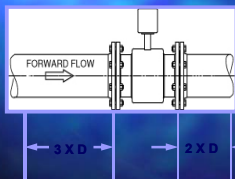
Technology Strengths

Feature:

- Not highly affected by pipe disturbances

Benefits:

- Installation Requirement:
- Only 3 diameters of
- Straight pipe upstream & 2 diameters downstream
- Minimizes meter vault size
- Reduces installation costs



Mag Meter Limitations

- Power required
- Pipe must be full
- Conductive fluid required
- Power outage—"stops registering"
 - Total retained in memory indefinitely

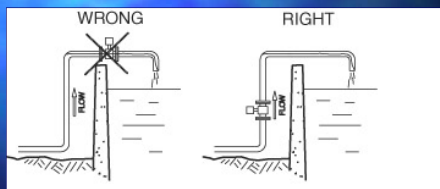
Application Considerations

- Meter Size?
- Installation Location in line?
- Meter Mount or Remote Amplifier?
- Vault installation?
- Grounding !
- Available power supply?

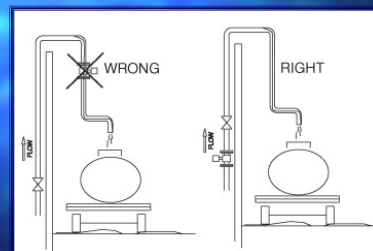
Installation Recommendations

- Can install Mag meter in vertical or horizontal piping configuration
- Recommended installation is in vertical location - liquid flowing upwards; assures full pipe condition

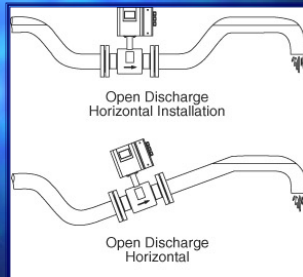
Installation Recommendations



Installation Recommendations



Installation Recommendations



Typical Applications

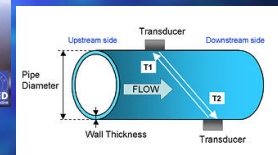
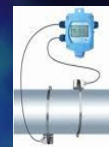
- Rural, commercial and industrial applications with available power supply
- Well pump stations
- Replacement of propeller meters



Ultrasonic Meters

- A typical ultrasonic water meter consists of a sensor and an electronic console.
- The sensor has two ultrasonic transducers (A and B) built into its body.
- Each transducer functions as both ultrasonic transmitter and receiver.
- The electronic console operates the two transducers by alternately transmitting and receiving a burst of sound energy and measuring the transit time that it takes for sound to travel between the two transducers. The difference in the transit time measured is directly and exactly related to the velocity of the water in the pipe.
- The flow-rate is calculated from the measured velocity and the pipe inner diameter.

Ultrasonic Meters

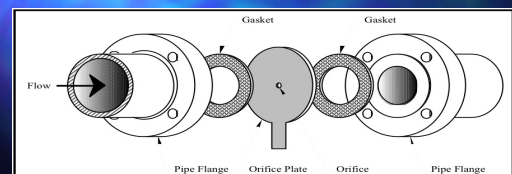
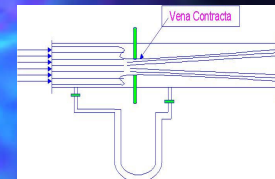


Orifice Meters

- Work on the same principle as venturi meters, except that, instead of the decreasing cross-sectional area, there is a circular disk with a concentric hole.
- Flow rate is calculated similarly to the venturi meter by measuring the difference in pressure.



Orifice Meters



Detector Check Meters

- Measure daily use
- Emergency main line flow, such as fire, by-passes meter
- Weight loaded check valve remains closed under normal usage, opens under increased flow



Compound Vs. Turbine

- Both compounds & turbines are excellent
- Complement each other
- Analyze your own factors
- You decide what is best
- Use resources:
 - A.W.W.A. M6, C701, C702, C703 standards
 - Specific manufacturers' literature

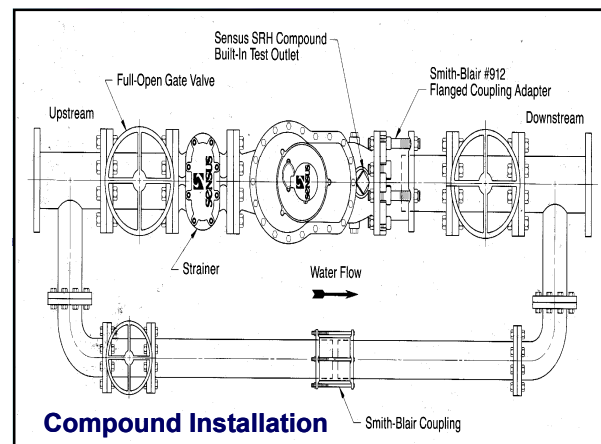
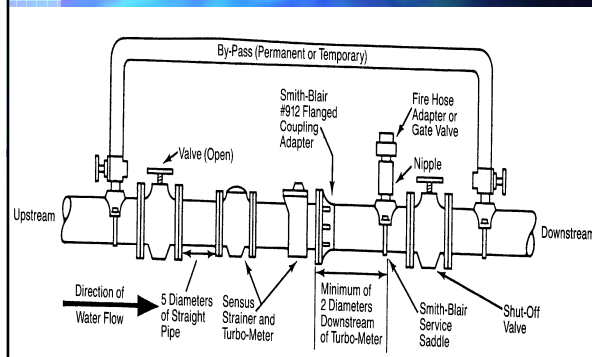
Proper Installation

1. When installing Turbo and Compound meters with a strainer, a **RECOMMENDED** minimum of **five (5)** pipe diameters of straight, unobstructed pipe should be installed upstream of the meter. Turbo and Compound meters installed without a plate strainer, **REQUIRE** a minimum of **ten (10)** pipe diameters of straight unobstructed pipe upstream of the meter. **The deletion of a plate strainer is not recommended.**
2. **Full-open** butterfly or gate valves **MUST** be **five (5)** pipe diameters or more upstream of the meter when using a strainer. **Full-open** butterfly or gate valves can be used downstream of the meter.
3. **DO NOT** install pressure reducing devices or check valves upstream of the meter.
4. Check valves **MUST** be located at least **three (3)** pipe diameters downstream of the meter and the bypass line.

Proper Installation

5. Pressure reducing devices **MUST** be located at least **five (5)** pipe diameters downstream of the meter.
6. Install backflow prevention devices according to state and local regulations. They **MUST** be located at least **five (5)** pipe diameters **after the meter and after the bypass line**. If the backflow prevention device is installed before the meter, a **RECOMMENDED** minimum of **fifteen (15)** pipe diameters of straight, unobstructed pipe and a strainer are required upstream of the meter.
7. The service saddle (or reducing tee) which is used for field accuracy testing should be at least **two (2)** pipe diameters downstream of the meter.
8. A bypass line with associated valves is recommended to perform routine maintenance and testing of the meter without disrupting service to the customer.

Turbo Installation



Compound / Turbo Comparison

Characteristic	Turbo	Compound
Flow Range	100:1	1000:1
Low Flow Sensitivity	Good	Excellent
Head Loss	Excellent	Good
Maintenance Periods	Extended	More Often
Purchase Price	\$X	\$1.5X - 2X

General Rule of Thumb

COMPOUNDS



Where
People
Live

TURBOS



Where
People
Work or
Play

Examples of Large Meter Selection



Condo or Apartment Complex

Selected Meter

Turbo

or

Compound

Examples of Large Meter Selection



Automatic Car Wash

Selected Meter

Turbo

or

Compound

Examples of Large Meter Selection



Large Manufacturing Facility

Selected Meter

Turbo

or

Compound

Examples of Large Meter Selection



Small Motel Building

Selected Meter

Turbo

or

Compound

Examples of Large Meter Selection



Anytown USA High School

Selected Meter

Turbo
or
Compound

Examples of Large Meter Selection



Large Hotel Complex

Selected Meter

Turbo
or
Compound

How Do Your Meters Register?



- ✓ U S Gallons
- ✓ Cubic Feet
- ✓ Metric

AMR

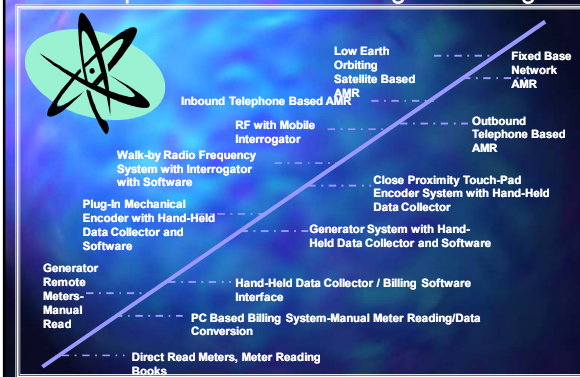
Automatic meter reading (AMR) refers to an automated process of collecting meter reading data.

Remote or Automatic Reading

- More efficient
- Safety
- Can be retrofitted to existing meters
- Customer information/usage easily accessed



Development of Meter Reading Technologies



Development of Meter Reading Technologies



Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies



PC Based Billing System-Manual Meter Reading/Data Conversion

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies



Generator Remote Meters-Manual Read

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies



Hand-Held Data Collector / Billing Software Interface

PC Based Billing System-Manual Meter Reading/Data Conversion

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies



Generator System with Hand-Held Data Collector and Software

Hand-Held Data Collector / Billing Software Interface

PC Based Billing System-Manual Meter Reading/Data Conversion

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies



Plug-In Mechanical Encoder with Hand-Held Data Collector and Software

Generator Remote Meters-Manual Read

Hand-Held Data Collector / Billing Software Interface

PC Based Billing System-Manual Meter Reading/Data Conversion

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies



Close Proximity Touch-Pad Encoder System with Hand-Held Data Collector

Generator Remote Meters-Manual Read

Conversion

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies

Walk-by Radio Frequency System with Interrogator and Software




Plug-In Meter Encoder with Data Collector and Software

Generator Remote Meters-Manual Read

Development of Meter Reading Technologies

RF with Mobile Interrogator




Walk-by Radio Frequency System with Interrogator with Software

Plug-In Mechanical Encoder with Hand-Held Data Collector and Software

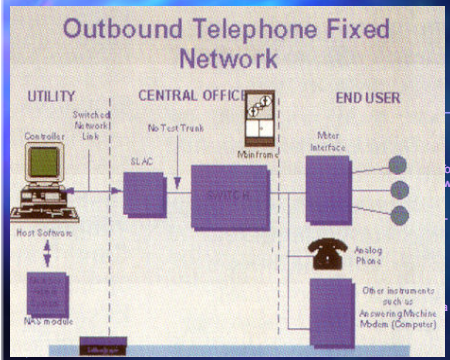
Generator Remote Meters-Manual Read

Conversion

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies

Outbound Telephone Fixed Network



UTILITY: Controller, Host Software, NIS module

CENTRAL OFFICE: Switched Network Link, SLAC, SWITCH, Mainframe

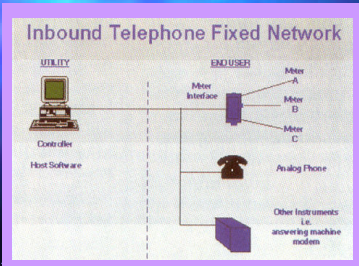
END USER: Meter Interface, Analog Phones, Other Instruments (e.g., answering machine, modem, computer)

Outbound Telephone Based AMR

Touch-Pad with Hand-Held

Development of Meter Reading Technologies

Inbound Telephone Based AMR



UTILITY: Controller, Host Software

END USER: Meter Interface, Meter A, Meter B, Meter C, Analog Phone, Other Instruments (e.g., answering machine, modem)

Outbound Telephone Based AMR

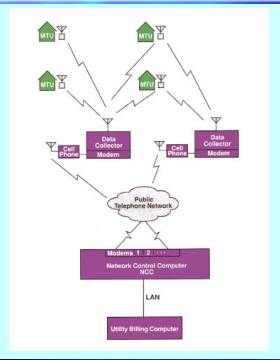
Proximity Touch-Pad Encoder System with Hand-Held Data Collector and Software

Conversion

Direct Read Meters, Meter Reading Books

Development of Meter Reading Technologies

Fixed Base Network AMR



UTILITY: Modem 1, Modem 2, Network Control Computer, Utility Billing Computer

Public Telephone Network

Cell Phone, Data Collector Modem, Cell Phone, Data Collector Modem

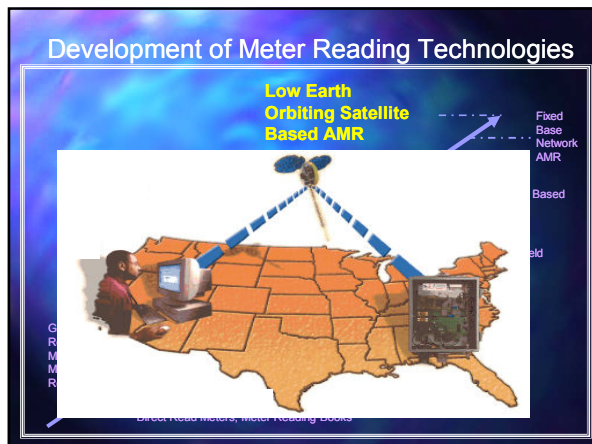
Fixed Base Network AMR

Outbound Telephone Based AMR

Close Proximity Touch-Pad Encoder System with Hand-Held Data Collector and Software

Conversion

Direct Read Meters, Meter Reading Books



AMR Benefits

Reductions / Meter Reading

Operations

- Staff – 50%
- Read Time – 47%
- Re-Reads
- Human Error
- Confined Space Issues
- Possible Injuries
- Vehicles, Gas, Maintenance, Depreciation
- Personnel Issues
- Overtime

AMR Benefits

Improved Customer Service

- Timely & Accurate Billing
- Eliminate Estimated Reads
- Eliminate Need to Enter Customer Premises
- Reduce Customer Complaints

AMR Benefits

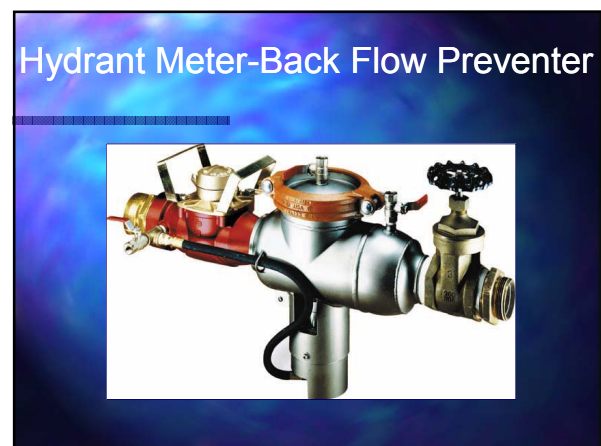
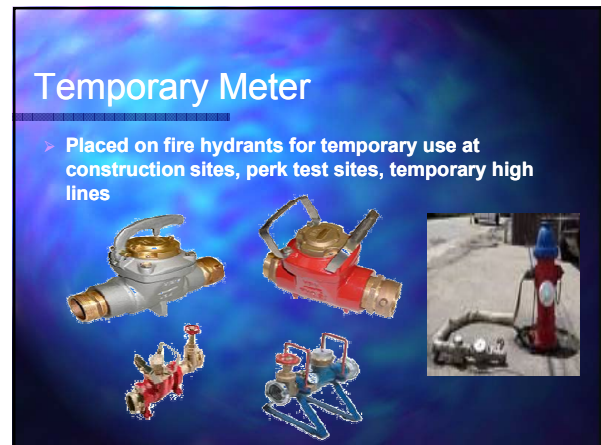
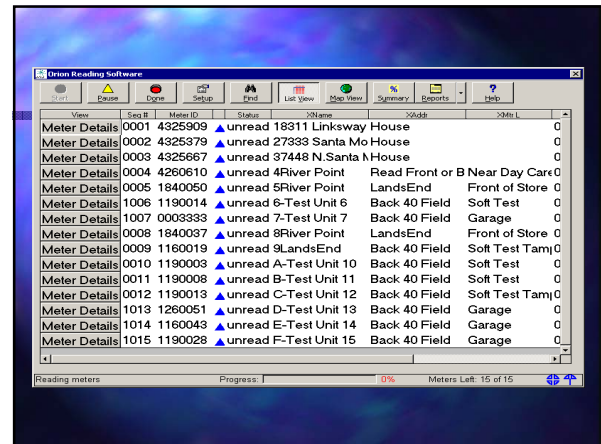
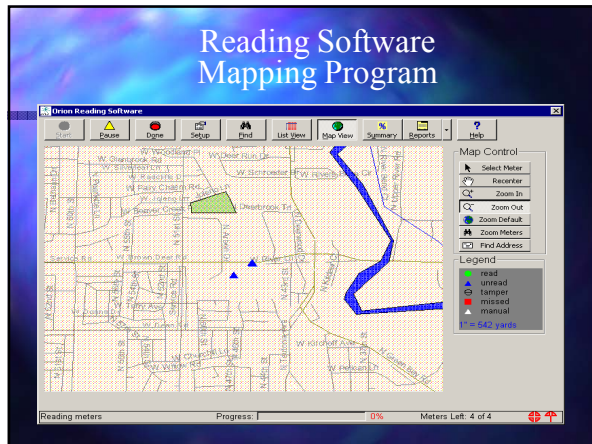
Revenue Protection

- Theft Detection / Deterrent
- Tamper Detection / Deterrent
- Unaccounted-for Water
- Replace Inaccurate Meters
- Lower Water Production Costs

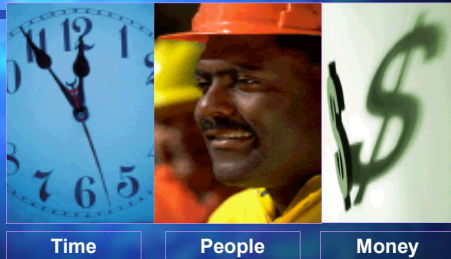
Elements of Improved Efficiency

- Key Element of AMR Efficiency is Meter Reading Productivity
- Estimate of Potential Improvements are . . .
 - Scan system: 350 to 450 reads/day
 - Estimated cost/read 50¢ - 65¢
 - RF HH Drive-by: 1,800 to 2,200 reads/day
 - Estimated cost/read 10¢ - 12.5¢
 - RF Mobile: 6,500 to 8,000 reads/day
 - Estimate cost/read 2.5¢ - 3.5¢
- Up to 96% reduction in reading costs based on reader costs of \$58,500/year fully loaded

**AMR Can Help Solve
Numerous Utility
Problems if the System
Selected is the Correct
One.**



Your Future



Time

People

Money

There is Never
Enough!

FLOW MEASUREMENT

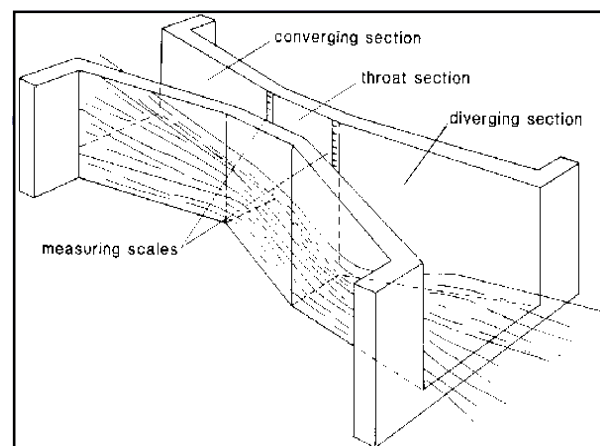
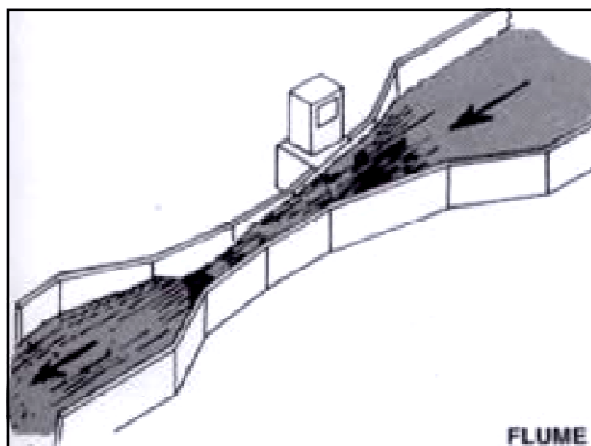
- Flow measurement devices are critical when it comes to properly operating treatment facilities and reporting discharge volumes for permit compliance purposes.
- Flow measurements are taken on the *influent, effluent and recycle flows* of large treatment plants and are taken on the effluent of small facilities, at a minimum.
- *Without flow measurement, operators do not know the hydraulic and organic loading to their treatment plant or the effluent loading rates discharged to the receiving waters.*

COMMON DEVICES USED FOR OPEN CHANNEL FLOW MEASUREMENT

- Open channel flow measurement is often used to measure the influent and effluent flow of wastewater treatment plants.
- However, because of inaccuracy and other problems, open rectangular channels are seldom used as flow measuring devices themselves.
- Flumes and weirs are commonly used devices that refine the measurement of flow in open channels and make it more accurate.

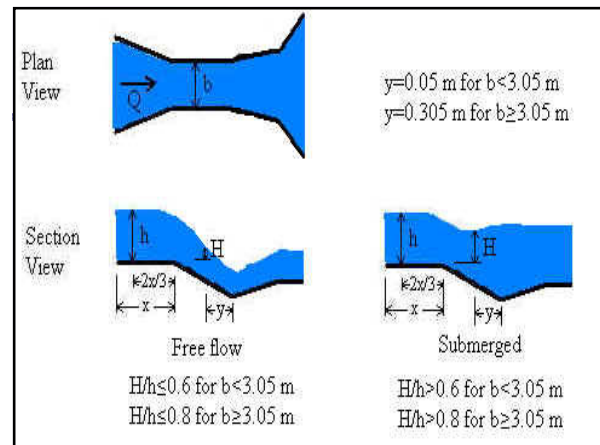
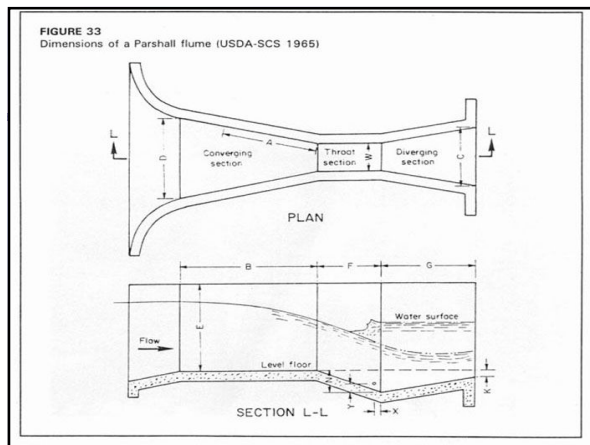
FLUMES

- A flume is a constriction within an open channel.
- Whenever a constriction occurs the level will rise within the channel.
- The more flow in the channel, the higher the water level will rise.
- If the flume is installed properly, no surging will occur and the water will be moving through in a plug flow fashion called laminar flow.
- Under these conditions, the velocity through the flume will be fixed.
- Because of this, we only need to measure the head rise at a specific point in the flume to determine the cross sectional area, (the width is fixed).



PARSHALL FLUME

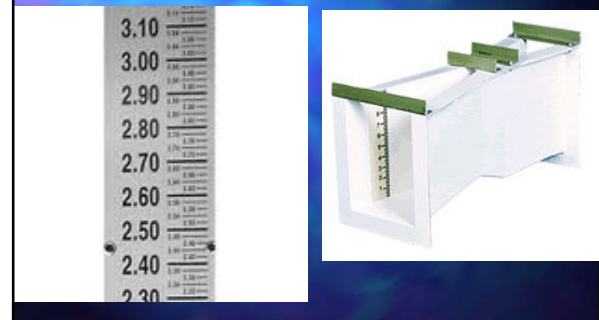
- With this information we can determine flow using the $Q = A \times V$ formula, (but it is more convenient to use a graph that is prepared specifically for the size and type of flume that we are using).
- The most common type of flume used to measure flows in wastewater plants is the Parshall flume.
- Parshall flumes are popular because they are inherently self cleaning, they can handle wide flow variations, they are available in sizes ranging from one inch up to fifty feet in pre-constructed form and they require only a small head loss in measuring flow.



PARSHALL FLUME

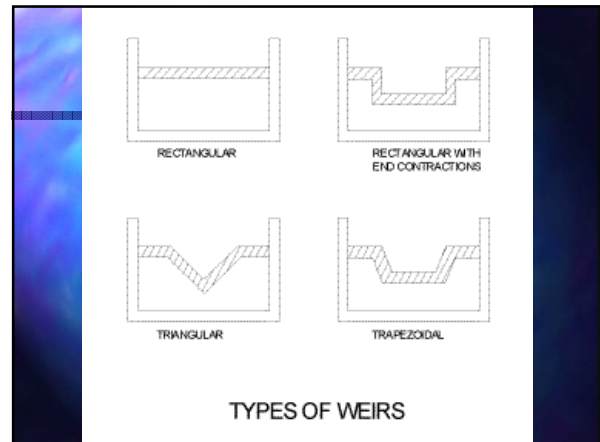
- The head rise measurement in a Parshall flume is made two-thirds of the way up the approach channel.
- A fixed ruler is usually mounted at this point in the flume.
- This ruler is known as a staff gage and it reads out in tenths or hundredths of a foot, not in inches.
- By reading the head rise off the staff gage and consulting a chart for the particular size and type of flume being used, the flow can be determined.

STAFF GAUGE

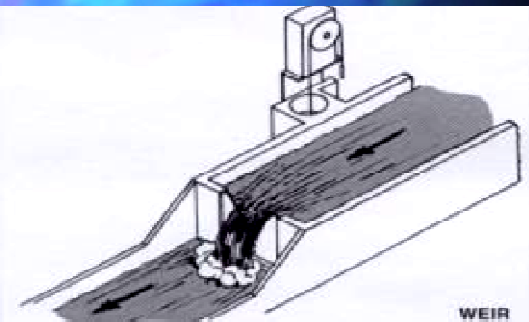


WEIRS

- Weirs are essentially dams that are placed across an open channel.
- Like flumes, weirs cause a head rise that can be translated into a flow measurement.
- There are many styles of weirs such as V-notch weirs (which come in many angles), rectangular weirs and trapezoidal weirs.
- Weirs should not be placed in flow streams that contain coarse debris or settleable solids because the debris will become caught on the weir and settleable solids will accumulate in the weir box in front of the weir.



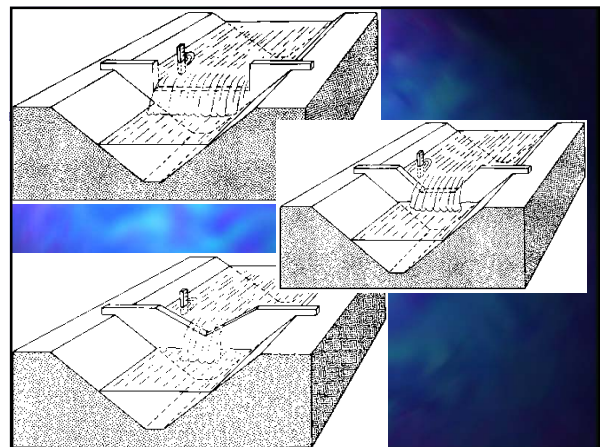
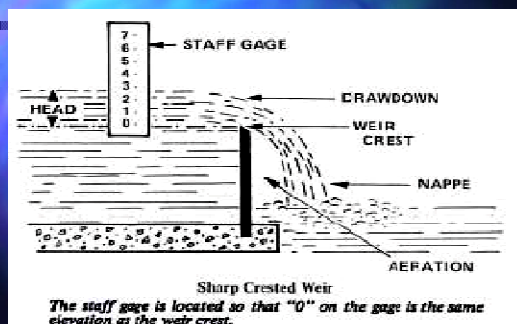
WEIRS



WEIRS

- For this reason weirs are most often used to measure effluent flows where coarse debris and settleable solids should be at a minimum.
- To avoid false readings caused by the drawdown that occurs near the weir overflow, staff gages should be located at least four times the maximum head rise away from the weir.

WEIRS



COMMON DEVICES USED FOR FLOW MEASUREMENT IN PUMPING SYSTEMS - FULL PIPES

- When used in wastewater applications these meters tend to become plugged with biological growths or debris causing them to become inaccurate or stop functioning.
- Flow can also be established in wastewater pumping systems by emptying or filling a calculated tank volume.
- By measuring the time it takes to pump a known volume, (pumping 1,000 gallons out of a wet well in 10 minutes for example; $Q = 100$ gpm), flow can be established.
- When a pump is equipped with an hour recorder and its pumping rate has been established with this method, totalized flows can be measured.

FLOW MEASUREMENT TRANSMITTERS AND READOUT EQUIPMENT

- Devices such as flumes, weirs and Venturi and magnetic meters are known as primary flow measuring devices.
- When installed and maintained properly they provide a flow measurement at the instant that they are read.
- If constant flow recording or totalized flow readings are desired, transmitting and readout equipment will be necessary.
- Transmitting devices include; ultra sonic, bubbler and probe type level detectors.
- Recording and totalizing instruments include; chart recorders, mechanical and electronic totalizers and computer programs designed to chart and totalize flow measurements.

CHART RECORDER



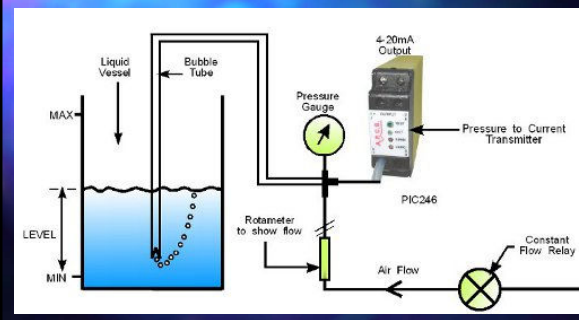
TOTALIZER



ULTRASONIC



BUBBLER TUBE



FLOW MEASUREMENT TRANSMITTERS AND READOUT EQUIPMENT

- General Units of Measurements, two types of units are used in measuring liquid *units of discharge and units of volume*.
- Discharge or rate of flow is defined as the volume of liquid that passes a set point in a unit of time.
- Common discharge units used in the field of wastewater treatment are *millions of gallons per day (MGD)*, *gallons per minute (gpm)* and *cubic feet per second (cfs)*.
- Units of volume that are commonly used include *millions of gallons (MG)* and *acre-feet (acft)*.

QUESTIONS ?



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YOU MISREAD MY METER !!!!!

