Water Meter Basics

Conducted by:
Kelly Byrd
NECO Territory Manager

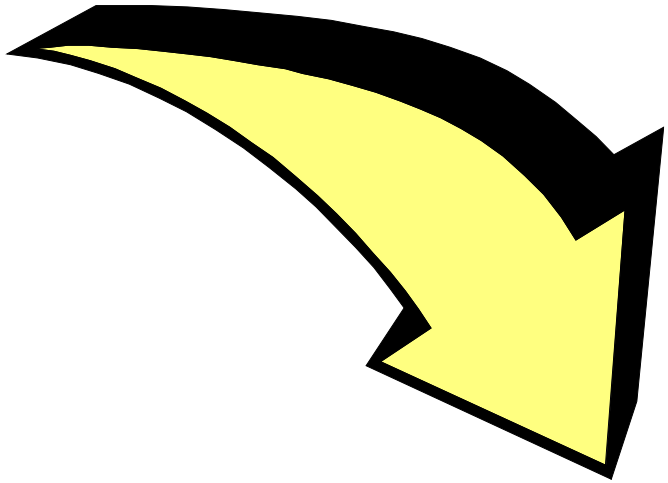
About NECO

- **Founded in 1934 as a family owned and operated business based out of Cincinnati, Ohio**
- **Providing Distribution Sales & Services featuring Neptune Technology Group Meters & Meter Reading Products**
- **Neptune Technology Group has manufactured meters and equipment for over 125 years**
- **Experience – 95% of our business is Meters & Reading Equipment**
- **All Field Sales People are Factory Trained**
- **Complete Services – Project Management, Meter Installation & Testing and Technical & Data Services**
- **Formerly known as Neptune Equipment Company**

Is your utility getting all the revenue it's entitled to?

How Is Revenue Lost?

- Meter Failures
- Meter Inaccuracies
- Misapplication
- Sizing
- Undetected Leaks
- Theft
- Other Free Water



History of Water Meters

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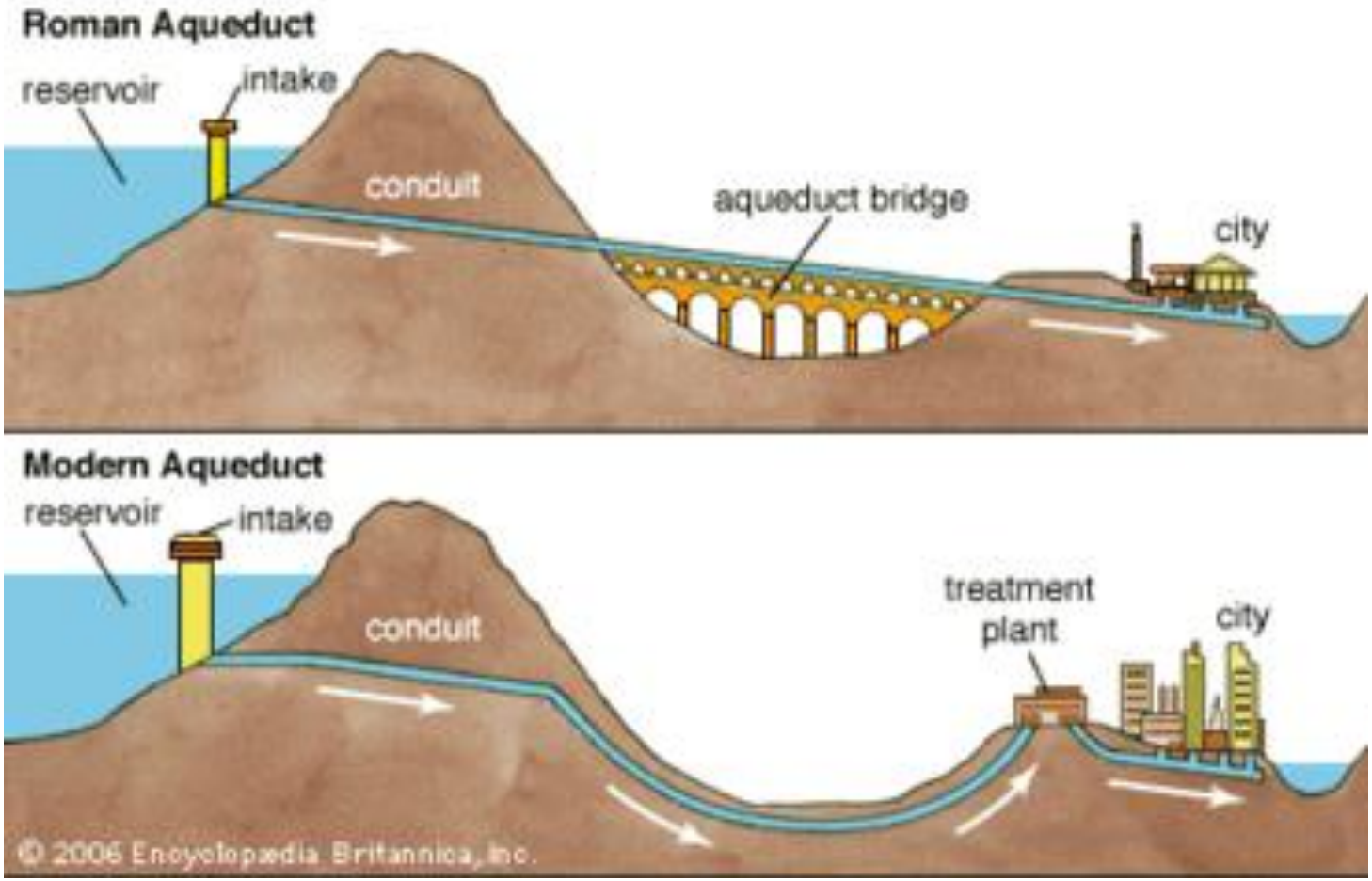
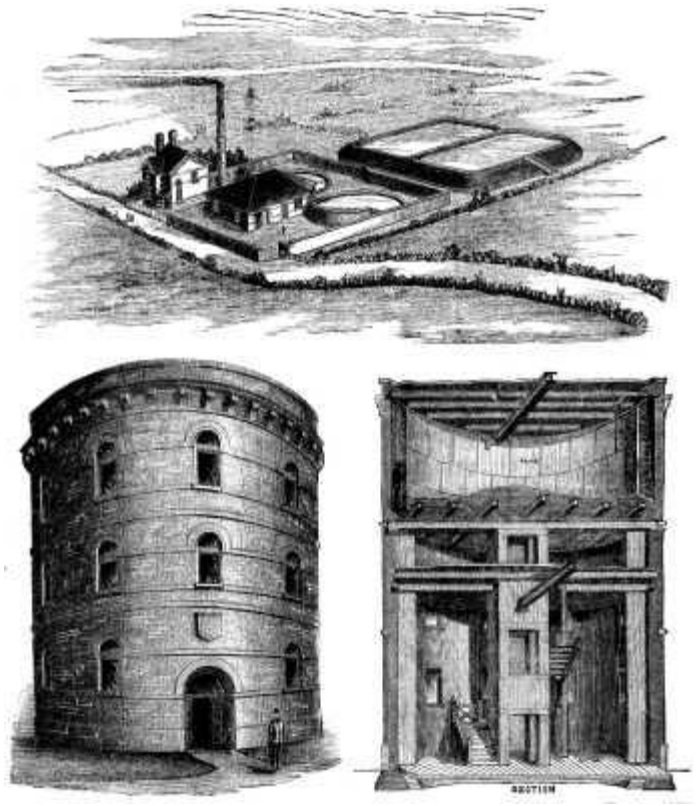
Smart Solutions, Water Powered

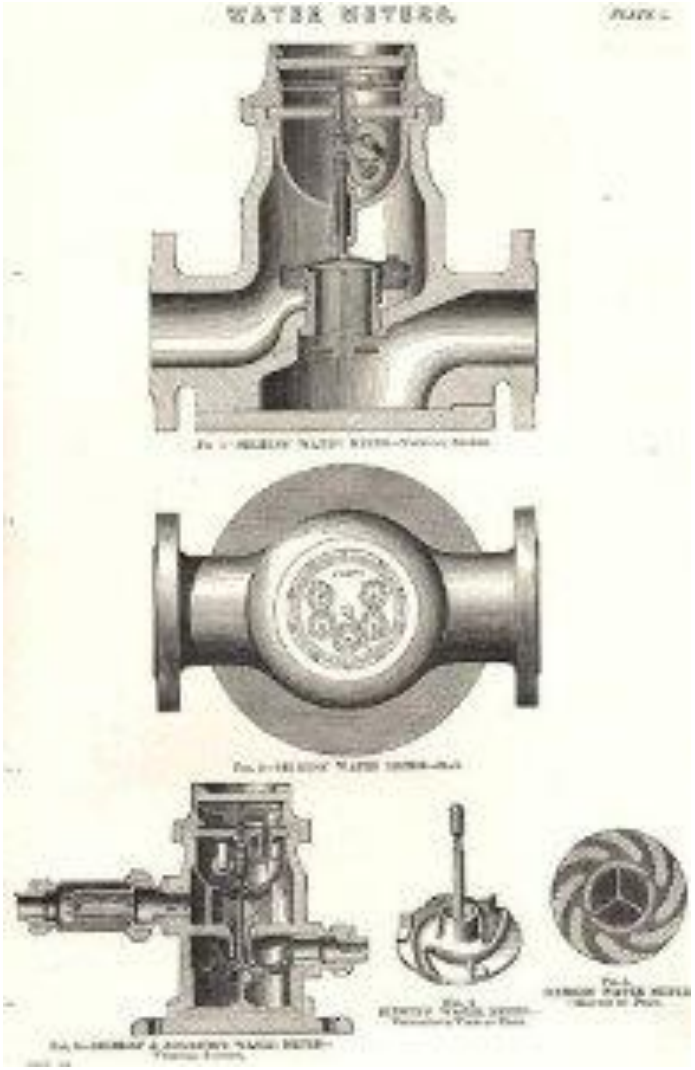


History of Water Meters



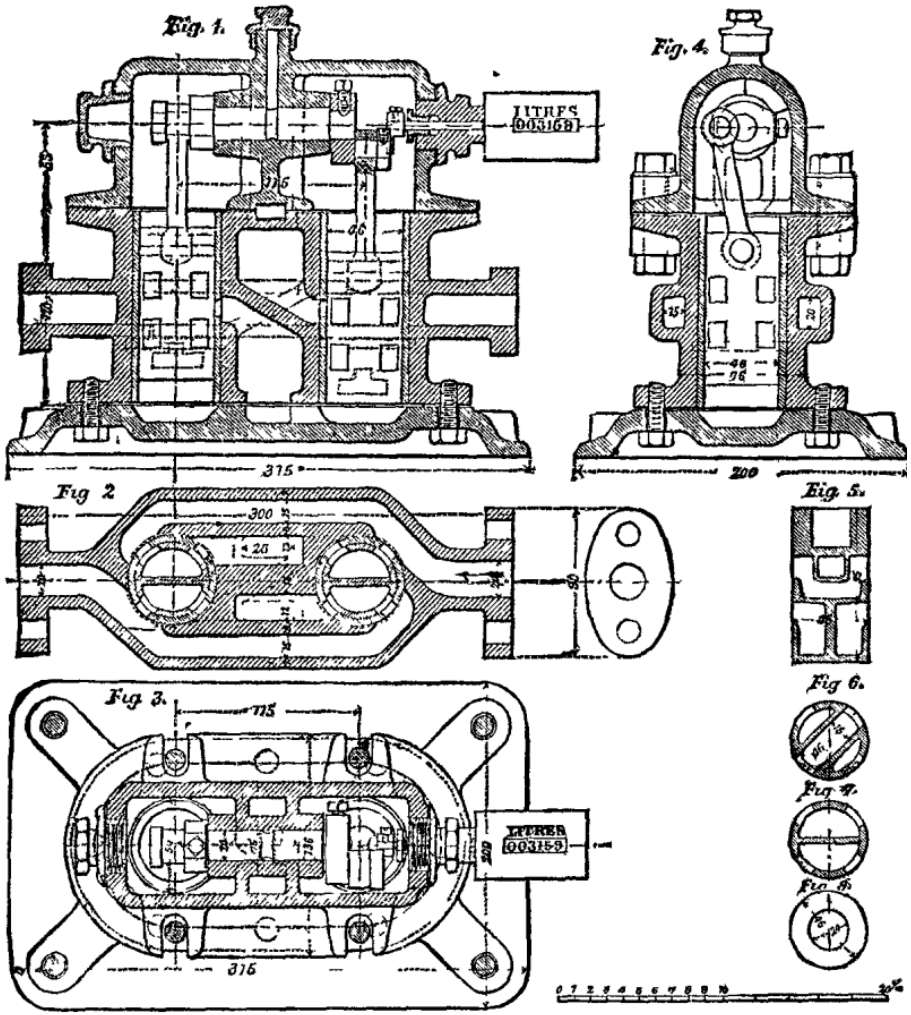
When water was first captured and stored for use in cities, it quickly became necessary to monitor and charge for its usage.

History of Water Meters



Invented in 1852 in England by Sir William Siemens.

History of Water Meters

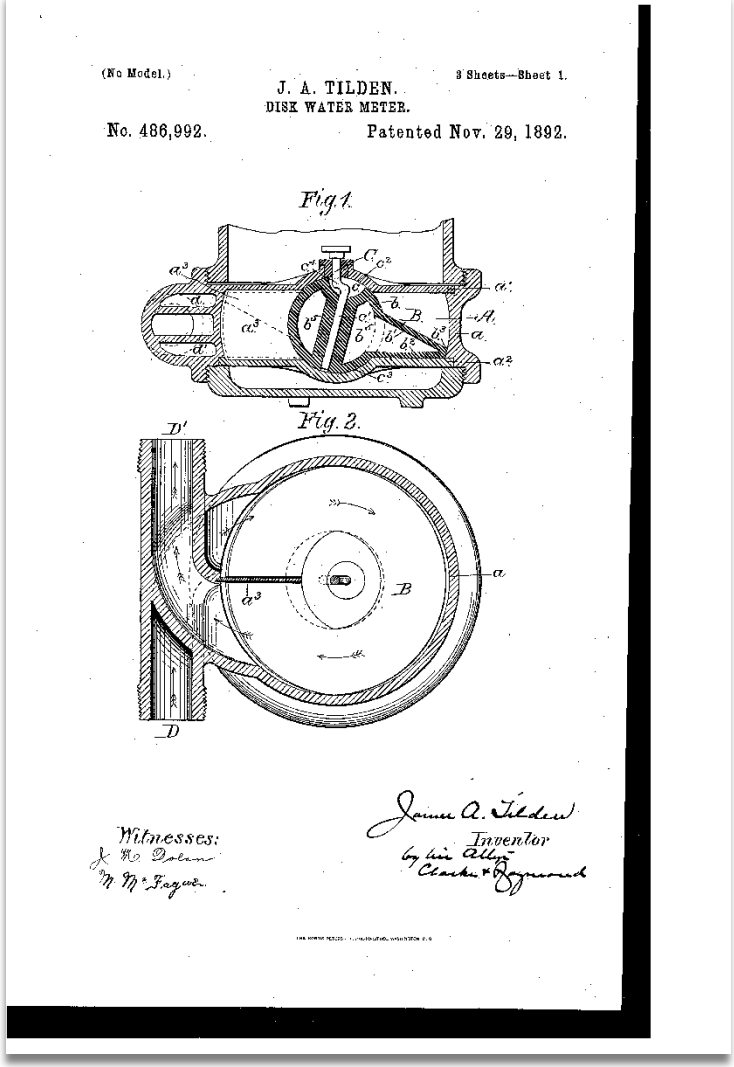


1855: First high-production Iron Water Meter invented by Henry Worthington

Complex Dual Piston Meter

History of Water Meters

1892: John Tilden invents the Nutating-Disc Meter



(No Model.) 3 Sheets—Sheet 1.

J. A. TILDEN.
DISK WATER METER.

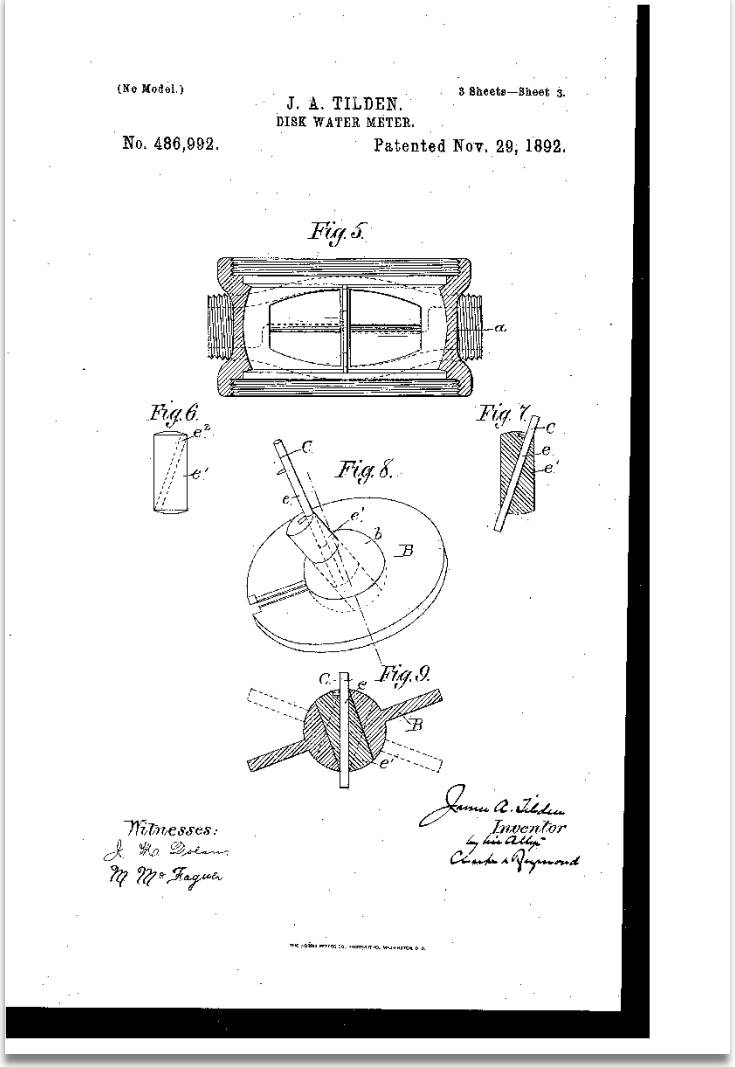
No. 486,992. Patented Nov. 29, 1892.

Fig. 1.

Fig. 2.

Witnesses:
J. Mc Dolan
M M. Fagan

James A. Tilden
Inventor
by his Attys
Clarke & Raymond



(No Model.) 3 Sheets—Sheet 3.

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Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

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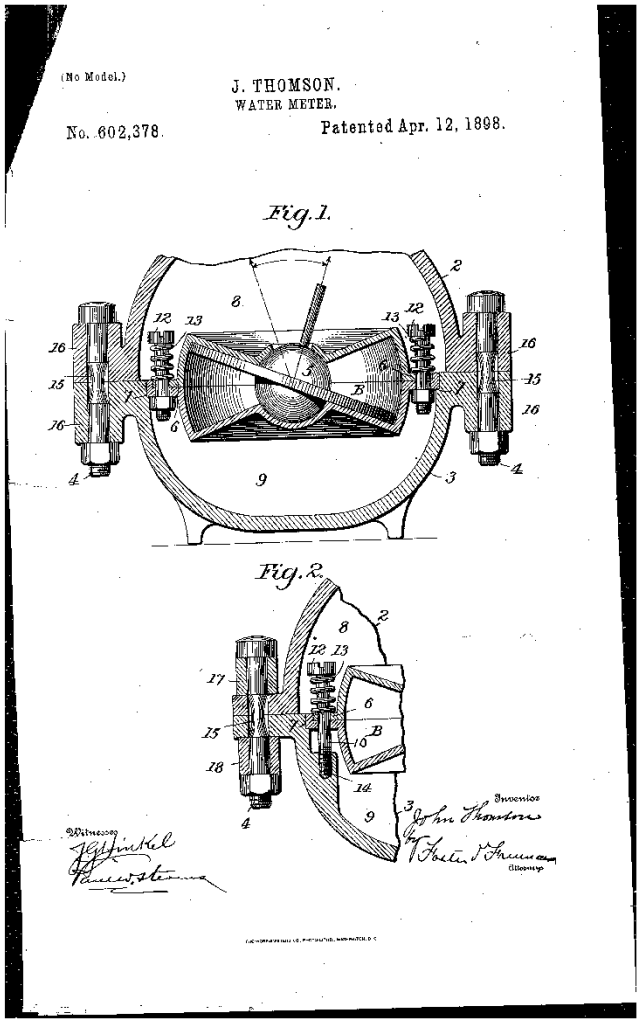
History of Water Meters



(No Model.)

J. THOMSON.

WATER METER.

No. 602,378. Patented Apr. 12, 1898.

Fig. 1.

Fig. 2.

1898: John Thomson of Neptune invents the freeze-repairable meter.

Water Meter Types

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- Positive Displacement
  - Nutating Disc
  - Oscillating Piston
  - Rotating Cam
- Velocity Meters
  - Single Jet, Multi Jet
  - Magnetic, Ultrasonic
  - Thermal, Oscillating, Vane, Float, Coriolis

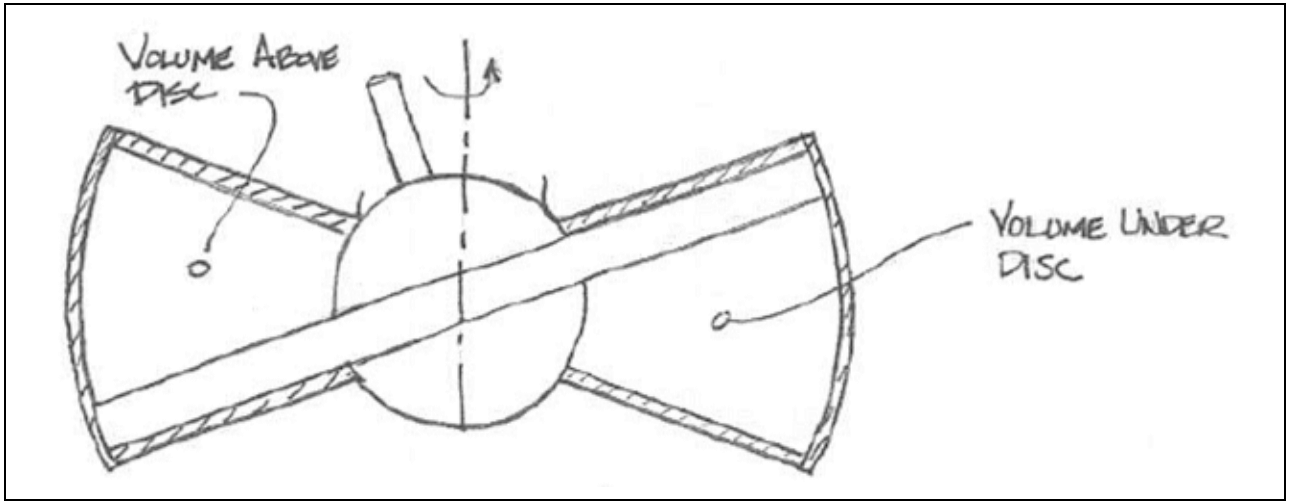
Positive Displacement –Nutating Disc

Advantages

- Excellent low flow accuracy
- Not affected by upstream flow disturbances
- Economical to produce

Disadvantages

- Limited in high flow rates by pressure losses
- Limited in size by forces on ball and disk.
- Mechanical wear



Nutating Disc

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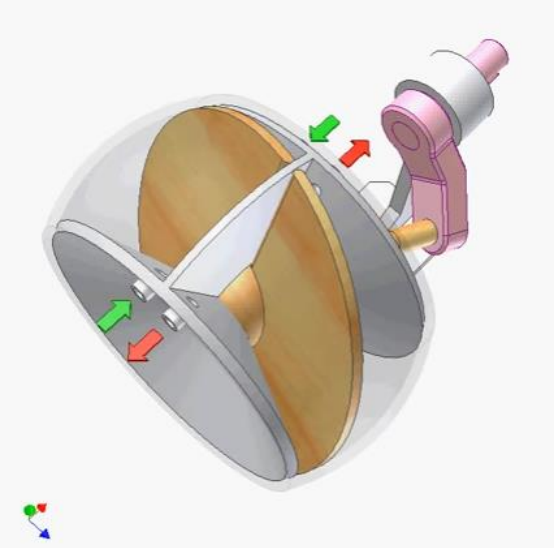
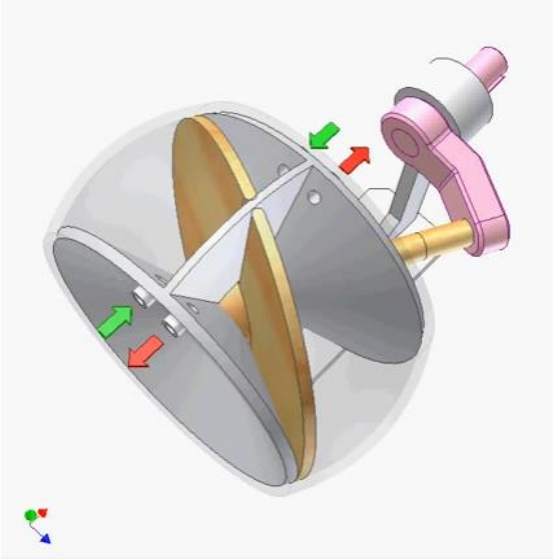
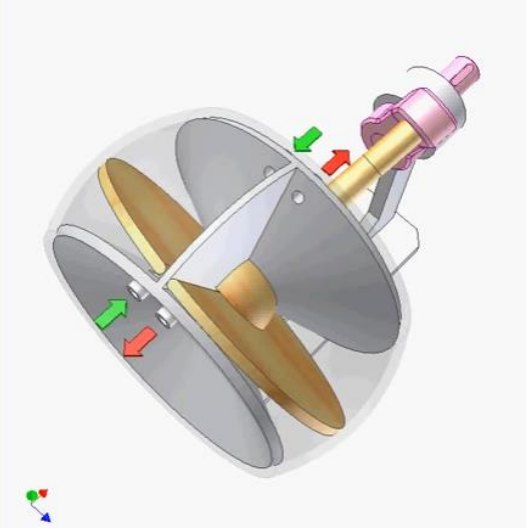
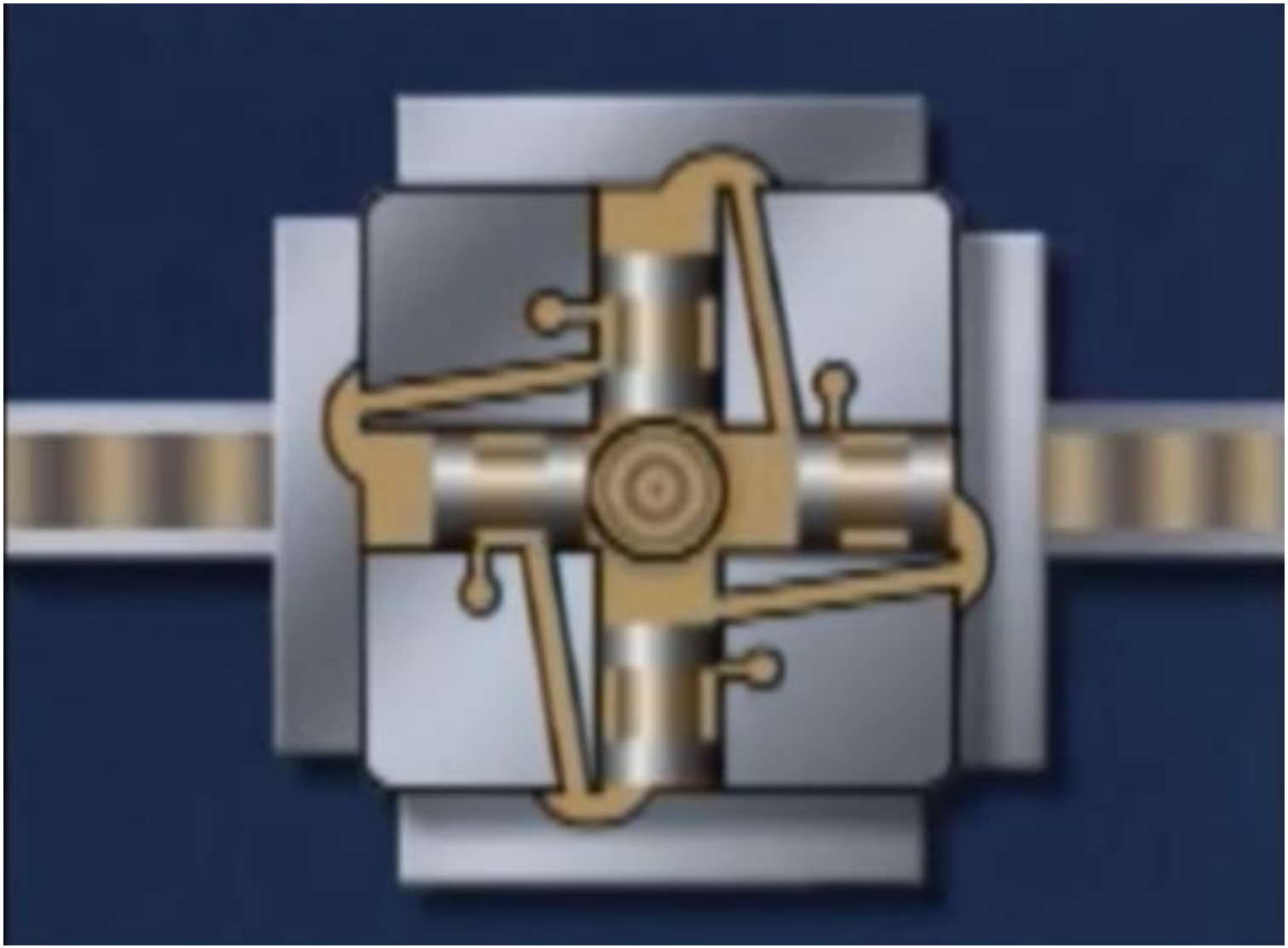




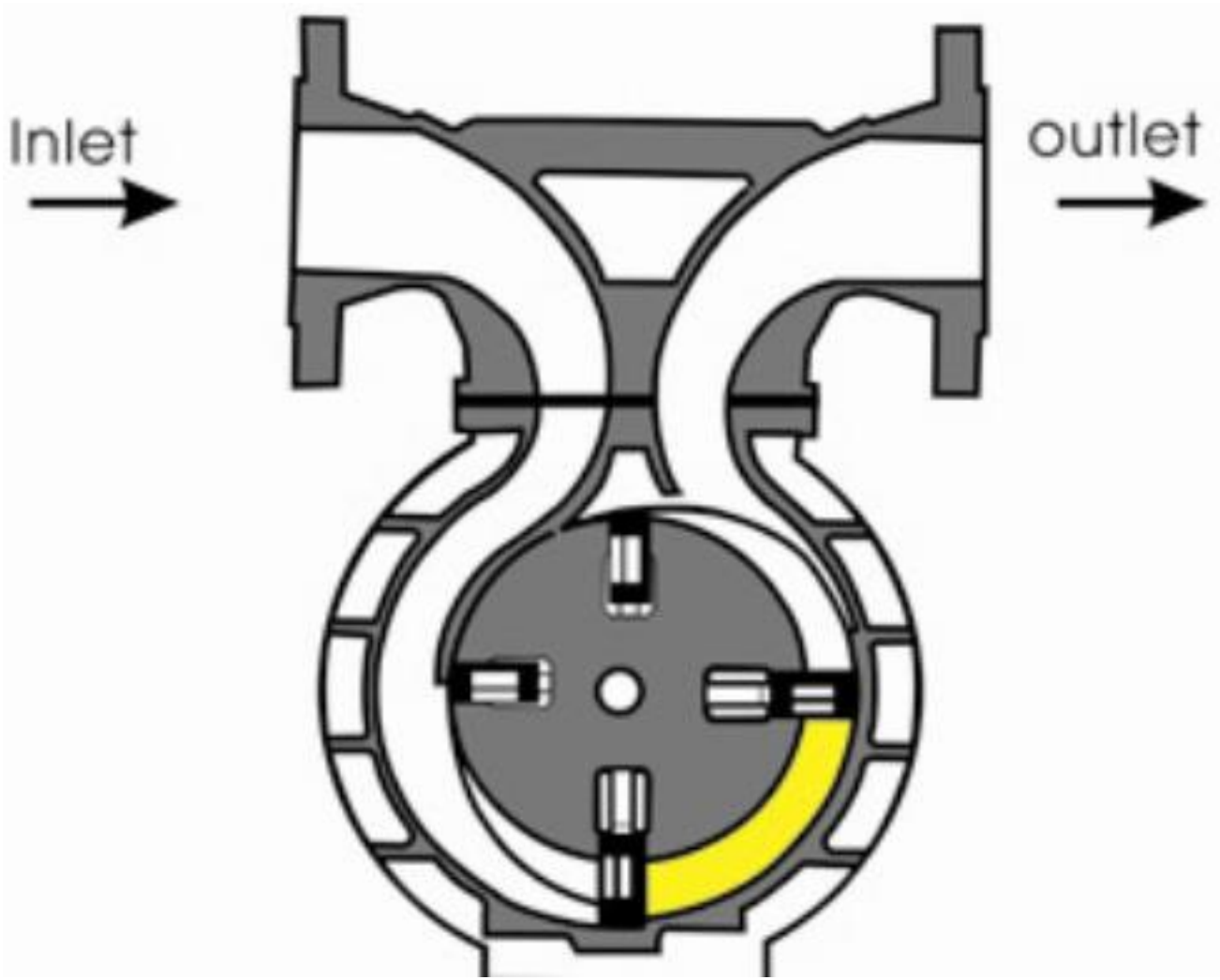


Positive Displacement – Piston

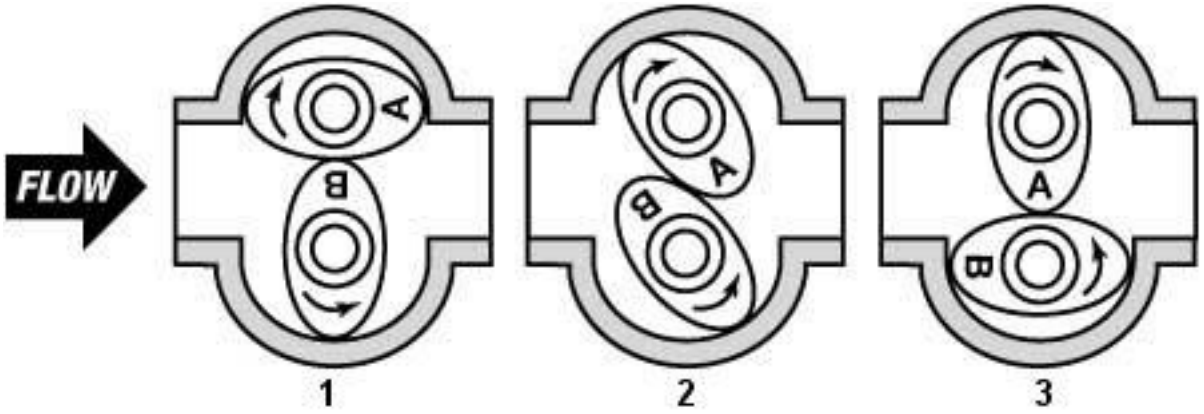


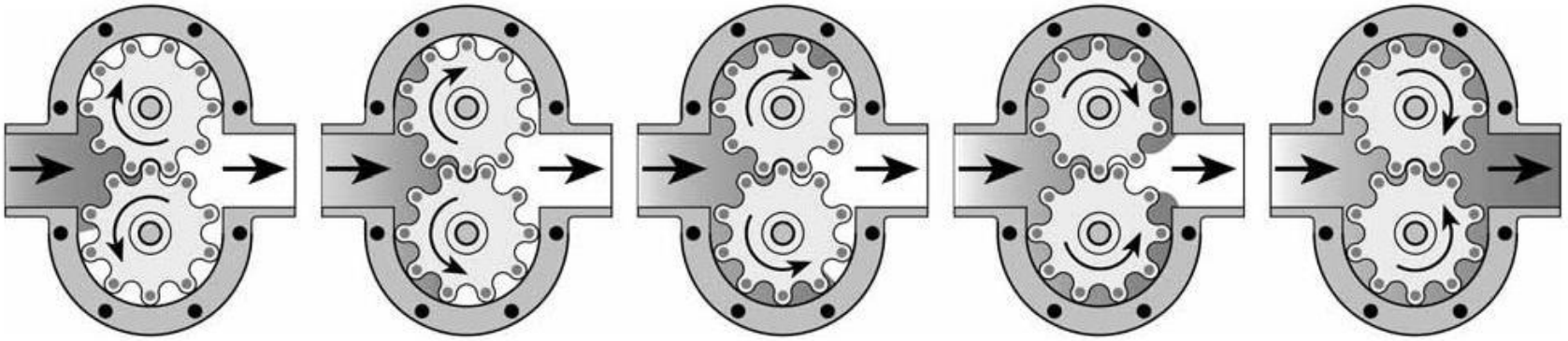
Positive Displacement – Piston

Positive Displacement – Gear



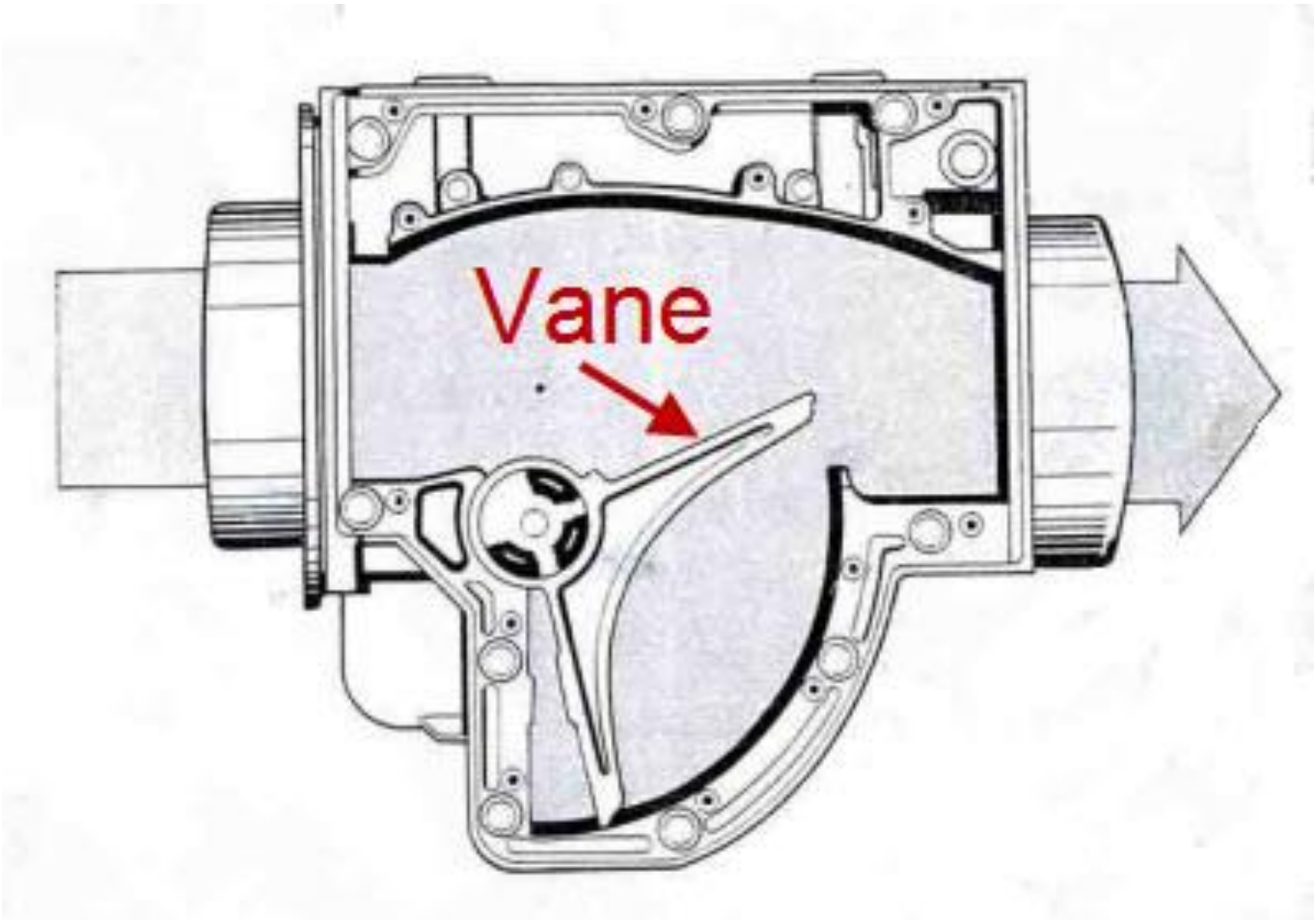
Positive Displacement – Gear



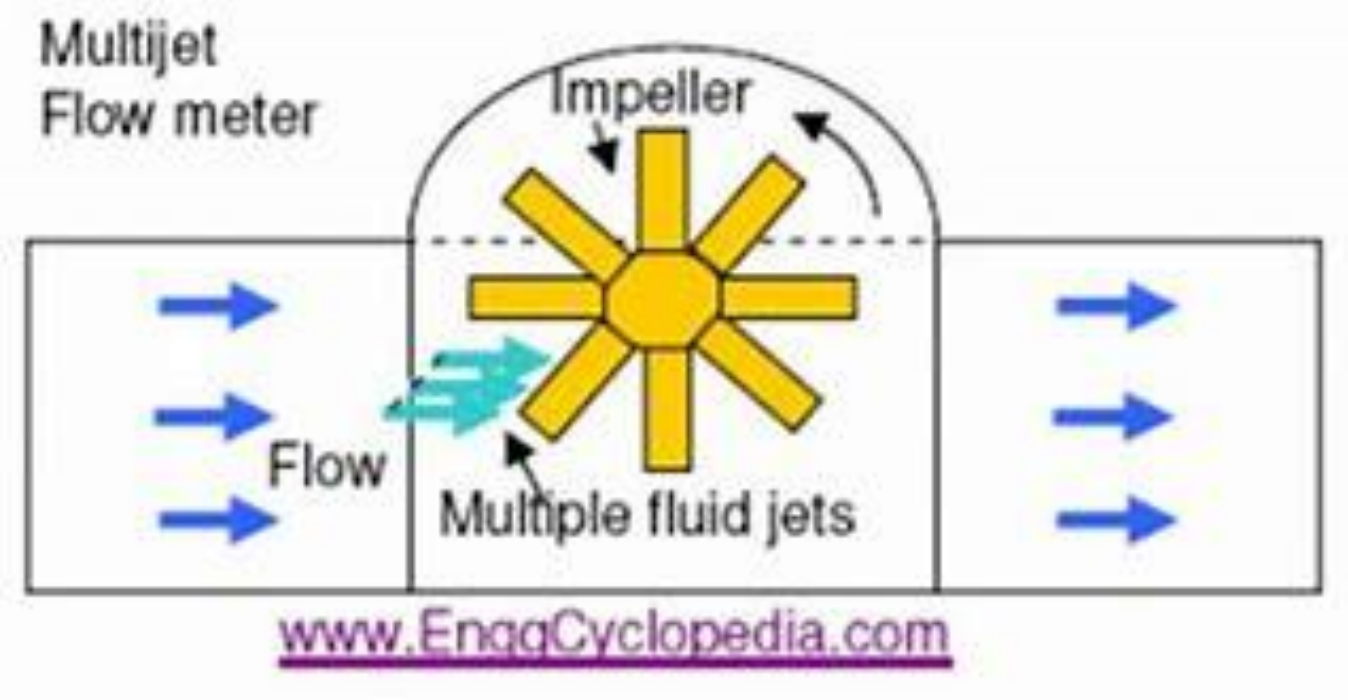


Velocity – Vane

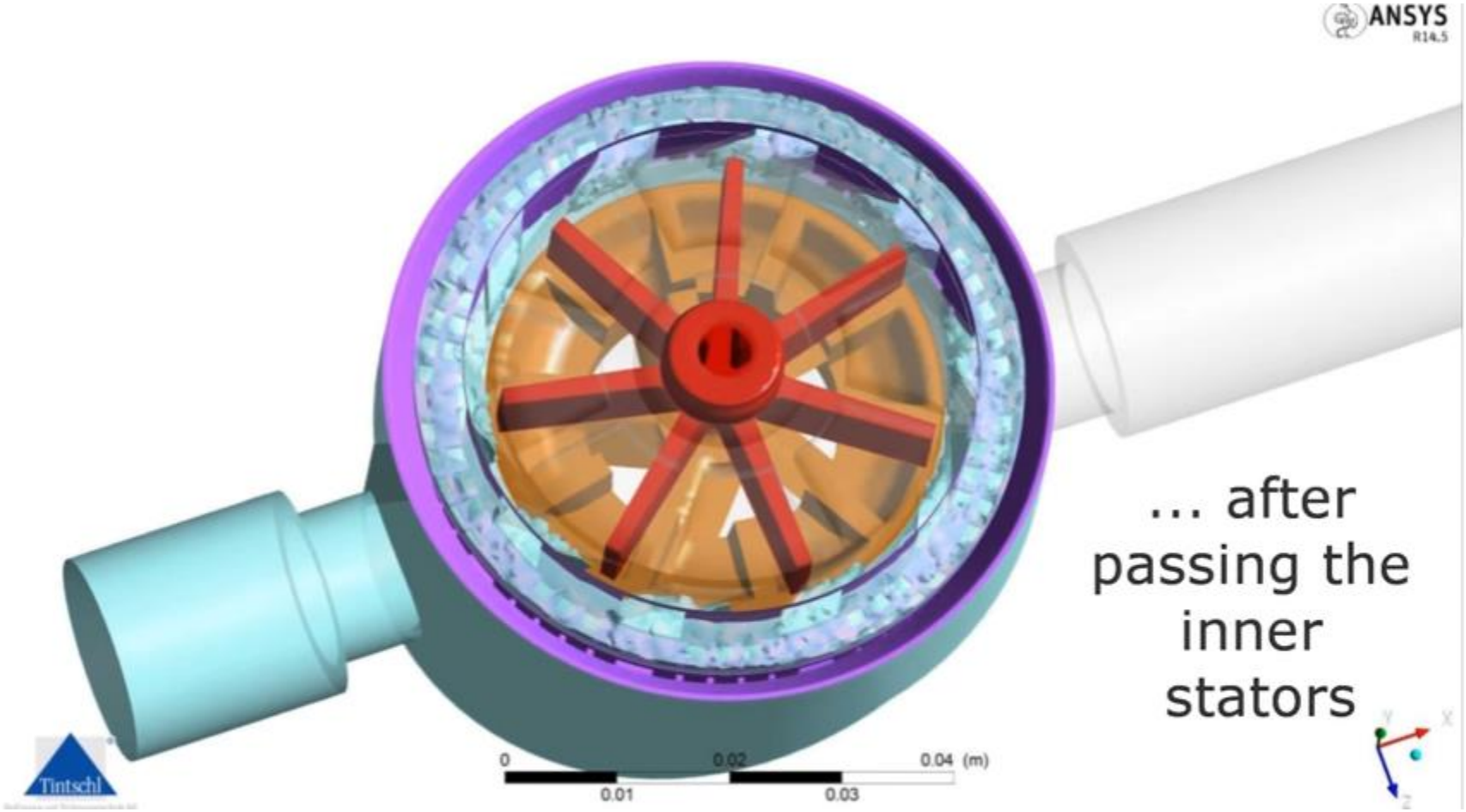
More flow pushes the spring-loaded vane farther.



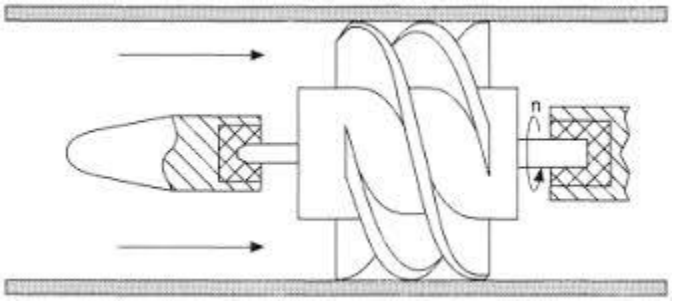
Velocity – Multiple Jet

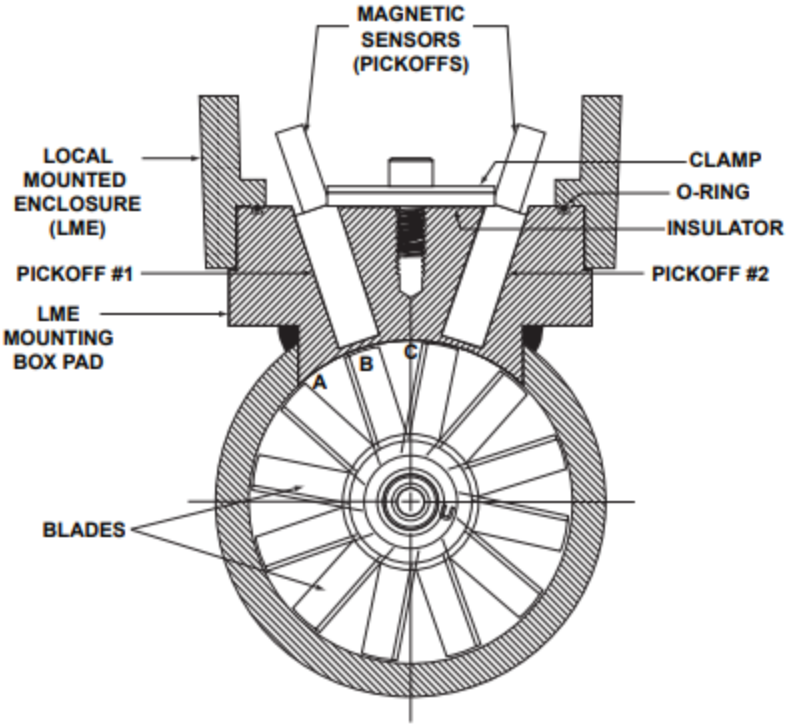


Velocity – Multiple Jet



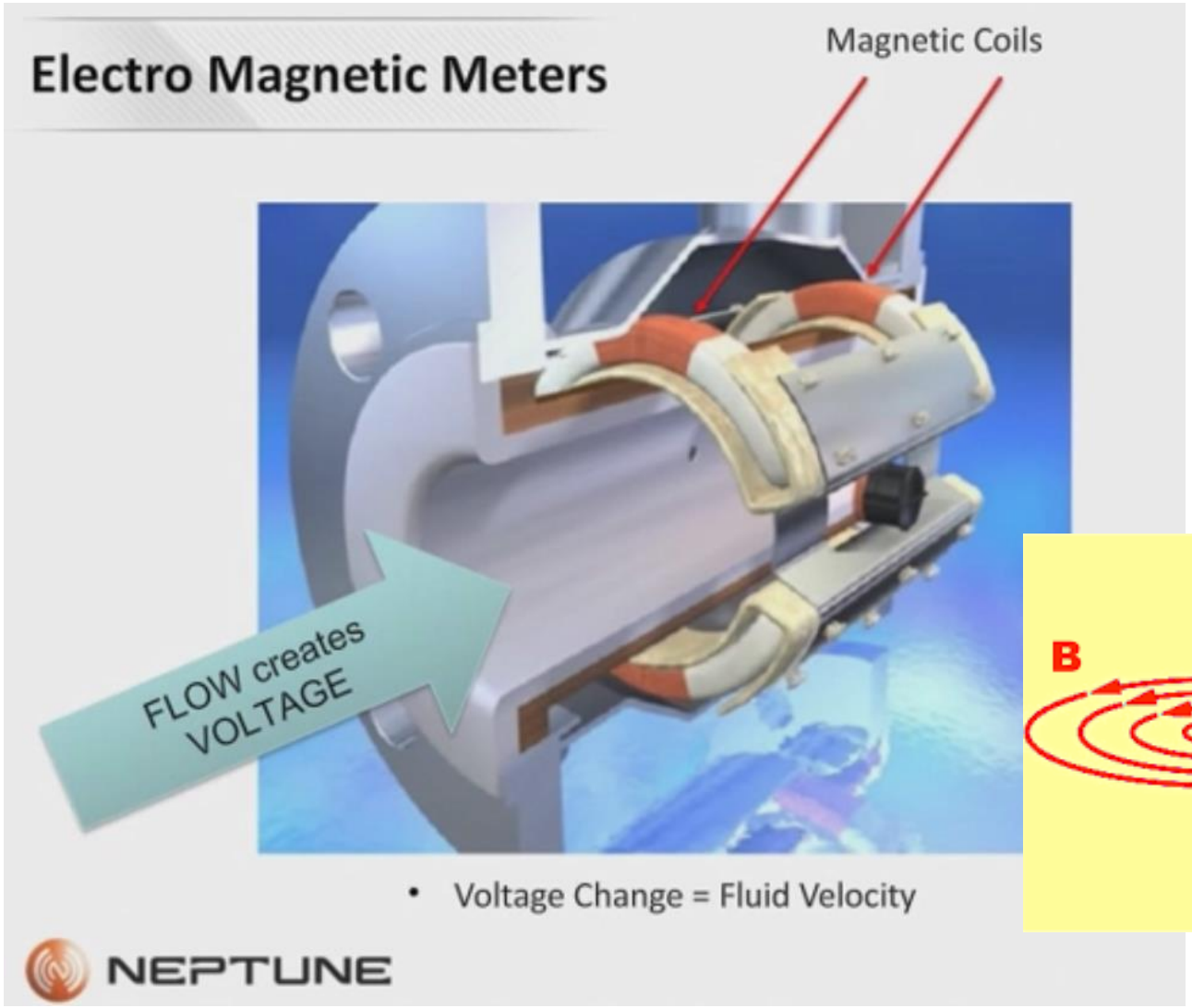
Velocity – Turbine

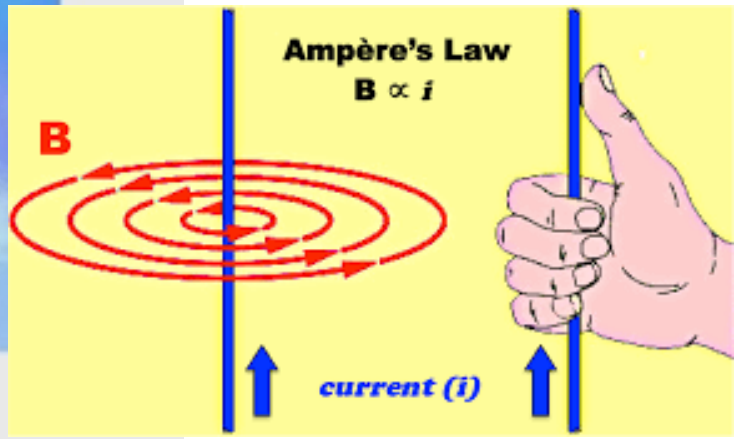




Velocity – Magnetic

Velocity – Magnetic





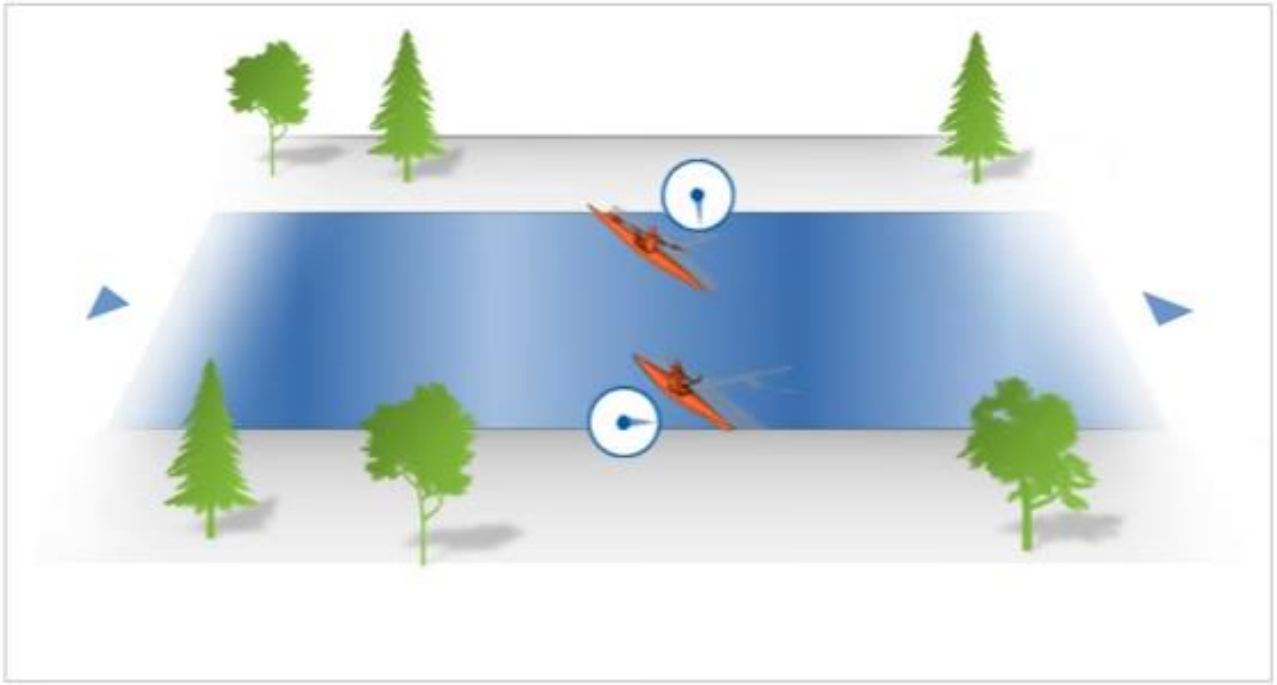
Velocity – Ultrasonic

KROHNE

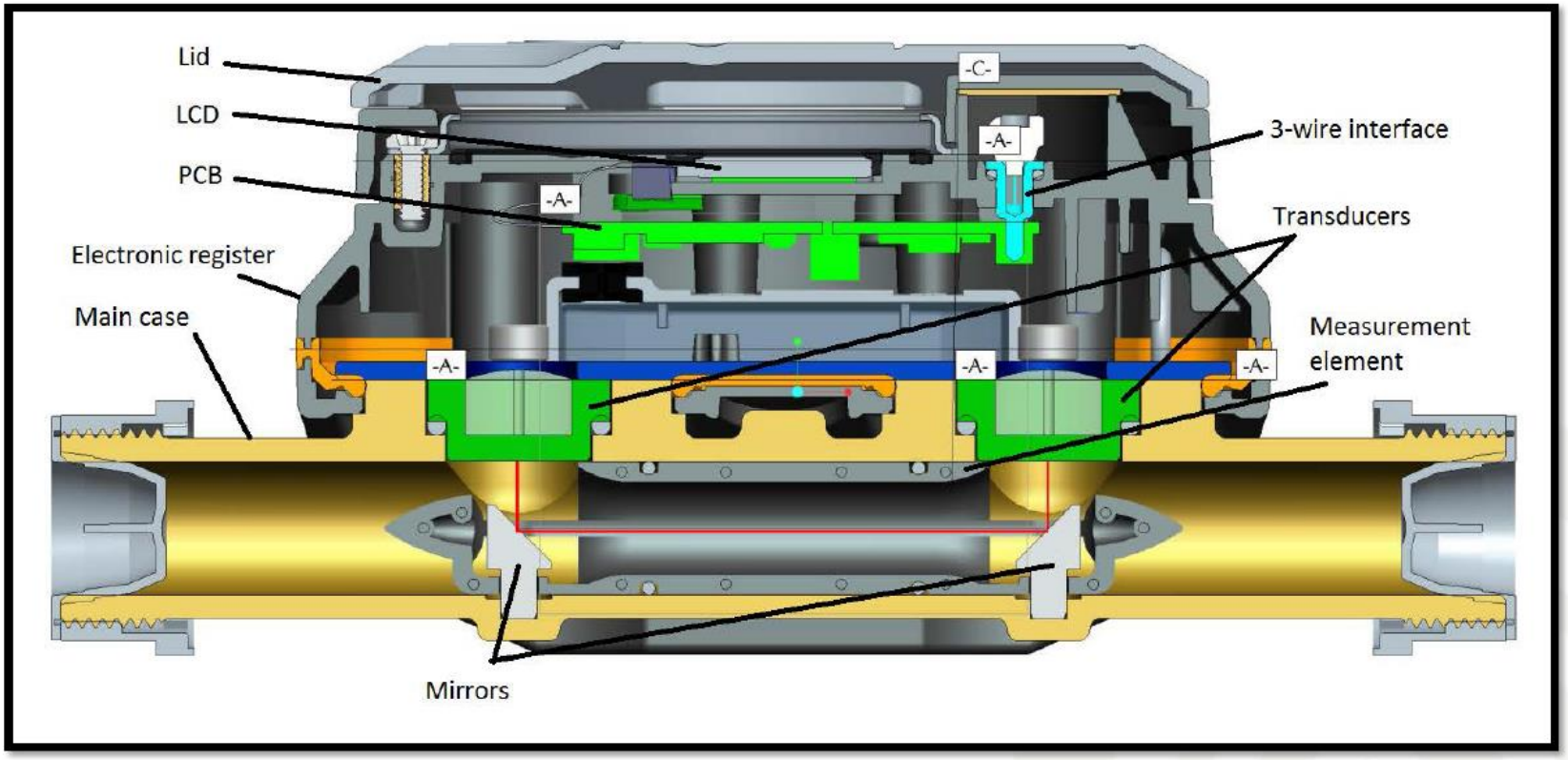
achieve more

Measuring principle: Ultrasonic

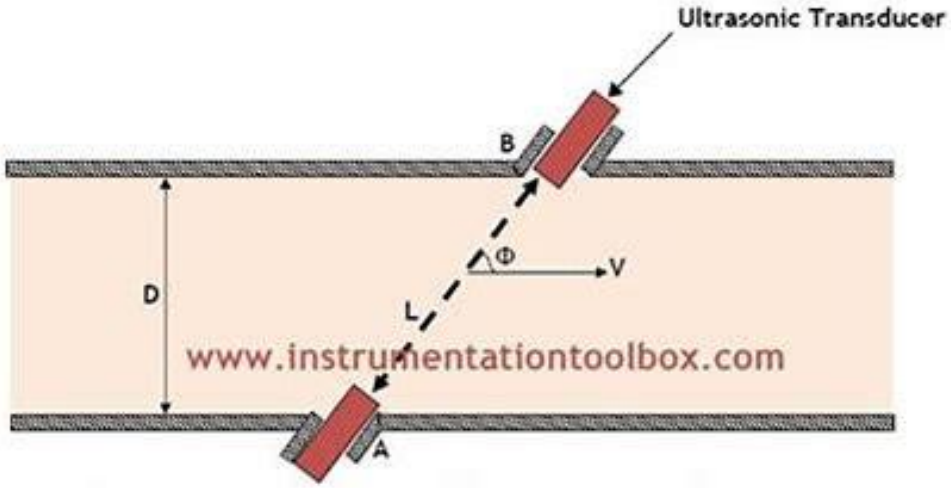
Transit time difference



Velocity – Ultrasonic

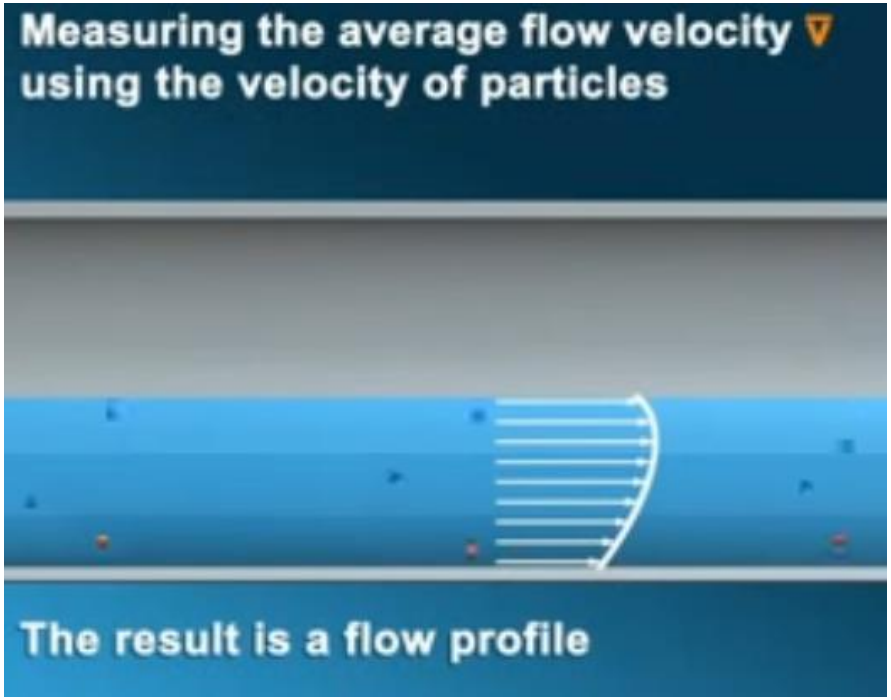


Velocity – Ultrasonic

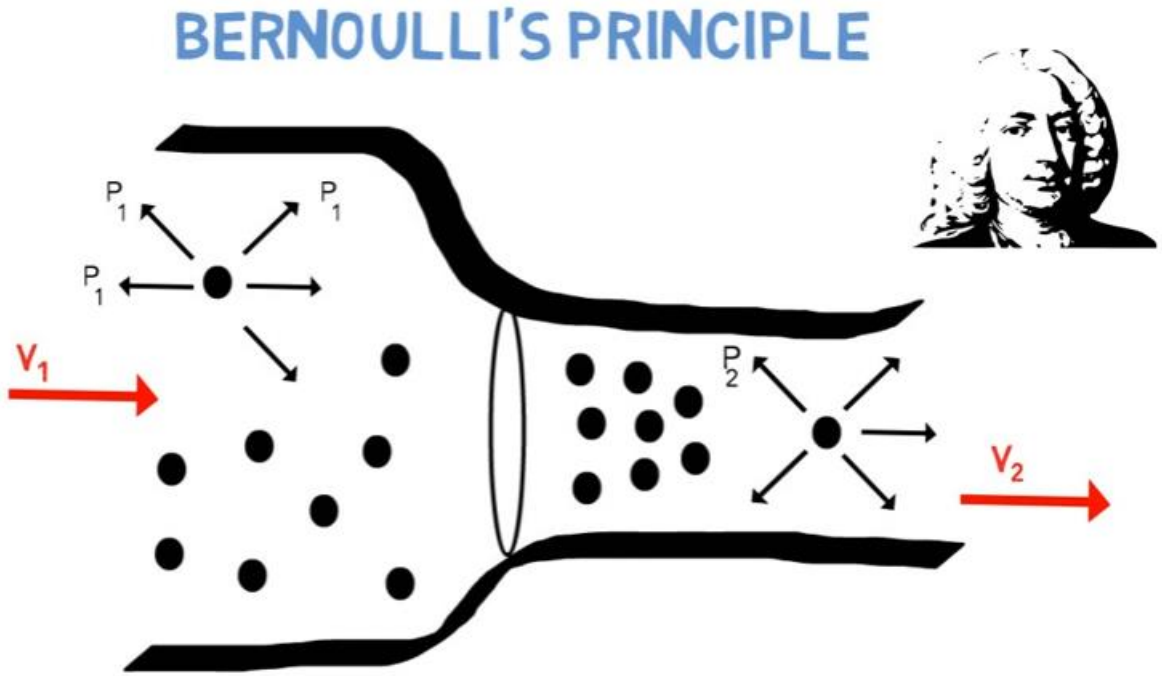


D = pipe internal diameter. L = Ultrasonic pulse path length

Velocity – Ultrasonic w/ Open Pipe

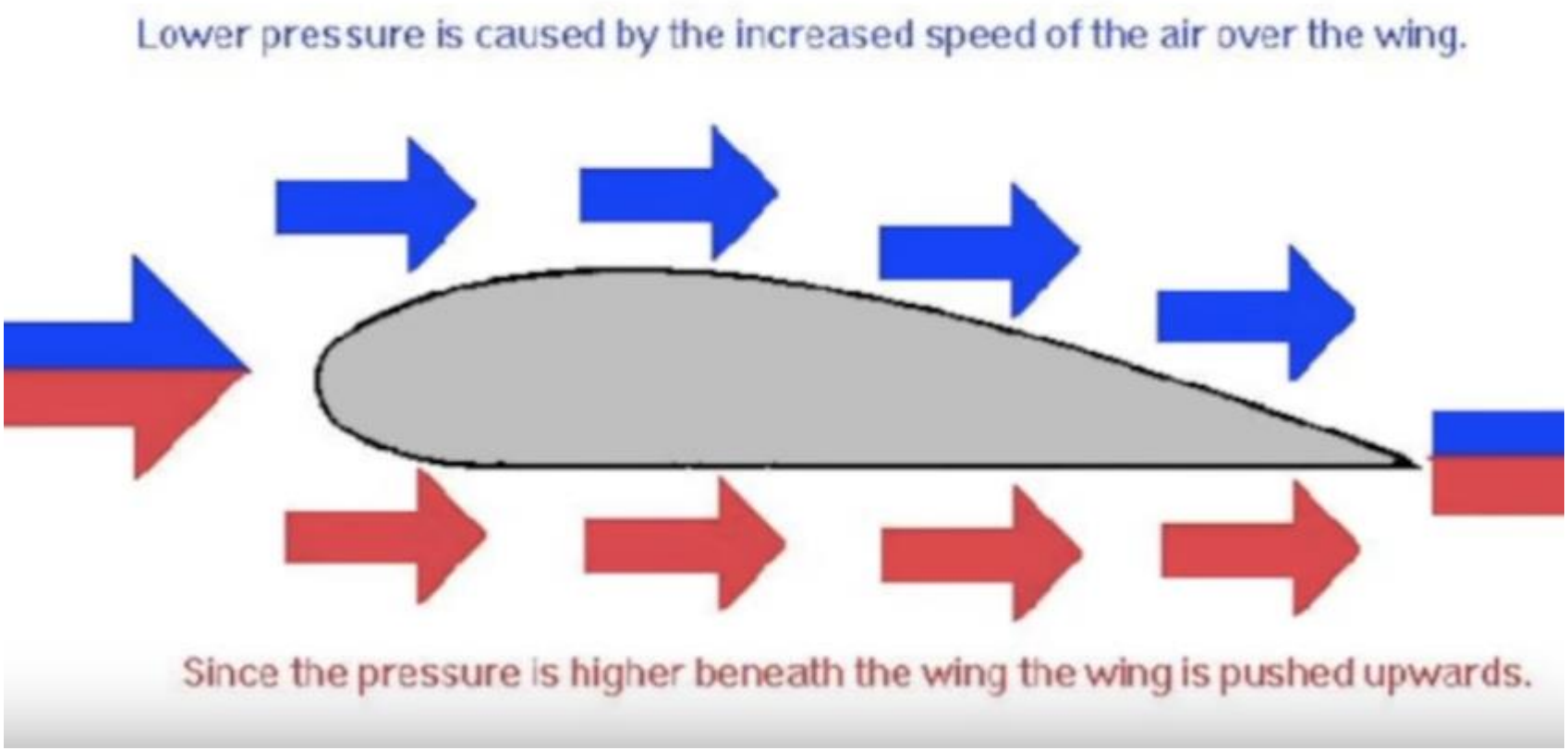


Velocity – Venturi Flow Tube

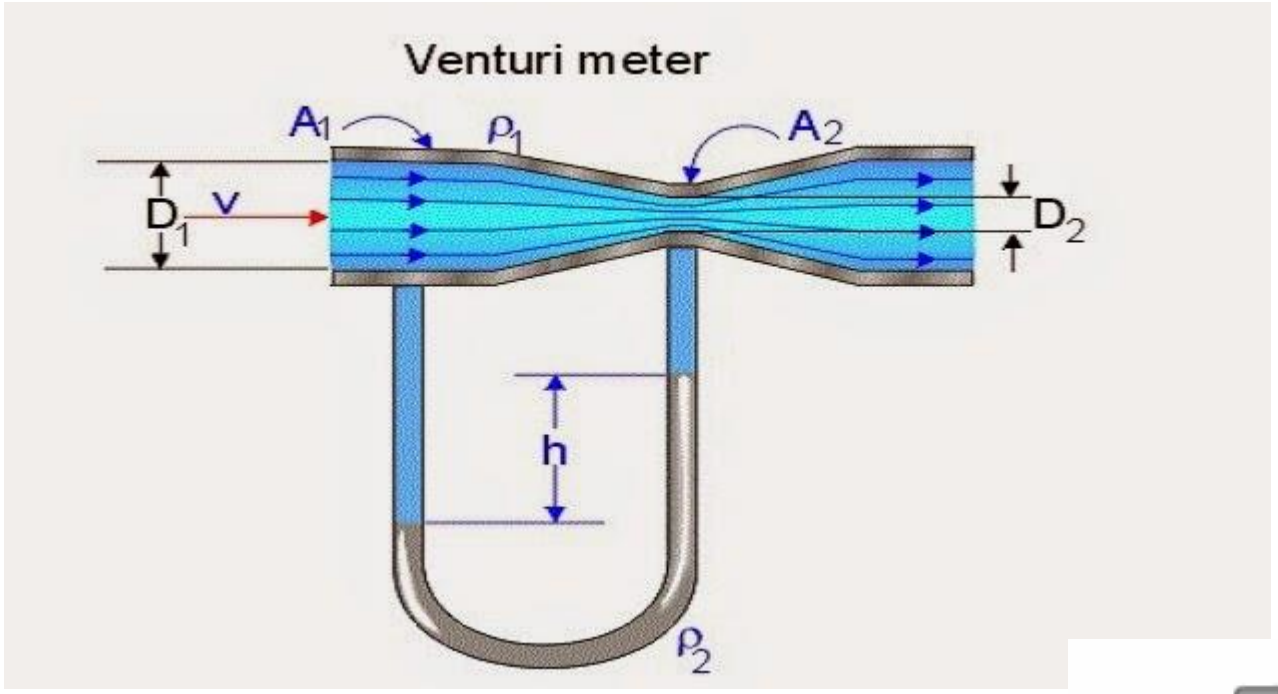


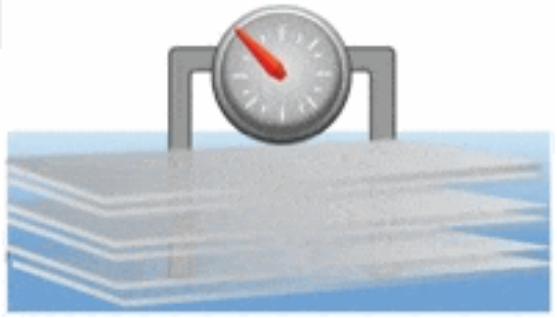
Bernoulli's Principle: as the velocity of a fluid increases, the pressure exerted by that fluid decreases.

Velocity – Venturi Flow Tube



Velocity – Venturi Flow Tube



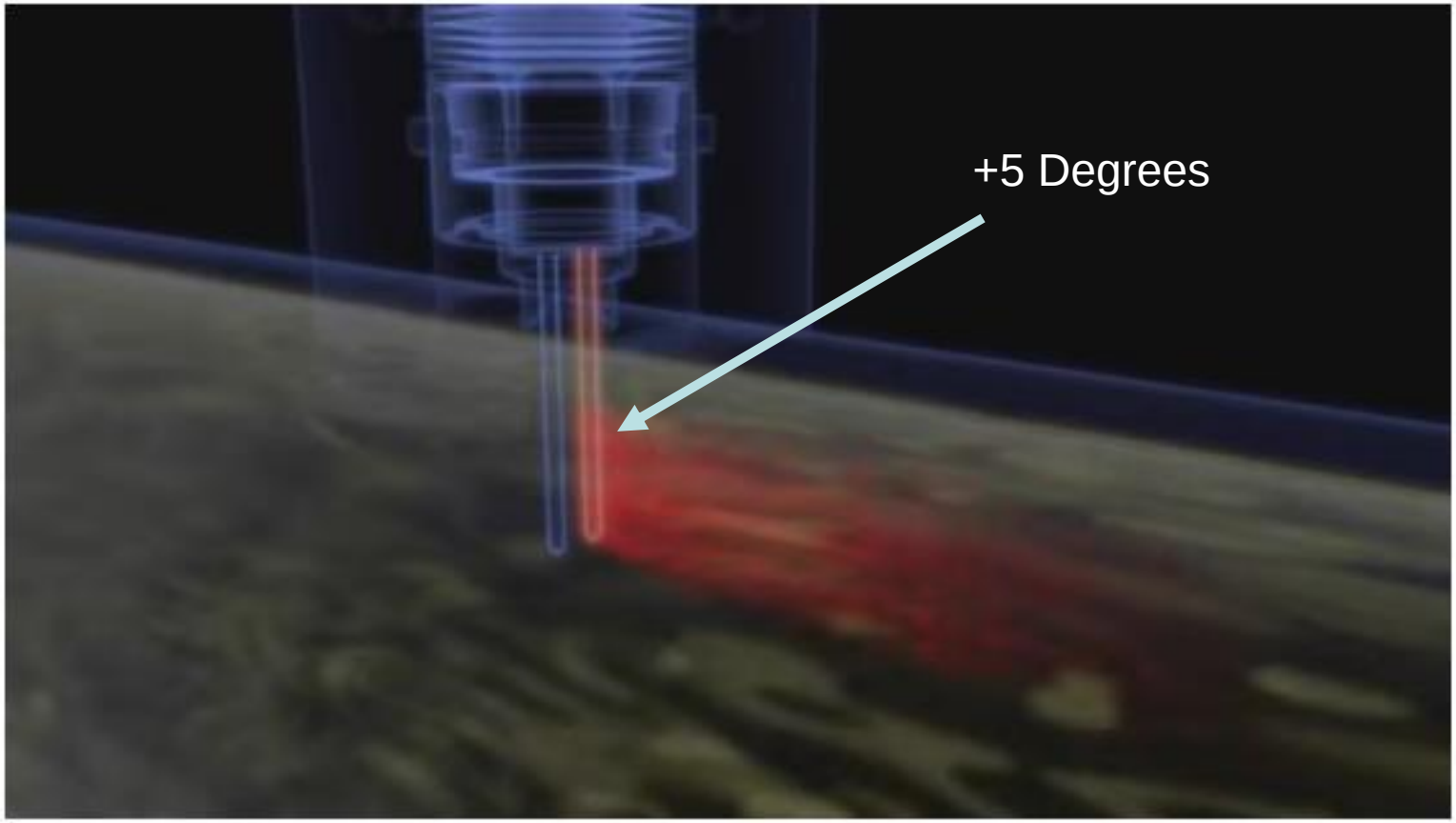


Laminar Flow Meter

Velocity – Venturi Flow Tube

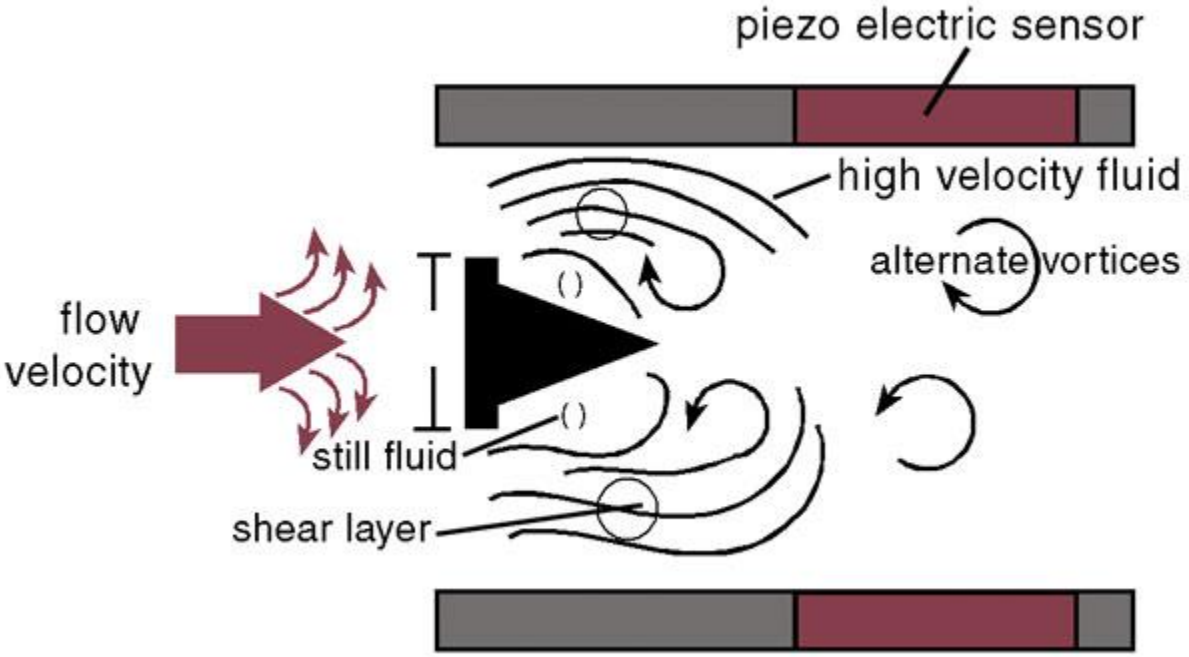
Velocity – Thermal

Flowing fluid cools the heated thermocouple. Measuring the power required to maintain temp difference tells you the flow.



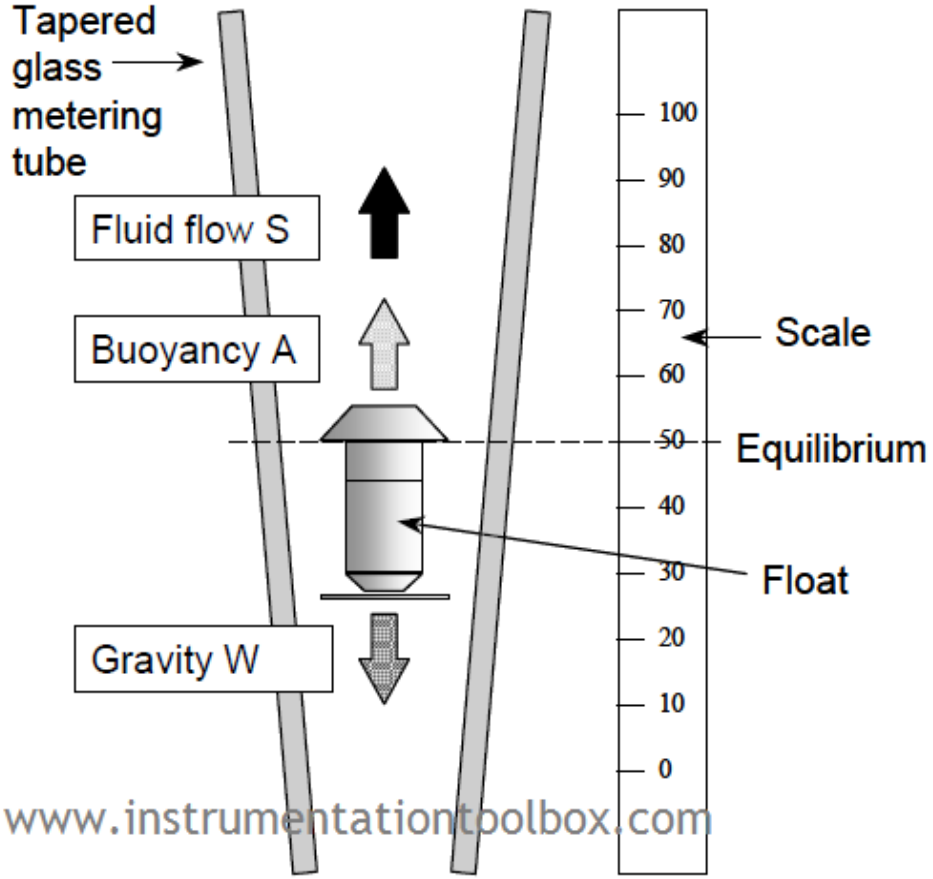
Velocity – Oscillating Vortex Shredder

Oscillations occur as water flows around the obstruction.
Sensors measure the force of the vortex and convert to flow.



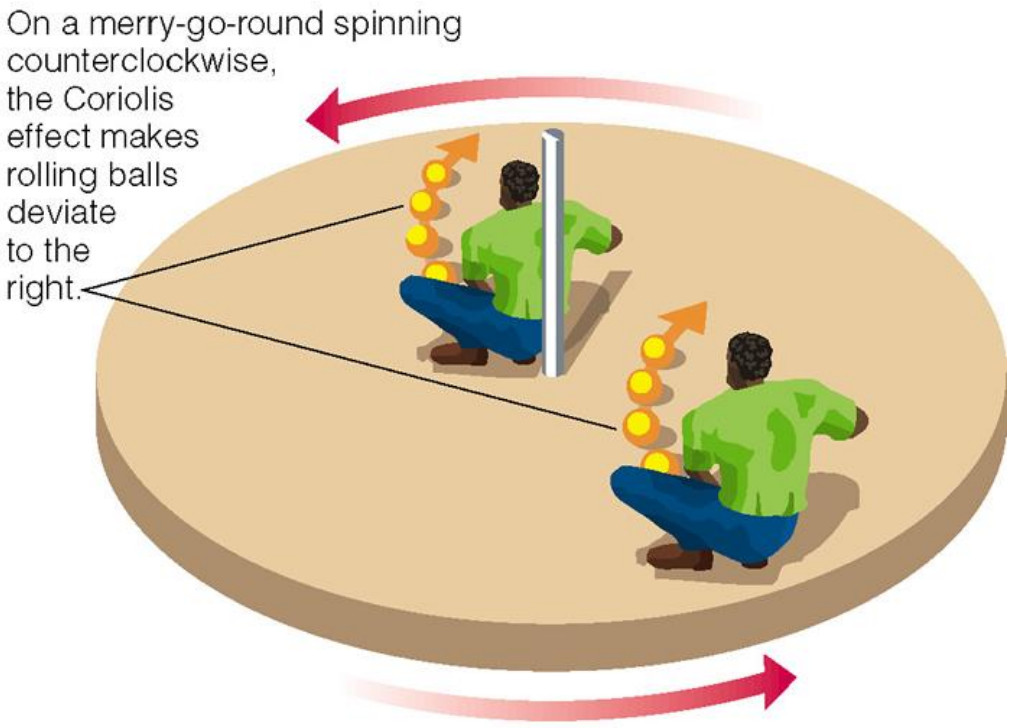
Velocity – Float

Variable area allows float to move higher when there is more water flow.



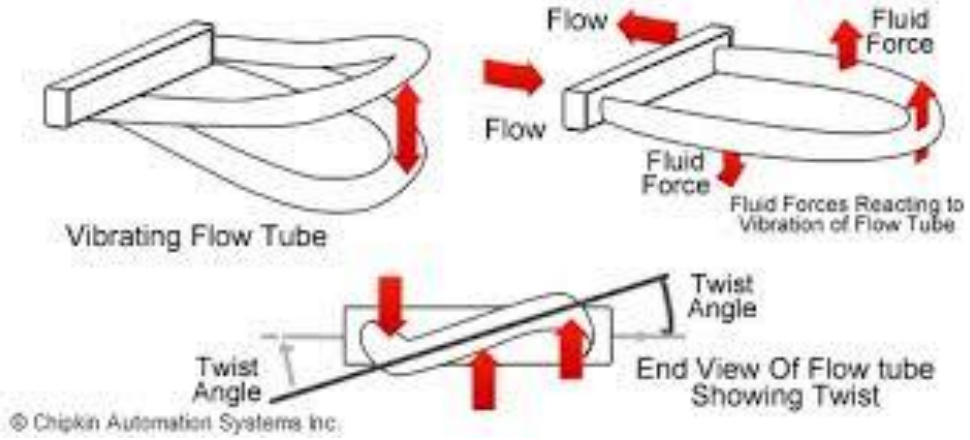
Velocity – Coriolis Effect

Water flowing toward and away from a center of rotation exert oppose forces on the tube.



Velocity – Coriolis Meter

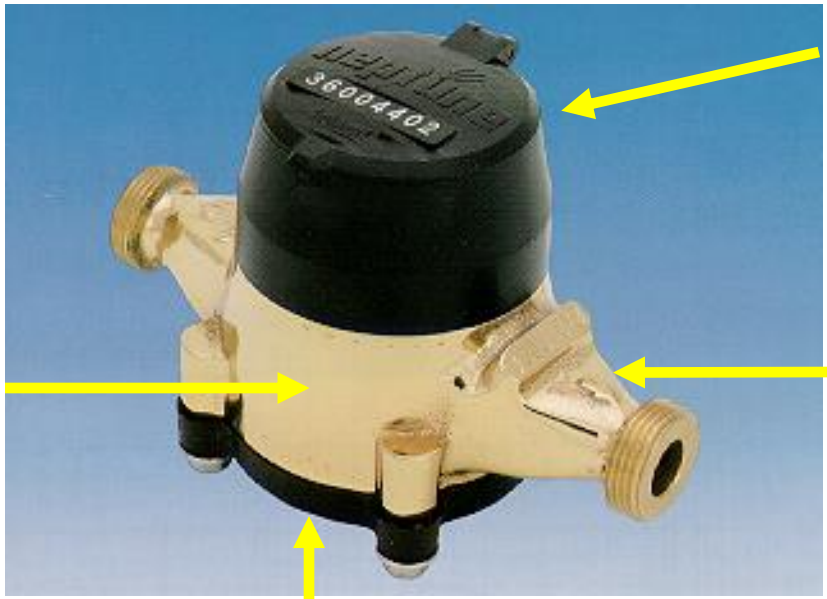
Water flowing toward and away from a center of rotation exert oppose forces on the tube.



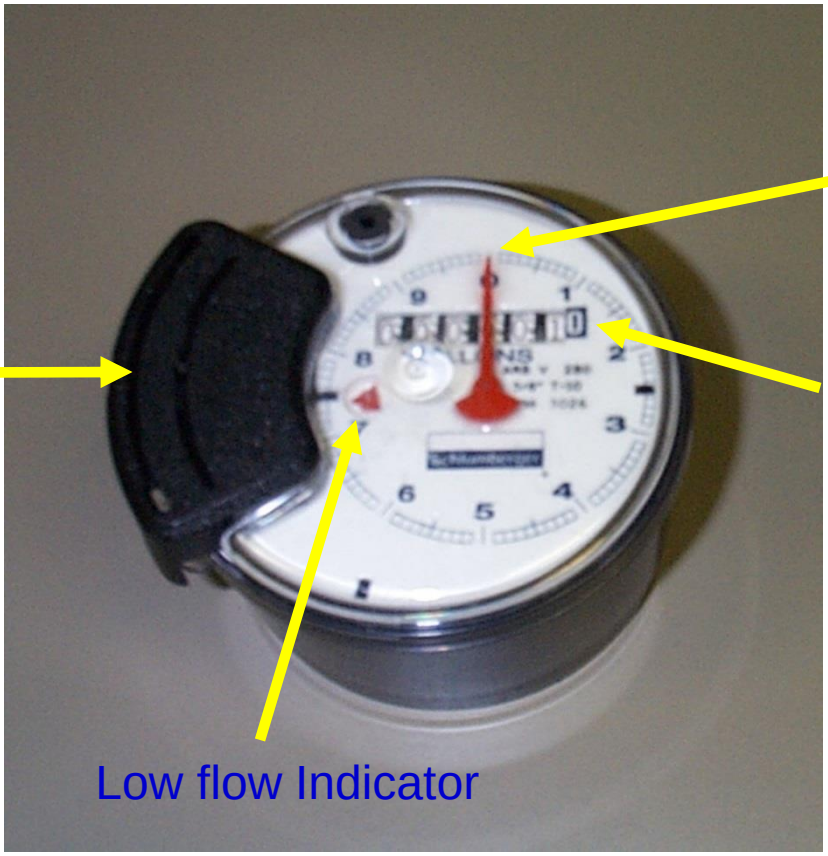
Residential Meters

- Typical Residential Meters
  - Positive Displacement
    - Nutating Disc
    - Oscillating Piston
  - Velocity Meters
    - Single Jet, Multi Jet
    - Ultrasonic
    - Electromagnetic

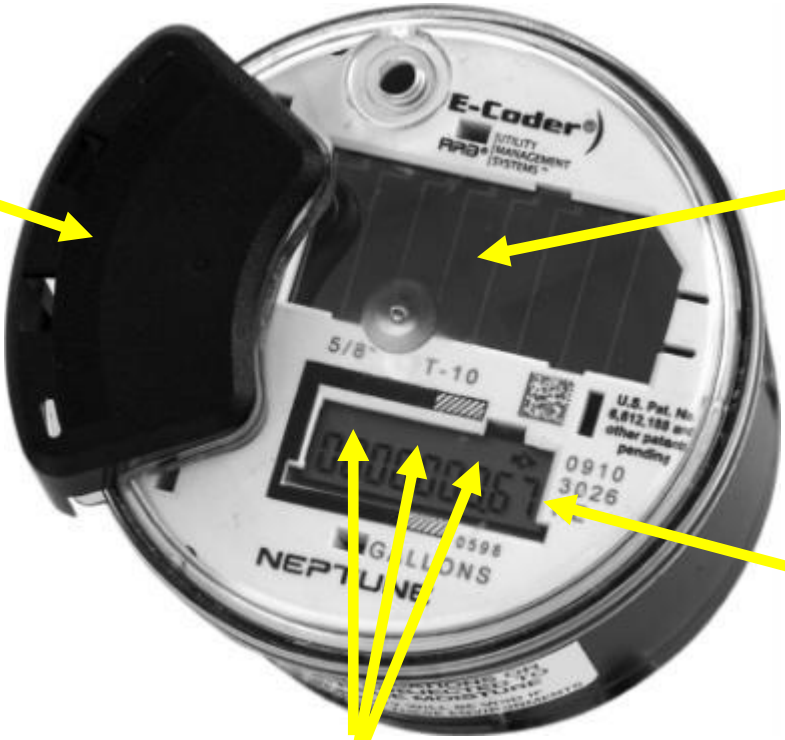
Residential Meter Components



Basic Register Dial Face



Register E-Coder Face



Communication wire connection

Solar Panel

Flow Indicator

Leak, Tamper & Backflow Indicator Icons

Register ProCoder

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Transmitters

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Smart Solutions, Water Powered

Register/Transmitter Combo

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Smart Solutions, Water Powered

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Smart Solutions, Water Powered

Commercial & Industrial Large Water Meters

Large Meter Family

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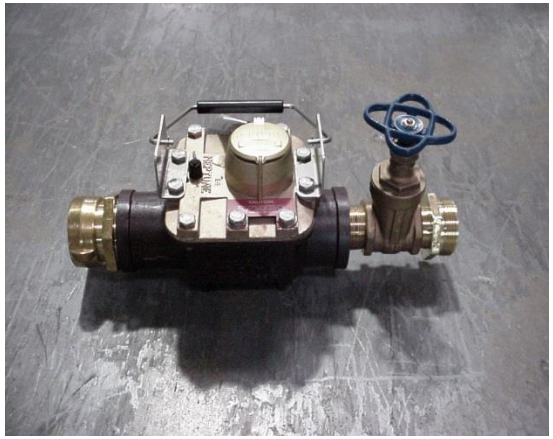

HP Turbines

- Cold Water Measurement
- Velocity Meter
- 1 1/2” - 20” Sizes
- Flow Range: 4-6500 GPM
- Moderate to High Flow Rates
- Accuracy to within +/-1.5%
- Sudden On/Off Flows
- Hydrodynamically Balanced
- Accuracy Calibration Vane

HP Turbines

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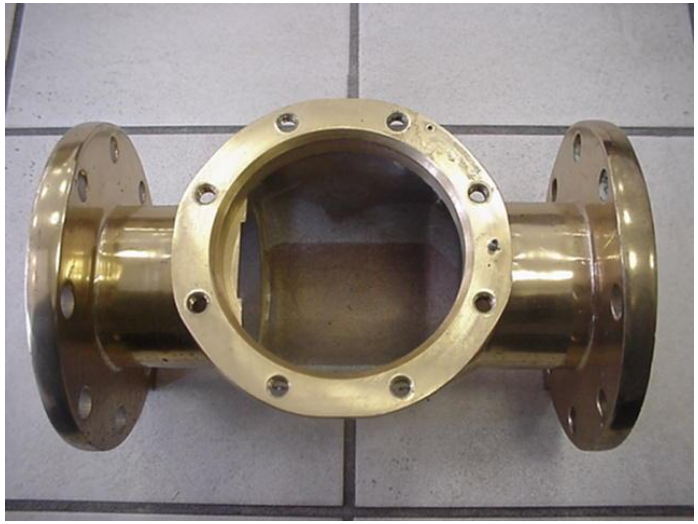
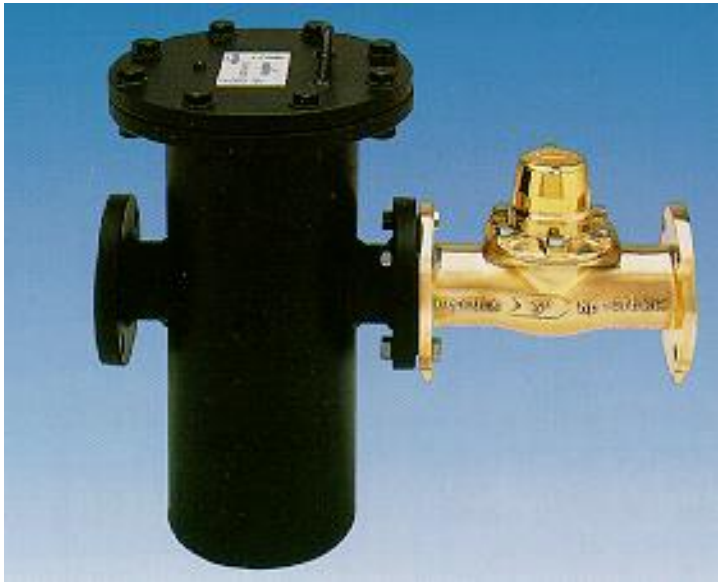
Smart Solutions, Water Powered



Fire Service HP Turbine



- Cold Water Measurement
- Fire Service Applications
- 3” - 10” Sizes
- 5 to 6500 gpm
- Moderate to High Flow Rates
- Uses Standard HP Turbine
- UL/FM Listed Basket Strainer
- Lightweight, easy to handle
- Corrects flow profile
- Stops debris

Moderate To High Continuous Flow Rates

- Processing Plants
- Manufacturing Facilities
- Irrigation Lines
- Lawn Sprinkler Systems
- Wells
- Effluent Water in Treatment Plants
- Booster (Pump) Stations
- Large Batching Operations
- Inter-system sales or transfer
- Office Buildings
- Public Transportation Centers

WHERE PEOPLE WORK!!

The World of Compounds

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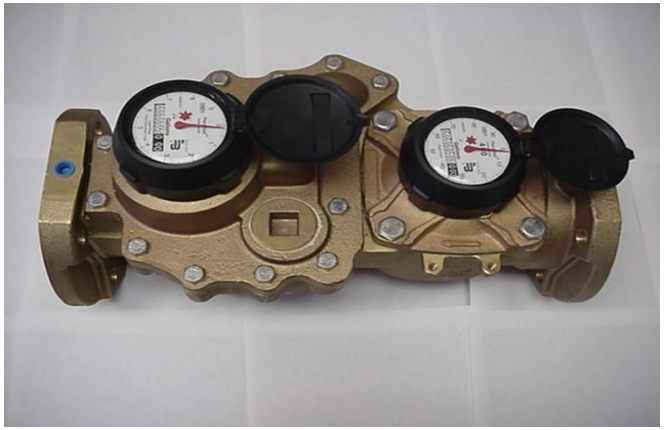
Smart Solutions, Water Powered

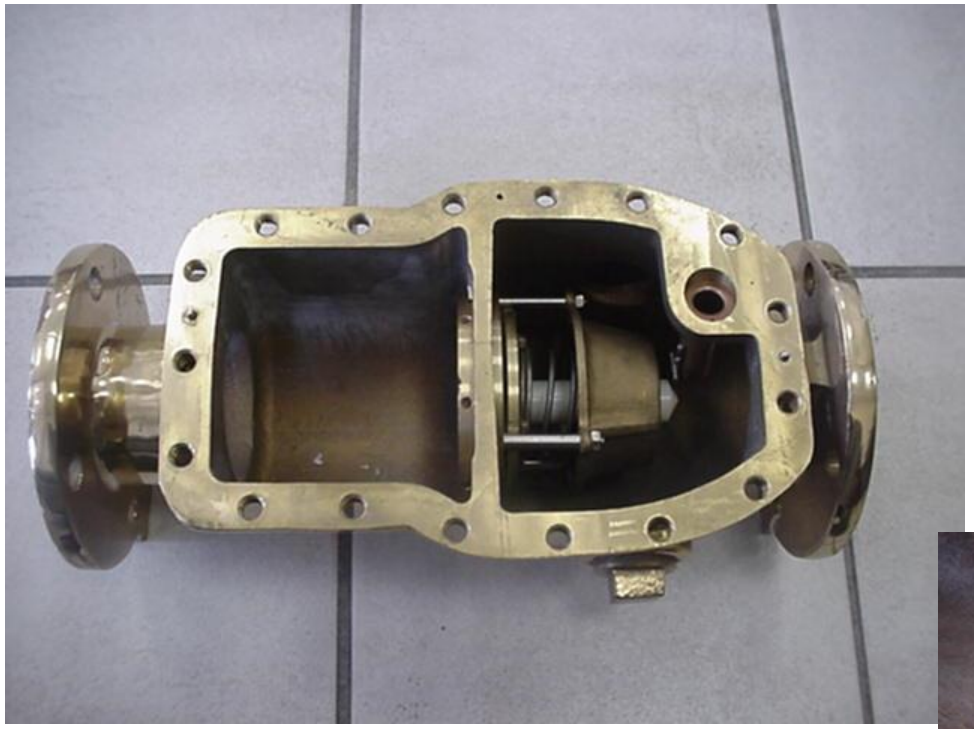


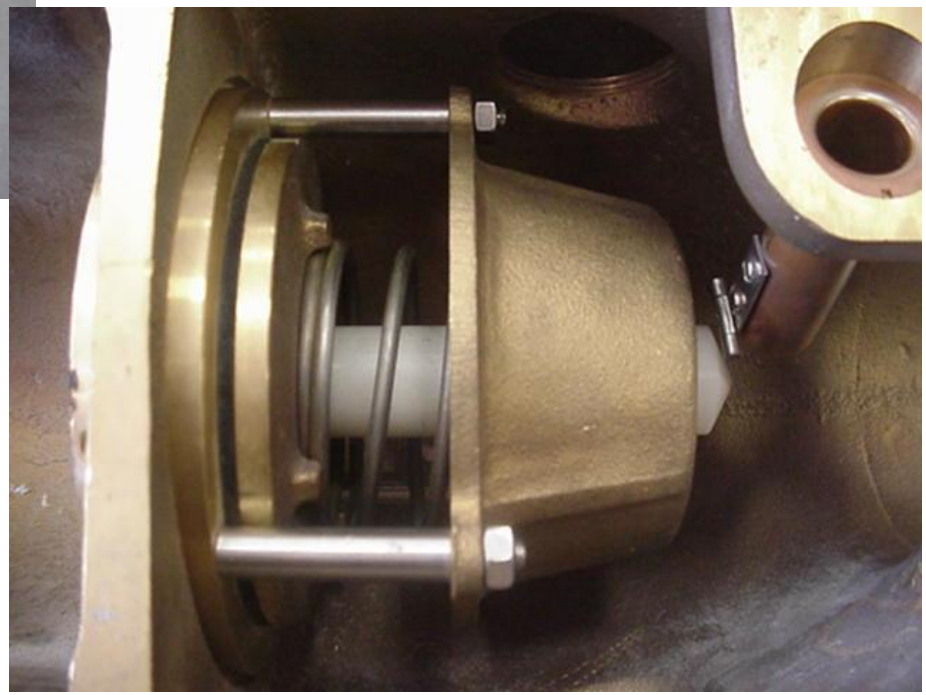
TRU/FLO Compound

- Cold Water Measurement
- EnviroBrass II (Lead Free)
- 2” - 6” x 8” Sizes
- Flow Range: 1/8-2000 gpm
- Low to High Flow Rates
- High & Low Side Register
- Patented Hydraulic Valve
- Narrow Crossover Range
- Std. T-10 & Turbine parts
- Automatic Throttling Valve
- UME / Calibration Vane
- Test Ports / TRICON/E3/S

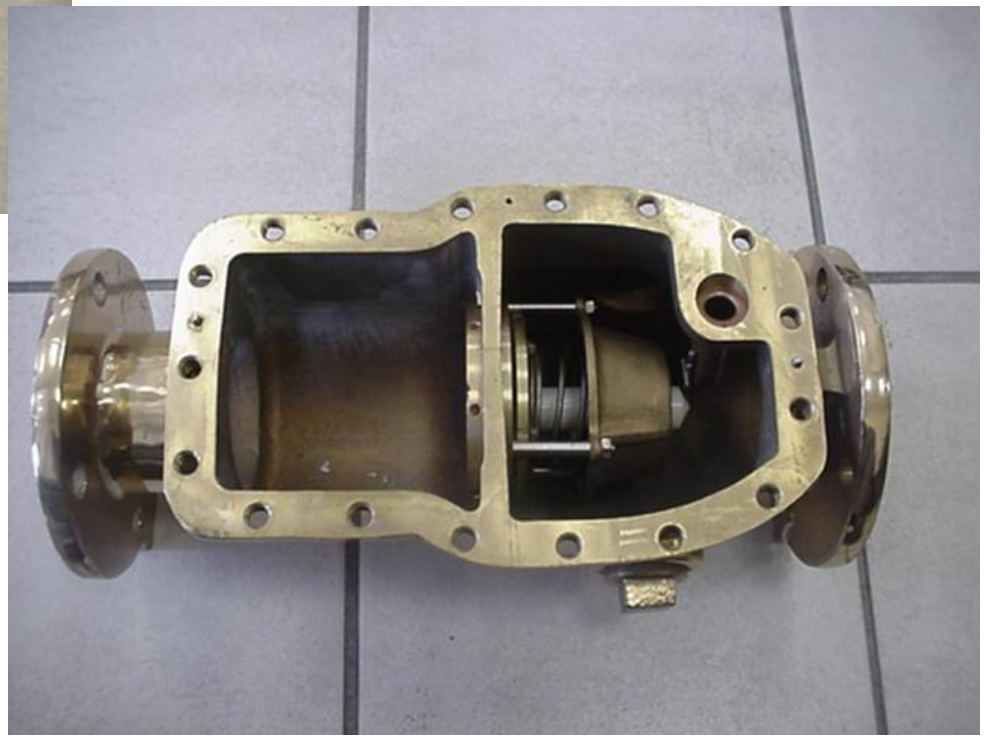
TRU/FLO Compound

NECO
Smart Solutions, Water Powered

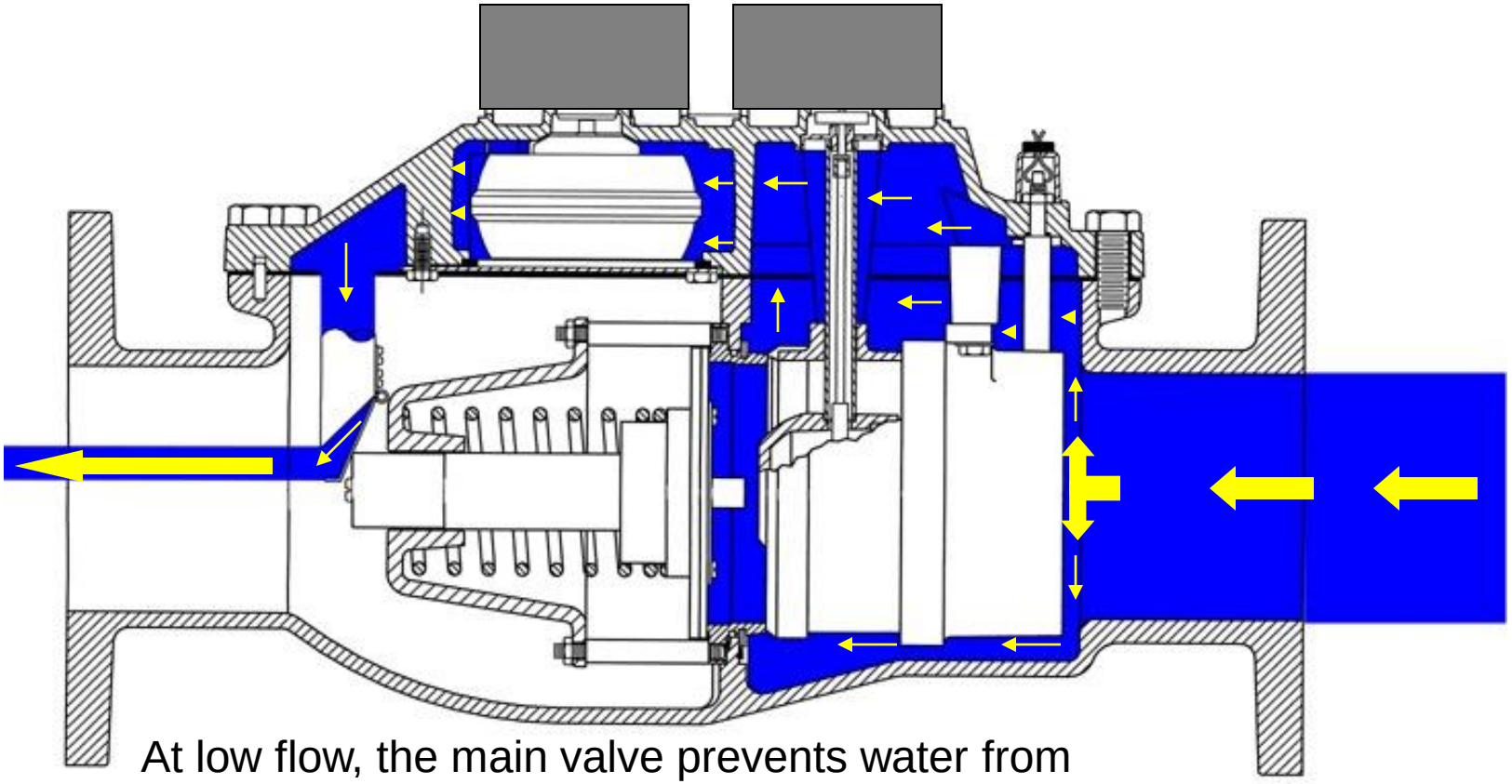




TRU/FLO Compound



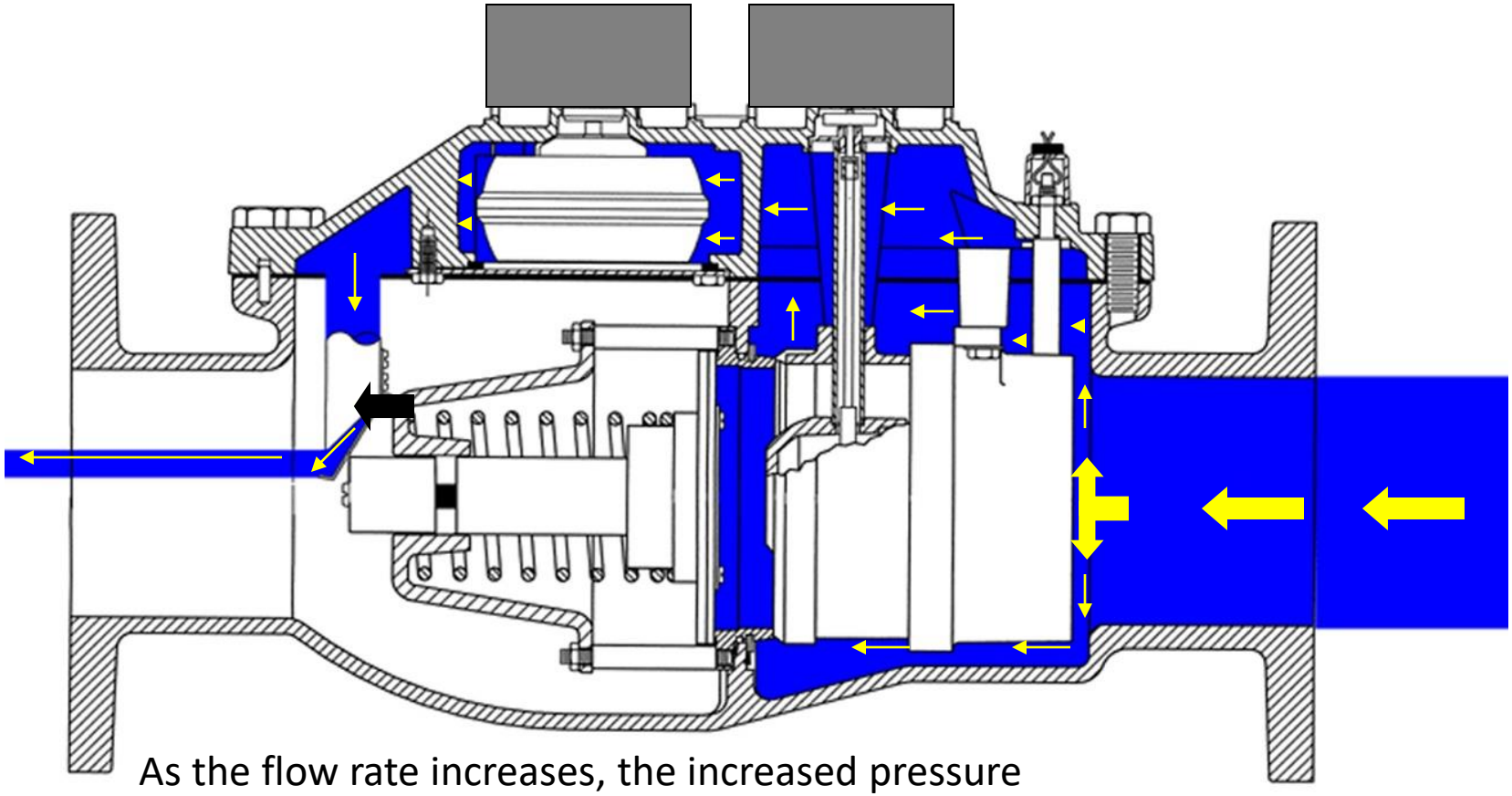
Low Flow



At low flow, the main valve prevents water from flowing through the Turbine element.

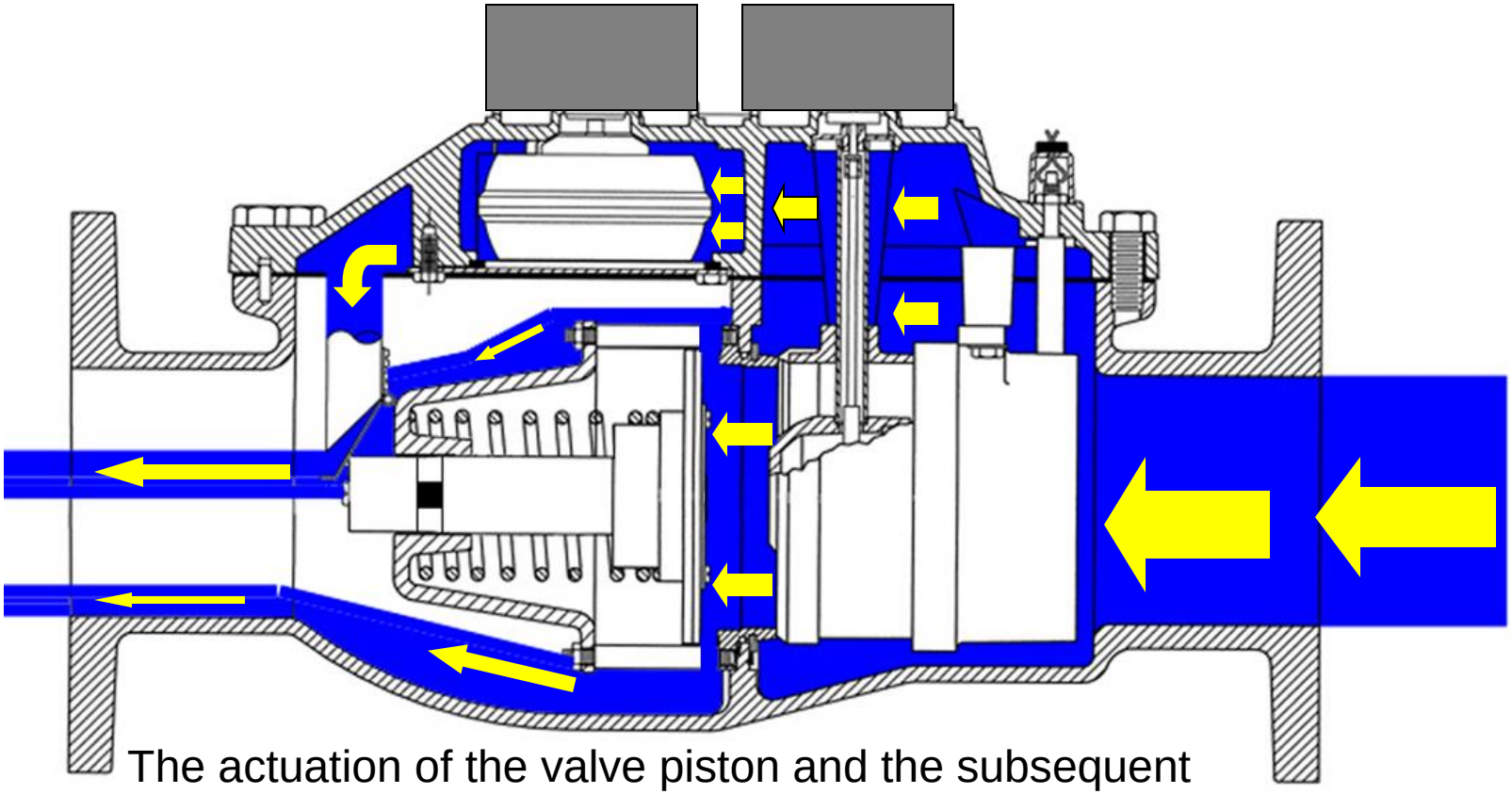
All water is diverted through the cover, into the T-10 chamber and out the throttle tube.

Crossover Imminent



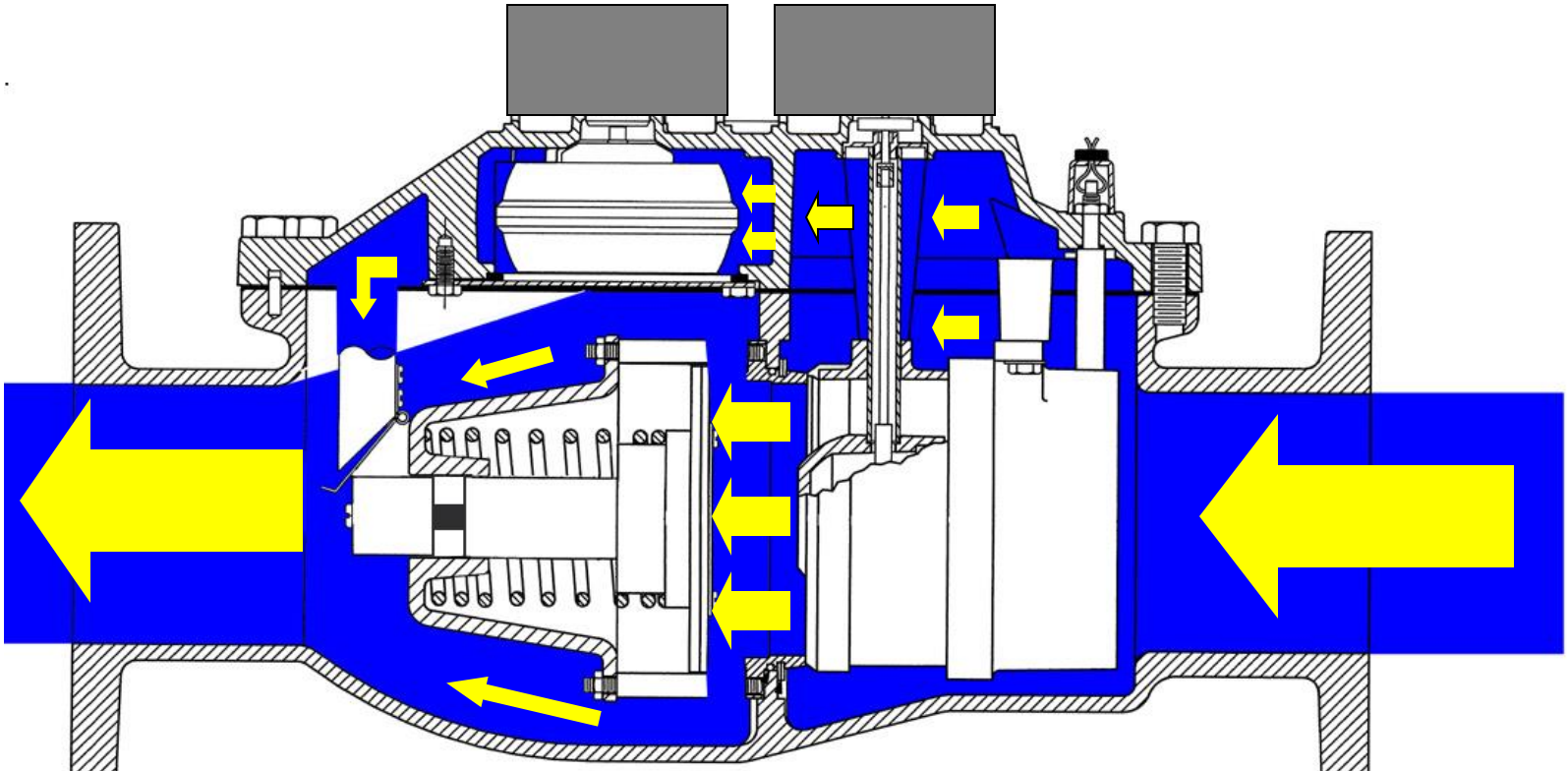
As the flow rate increases, the increased pressure differential causes the valve piston to move rearward, closing the throttle tube door, reducing the flow through the T-10 chamber.

Crossover



The actuation of the valve piston and the subsequent reduction of flow through the T-10 chamber “shunts” a large volume of water through the turbine measuring element forcing the main valve open. Both the turbine and the T-10 are operating.

Intermediate & High Flow



At intermediate and high flow rates, the main valve is fully open and the majority of the water flows through the turbine. Water continues to flow through the T-10 at a greatly reduced rate. This helps “flush” the the T-10 while simultaneously insuring that it does not “over-speed”

Low To High Continuous Flow Rates

- Apartment Buildings
- Motels
- Hotels
- Condominiums
- Mobile Home Parks
- Hospitals
- Schools
- Restaurants
- Dormitories
- Department Stores
- Shopping Malls
- Public Transportation Centers

WHERE PEOPLE LIVE, EAT & PLAY!!

Fire Service Compound

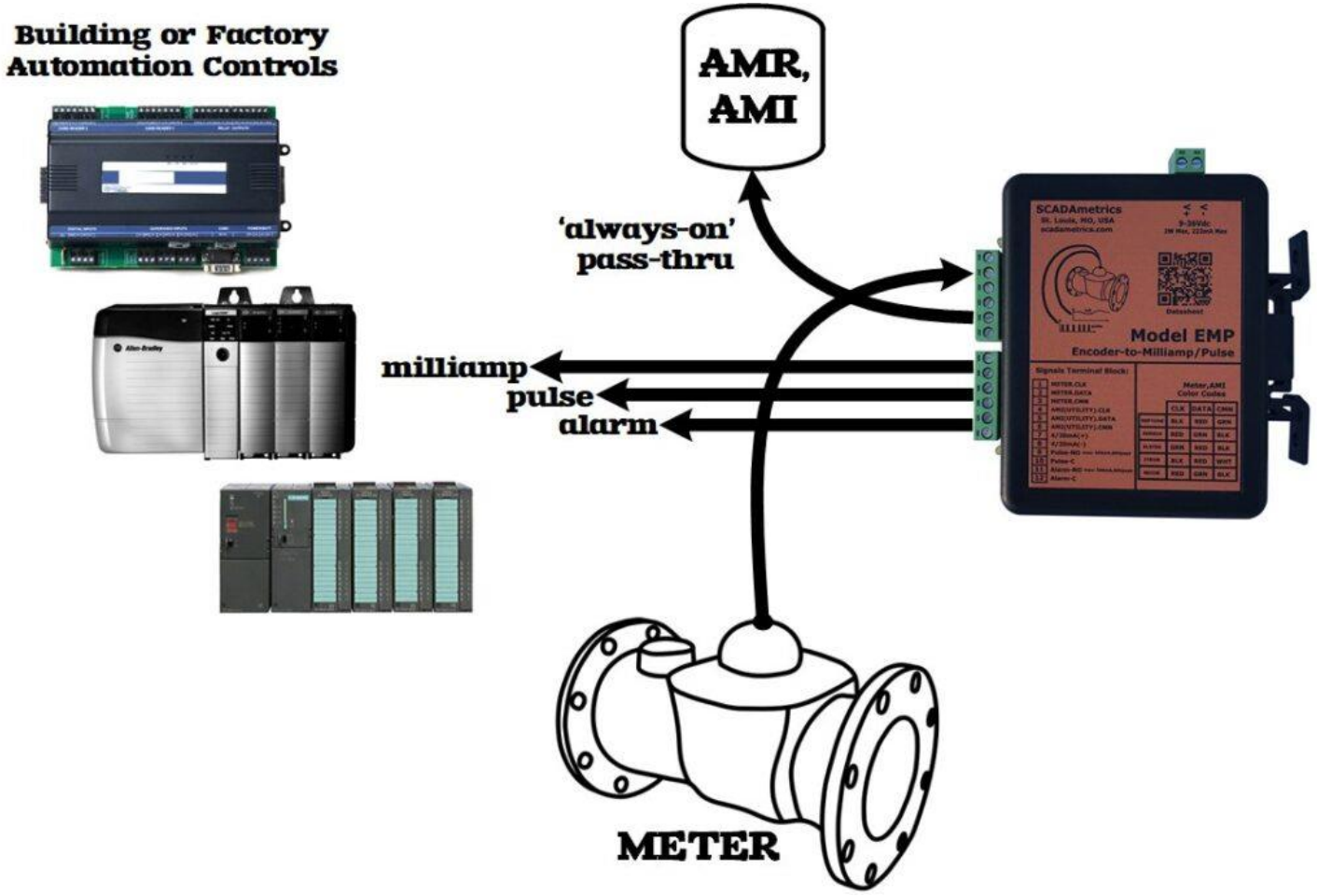
Must be UL/FM Approved

Designated Fire Protection Lines

Any of the HP Turbine or TRU/FLO meter applications that utilize the same service line to provide fire protection

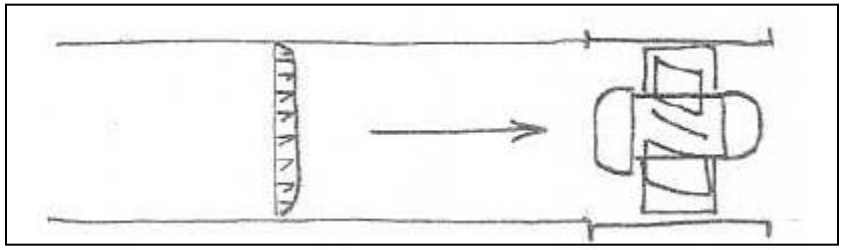
WHERE PEOPLE WORK AND LIVE!!

Scadametrics Signalizer



Correct vs Irregular flows

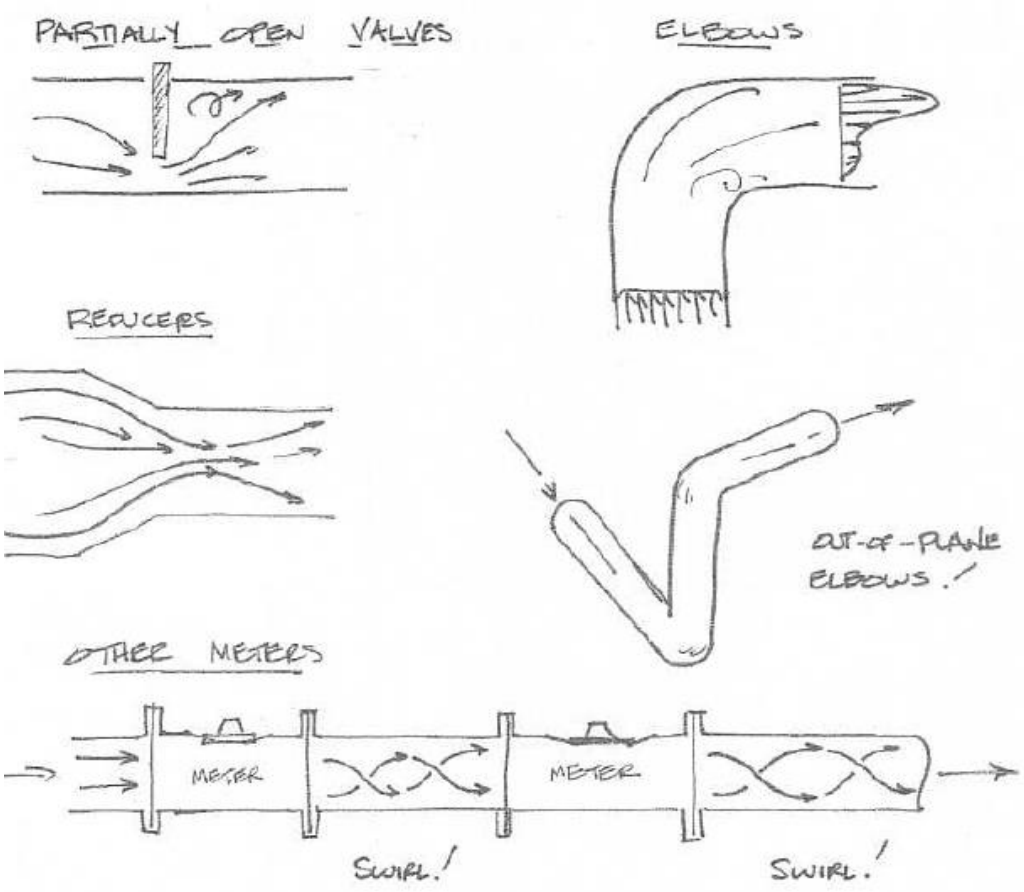
- **For best performance, a turbine meter expects a uniform velocity profile.**
- **No swirl is allowed.**



- **Generally speaking, 8-10 diameters of straight pipe upstream will correct velocity profile, but not always.**
- **This extra length promotes mixing, and helps to eliminate flow irregularities.**

Correct vs Irregular flows

- What causes irregular flows?



- **Generally, any abrupt change in the plumbing is a potential source of flow irregularities.**

Mach 10 Ultrasonic

- Cold Water Measurement
- Velocity Meter
- 5/8” to 12” Sizes
- Flow Range: 0.05 to 8000 GPM
- Ultra Low to High Flow Rates
- Accuracy to within +/- 1.5%
- Low flow accuracy +/- 3%
- Unitized Measuring Element
- Fire Rated!
- No need for a strainer
- Guaranteed Accuracy

Need for Correct Sizing

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Historical "Rule of Thumb":

• 3" meter for 3" pipe

Actual Realization:

• Flow capacity not always dictated by pipe size

• More and more customers use low flow devices - e.g. ULF Toilets = less consumption

• Often consultants recommend larger meters anticipating future growth which never occurs

• Buildings/facilities no longer used for original intentions - e.g. processing plant now converted to office space

Sizing Guide Background

- Developed in the late 1980's by the AWWA
- Dedicated 1 person in utility to collect data full time
- Used data logger
- Collected 5 year's worth of data
- Corrected sizing in many cases - e.g. 2" PD on 6" pipe
- Findings - correct sizing contributed in 2 major ways:
    - Increased annual revenue
    - Decreased annual capital expenditures

Sizing Meters

- ALWAYS based on flow requirements
- Not based on pipe size
- AWWA M22 New Edition “Sizing Water Service Lines and Meters”
- Based on peak demand
  - Pressures
  - Type of customer
  - Fixture values
  - Continuous use demand
- Requirements can change over time

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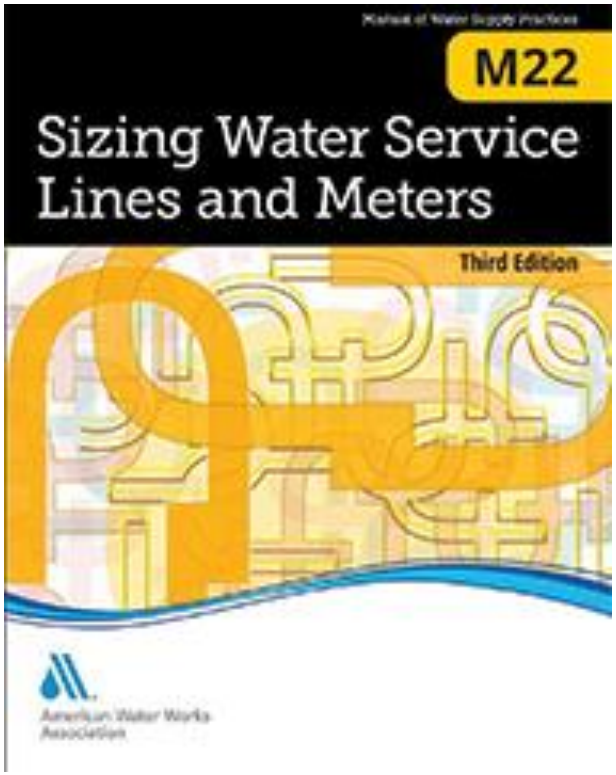
Sizing Water Service Lines and Meters (M22), Third Edition

This operations manual will guide engineers, architects, designers, and technicians in accurately sizing customer water service lines and water meters. Coverage includes estimating consumer water flows, peak water demands, demand profiling, metering equipment, and procedures for calculating service lines and meters for optimum water revenue and lowest service cost. Numerous tables and sample calculations included.

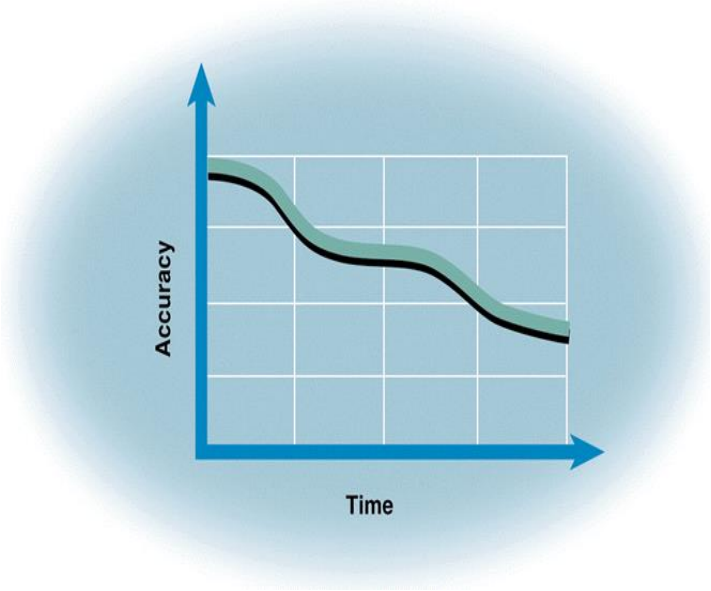


NEPTUNE.

SEER PROGRAM

Revenue vs Loss Analysis

SEER PROGRAM



Results:

lost revenue for the utility

OR

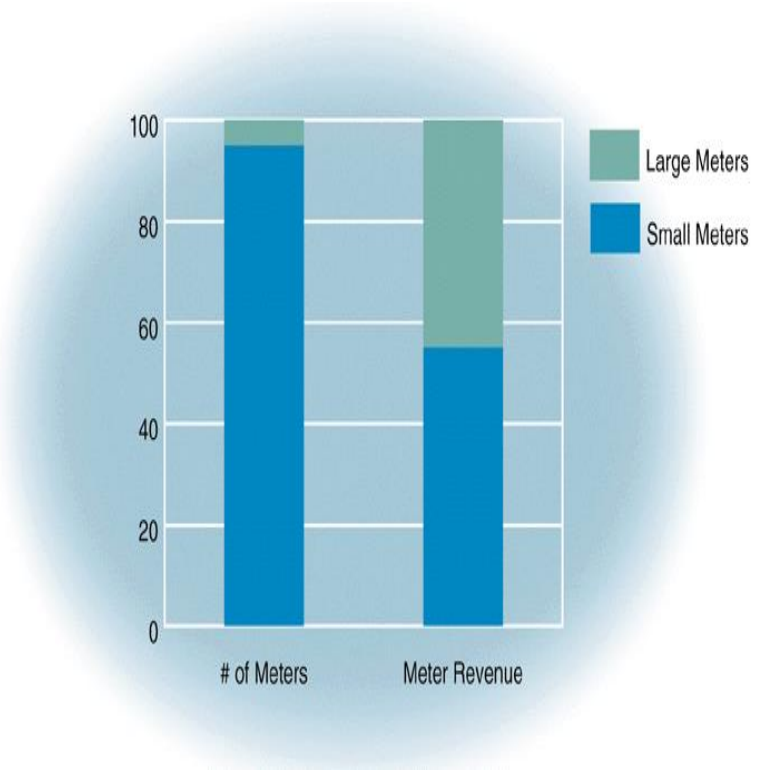
higher rates to recover losses

SEER PROGRAM

Focus on the Commercial and Industrial Meters

Often, less than 5% of a utility's meters generate more than 40% of the revenue

	C&I Accounts	C&I % Sales
Hartford, CT	6%	54%
Springfield, MA	8%	57%



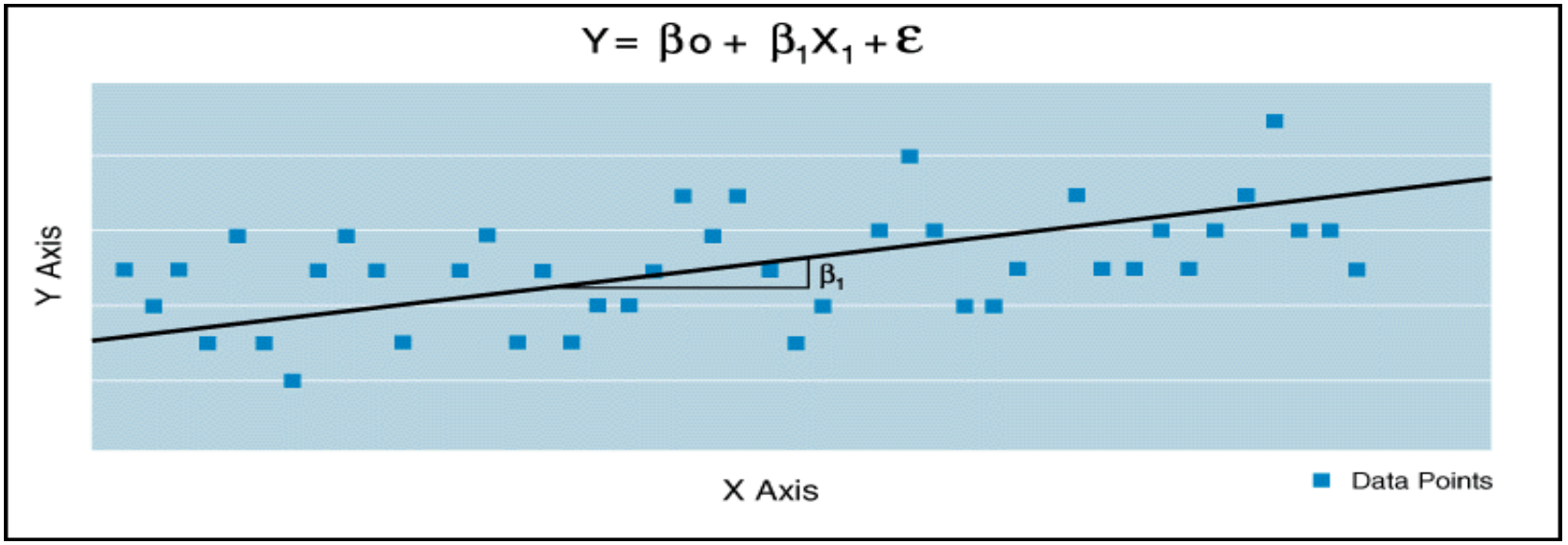
SEER PROGRAM

SEER™ Software

Based on over 10,000 large meter tests

Multiple linear regression

Developed and patented by Neptune



SEER PROGRAM

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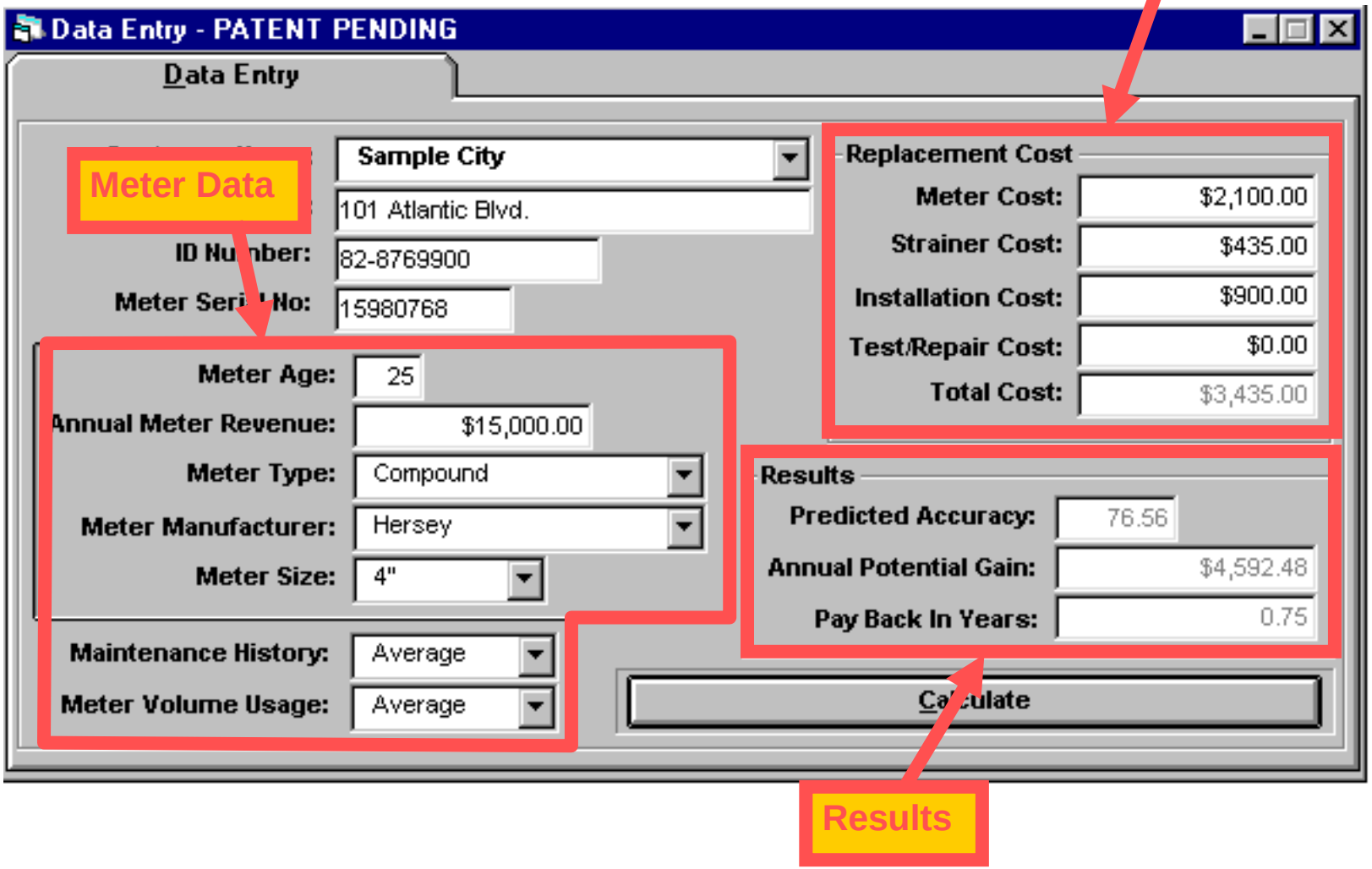
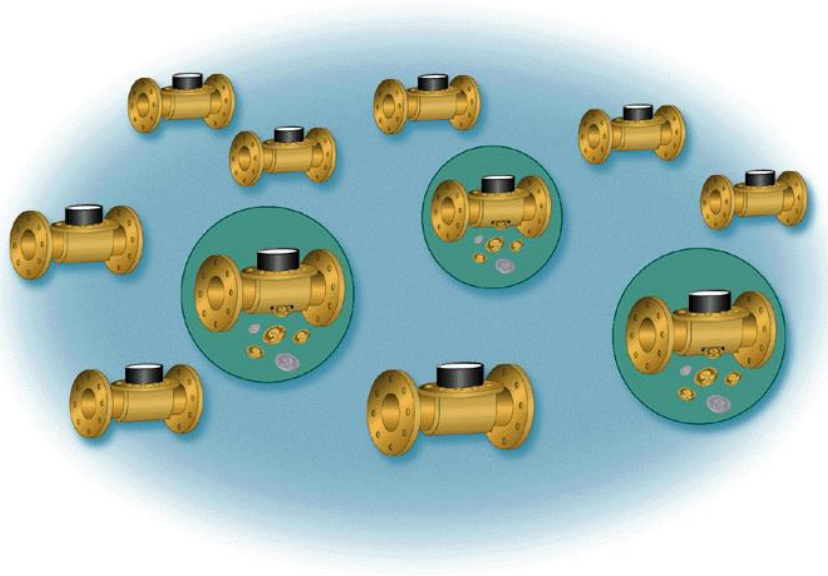


SEER PROGRAM

SEER™ Software
Identifies which meters need attention

Establishes priorities based on revenue gain and payback

Allows utilities to implement targeted revenue enhancement programs



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Questions & Discussion

NEPTUNE TECHNOLOGY GROUP INC.

Take Control.

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Understanding AMR/AMI Meter Reading Technology

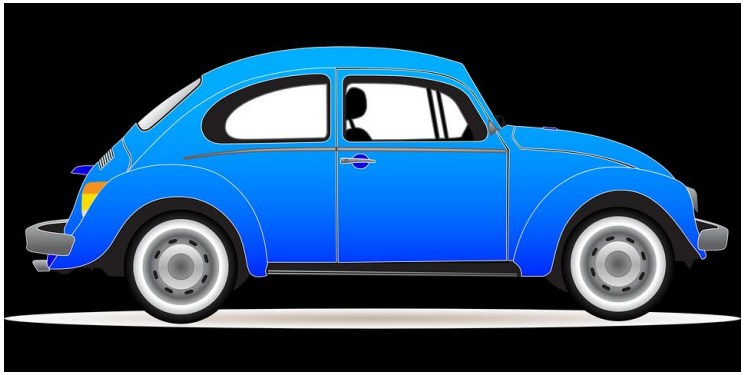
AMR vs AMI

- **AMR – Automated Meter Reading**

- **AMI – Advanced Metering Infrastructure**

AMR vs AMI

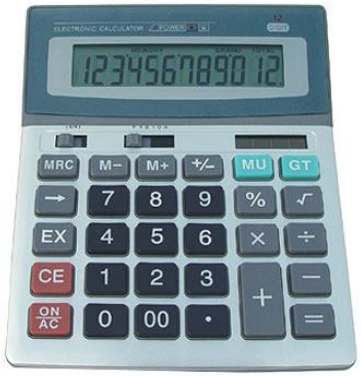
- **AMR – Easy Data Entry**



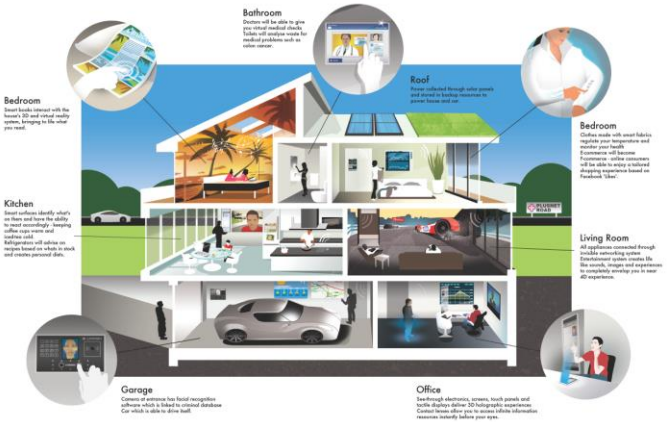
- **AMI – Using Data for a Purpose**

AMR vs AMI

- **AMR** – Automated Meter Reading



- **AMI** - Advanced Metering Infrastructure



The Evolution of AMR

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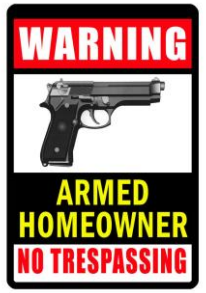
AMR Market Drivers

- Meter reading cost and time
  - Repeated Trips
  - Access to Meter
  - Vehicle Costs
- Meter reading safety
  - Dogs
  - People
  - Weather
  - Driving
- Liability insurance
- Hard-to-Read meters



AMR Market Drivers

- **Aging infrastructure**
  - Main maintenance
  - Fire hydrant maintenance
  - Distribution System Tampering
- **Customer Service**
  - Eliminate estimated reads
  - High water bill complaints
  - Excessive water use
  - Higher customer expectations
- **Department Efficiency**
  - What else needs attention?
  - Total Operating Budget
    - Man Hours
    - Vehicle Maintenance
- **Increase Cash Flow**
  - Shorten billing cycle

The Evolution of AMR

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Paradigm Shift in Metering
– From Data to Valuable Information

Manual

- Labor intensive
- Unsafe for meter readers
- Unscheduled/special reads cost ineffective
- Customer intrusive
- Error potential is very high

Touch

- Cost ineffective for more than monthly read
- Potentially unsafe
- Minimal automation
- Customer intrusive

Mobile RF

- Enables cost-effective monthly reads
- Faster meter reading and collection
- Reduced labor costs
- Unscheduled/special reads cost ineffective

Fixed-Network

- Revenue Enhancement
- Eliminates Estimated Reads
- Daily Leak Detection
- Daily Theft Detection
- Interval Metering for Usage Profiling
- Customized Value-added Services
- One –way or Two-way capabilities

Remember This?

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COLD WEATHER

AMR and AMI Overlap Somewhat

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AMR

- Basic Meter
- Electronic Meter
- Intelligent Meter
- Smart Meter
- Remote Shut-Off Valves
- Leak Detecting Sensors
- Pressure Sensors

AMI

- Basic Meter
- Electronic Meter
- Intelligent Meter
- Smart Meter
- Remote Shut-Off Valves
- Leak Detecting Sensors
- Pressure Sensors

Benefits of AMR/AMI

Leak Detection
Daily reception of E-Coder® leak intermittent and continuous leak flags

Customer Service
Easily accessed and daily reading data allows utilities to improve customer service and resolve billing disputes

Off-Cycle Reads
Daily readings from the Gateway are available to support off-cycle readings without rolling a truck, saving time and money

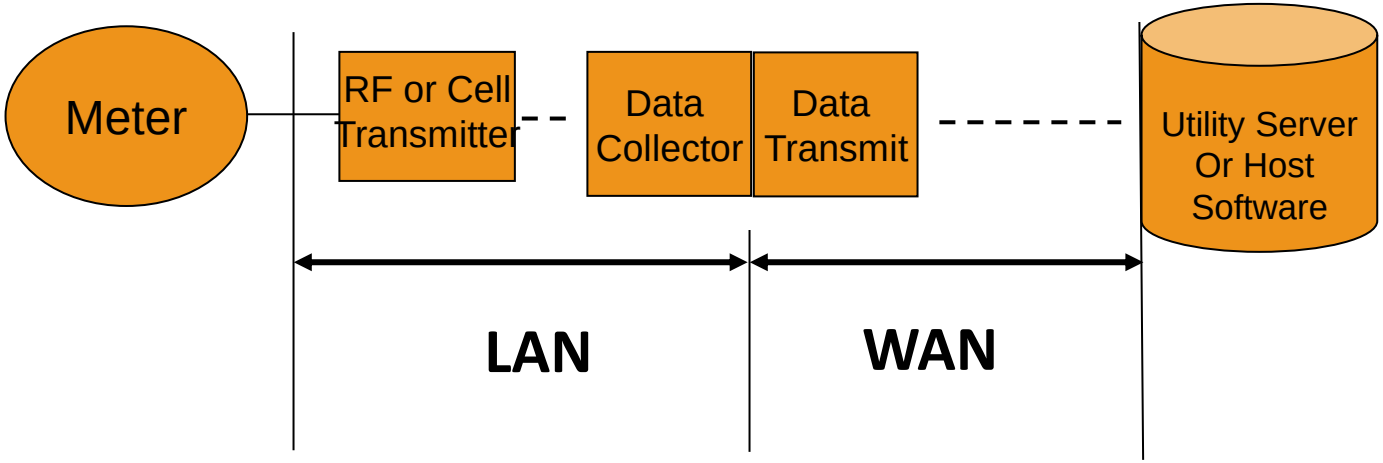
Reverse Flow Monitoring
Daily access to E-CoderPLUS flags provides continuous reverse flow monitoring 24 hours per day

Tamper Detection
Advanced E-CoderPLUS tamper detection provided daily to the Gateway

Usage Profile Analysis
Data received by the R900® Gateway allows a utility to provide more data to industrial/commercial customers so that those customers can manage usage

AMI Fixed Base System Architecture

- Readings Collected from Meter via RF or Cellular Transmission
- R900 or 450-470MHz Licensed Band or 2G/3G/4G LTE
- Full data transmission
- Multiple Backhaul Options
- Server Based or Hosted



Fixed Network vs AMI

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Types of AMI Systems

- Tower Based
  - Collector antennas placed strategically throughout the reading area for total collection
  - Normally located on water towers, tall buildings and antenna towers
  - Power Limits

AMI FixedBase - RF Collector

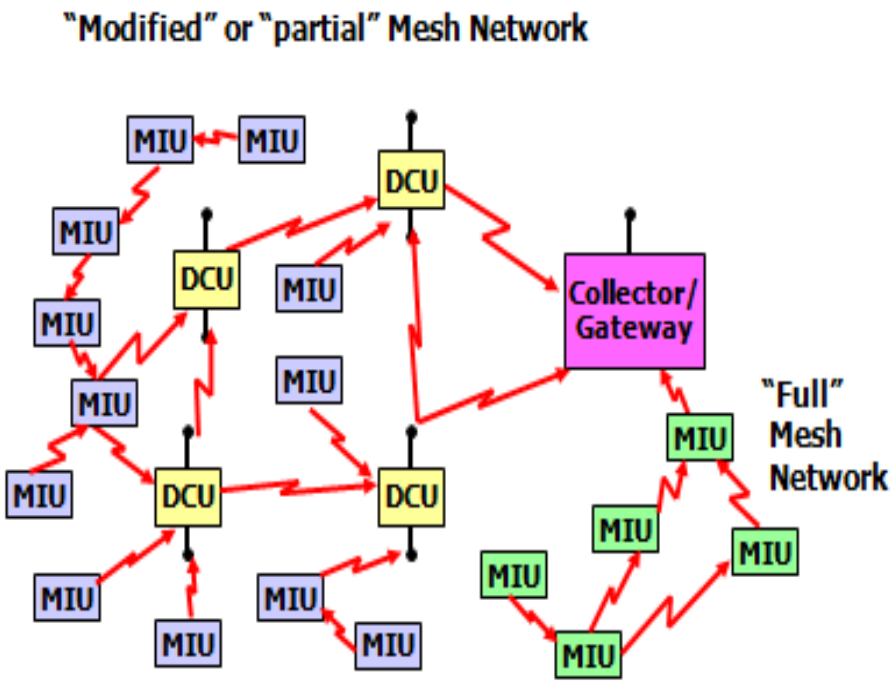
- Tower-based system
  - ≥ 150 feet preferred antenna height
  - Collectors can be located on rooftops of buildings, or telephone poles (lower heights reduce coverage area)
- Antenna is mounted on the top of the tower
- Data collector is mounted at the base of the tower
- 110 V power requirement
- 2G/3G/4G LTE modem standard (Ethernet, Wi-Fi backhauls are optional)

Benefits

- **Reduced number of collectors**
- **Ease of access to equipment**
- **Lower maintenance costs**
- **Buy it and let it run**

Types of AMI Systems

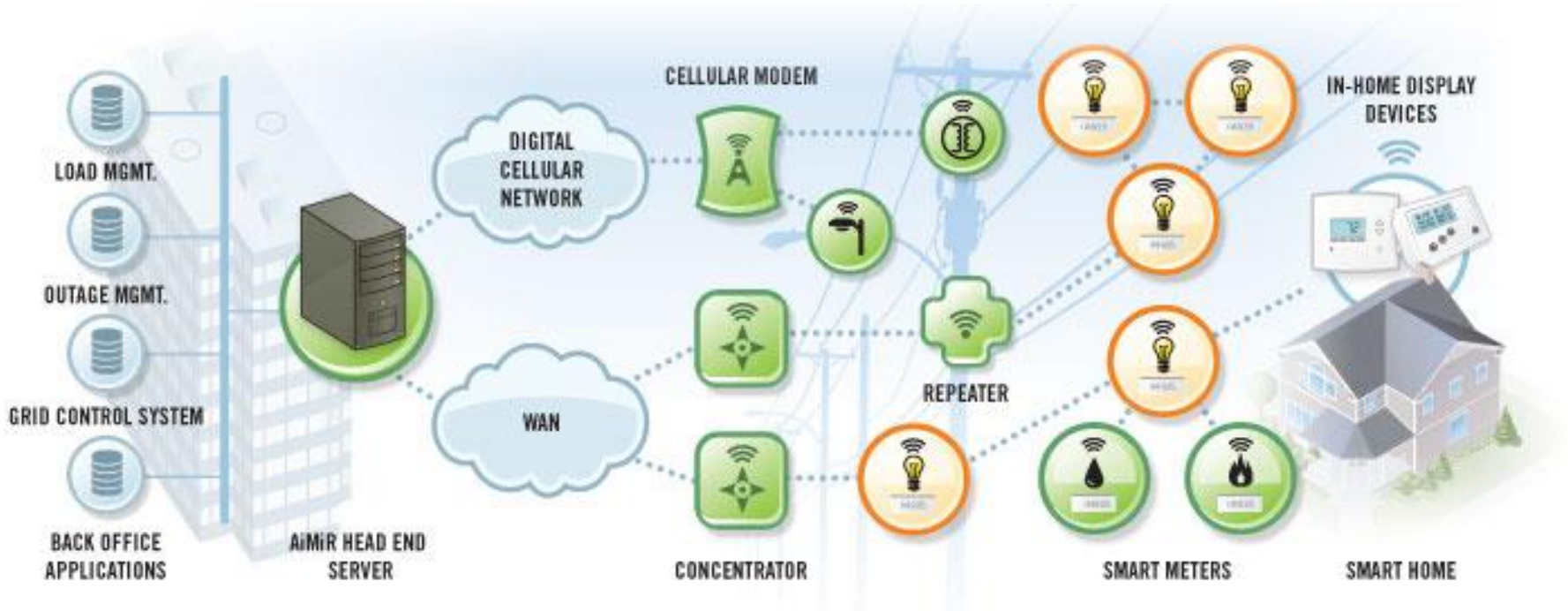
- Mesh Network
  - Relaying data information from one unit to another to relay the readings to the host computer.
  - The individual units gather their own data but also pass other data



Types of AMI Systems

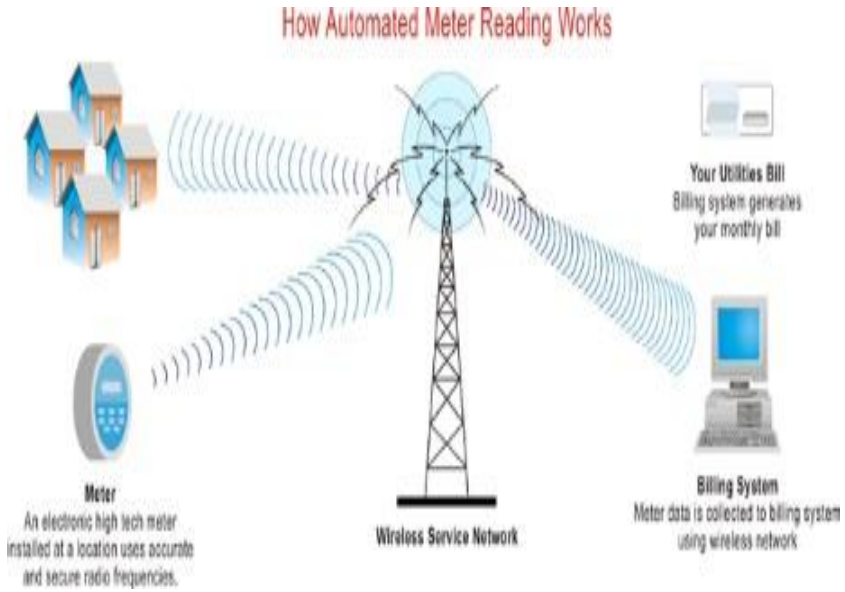
- Combined Network

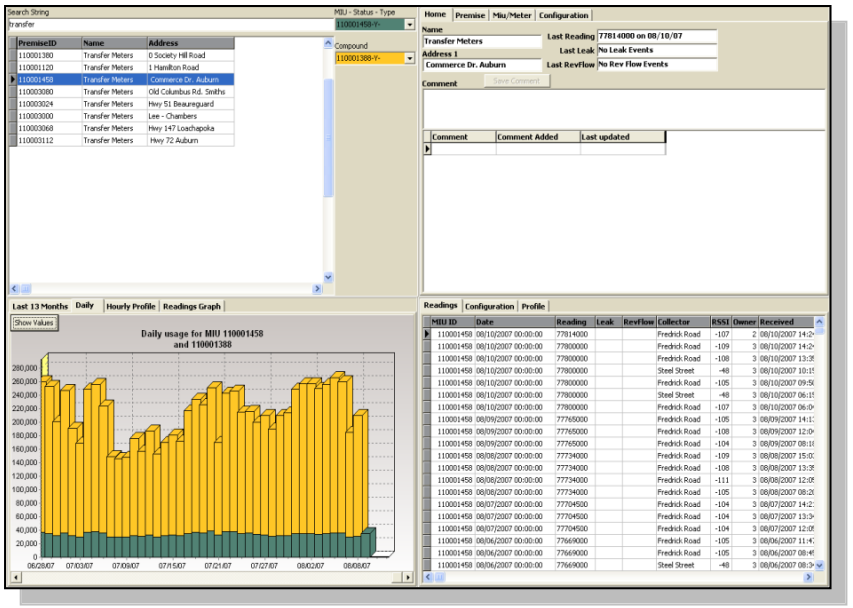
  Relaying data information from one unit to another
  to a tower to the host computer.



AMR & AMI Provide Two Major Benefits

- Meter Reading Improvement
- Better Data





AMI offers more than reading the meter: It's all about the Data

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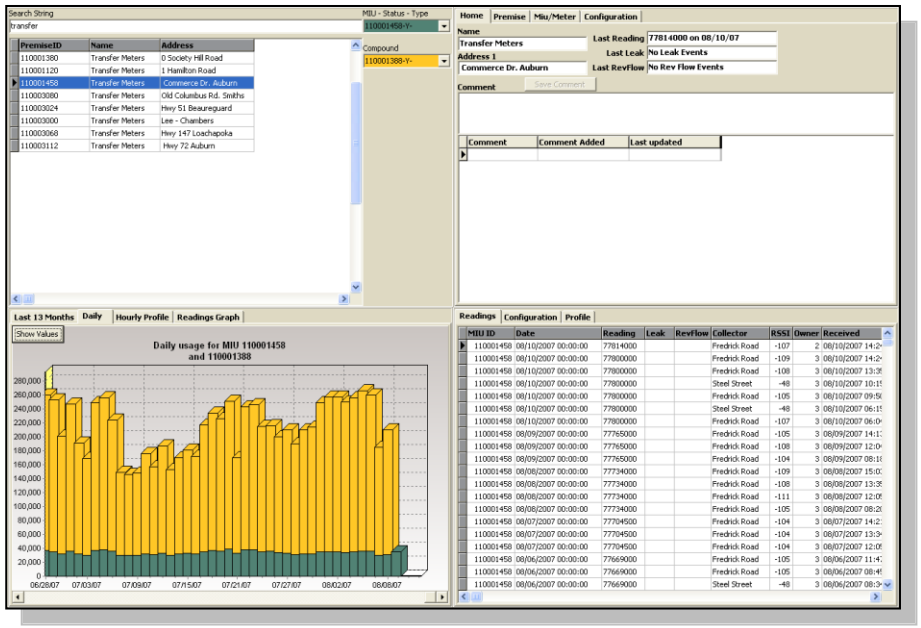
- Precise consumption information
- Clear and accurate billing
- Automatic leak notification
- Better & Faster Customer Service
- Billing disputes are resolved faster because of better information
- Flag potential high consumption before customers get the high bill



Improving AMI System Operations

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- Meter selection and accuracy
- Non-Revenue Water Evaluation
- System Leak Monitoring
- System Backflow
- System Pressure
- Water Quality Monitoring

Smart Meters

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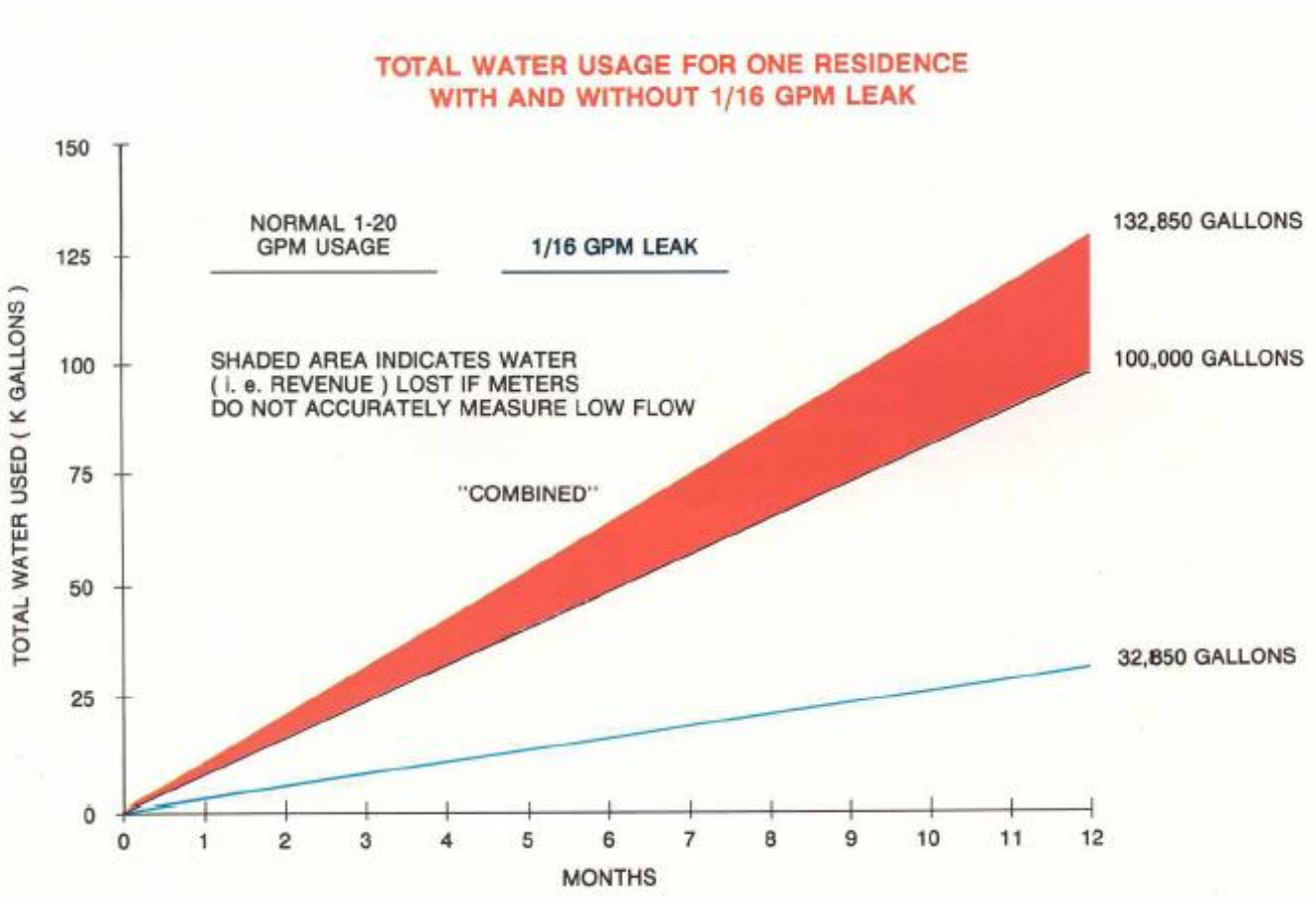
- **Higher Resolution**
- **Leak Detection**
- **Reverse flow Detection**
- **Tamper Detection**
- **Data Logging**

- **Actionable Information**
- **Improved Customer Service**
- **More Information to you**

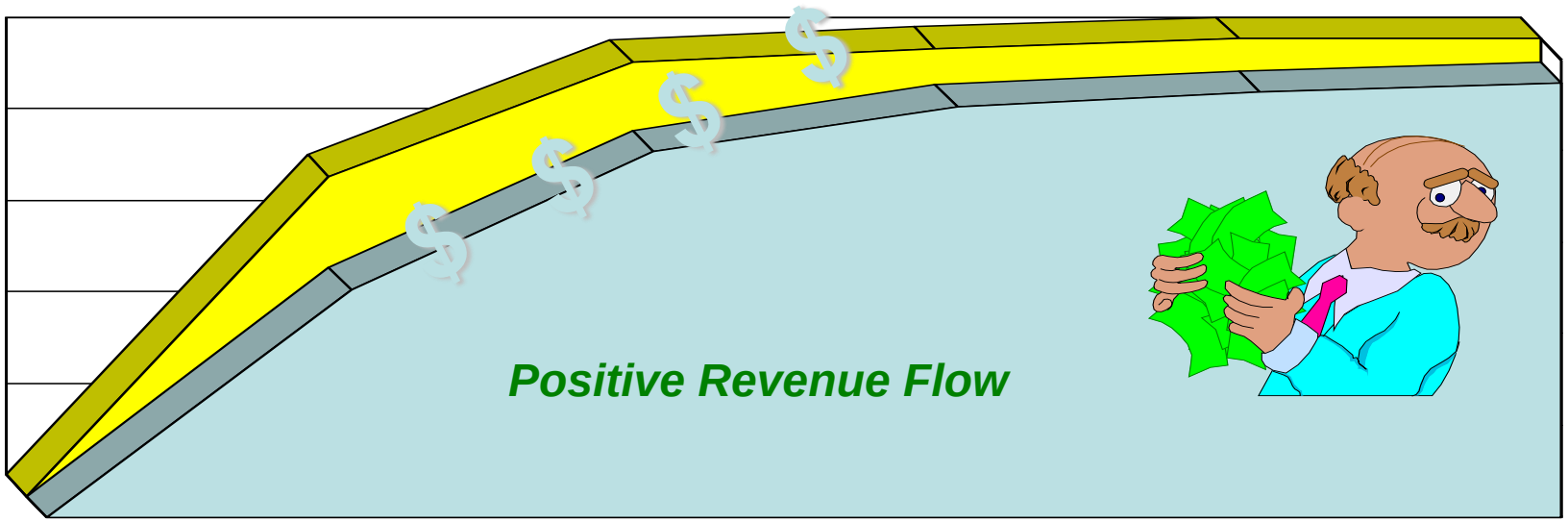
The affects of 1/16 gpm leak

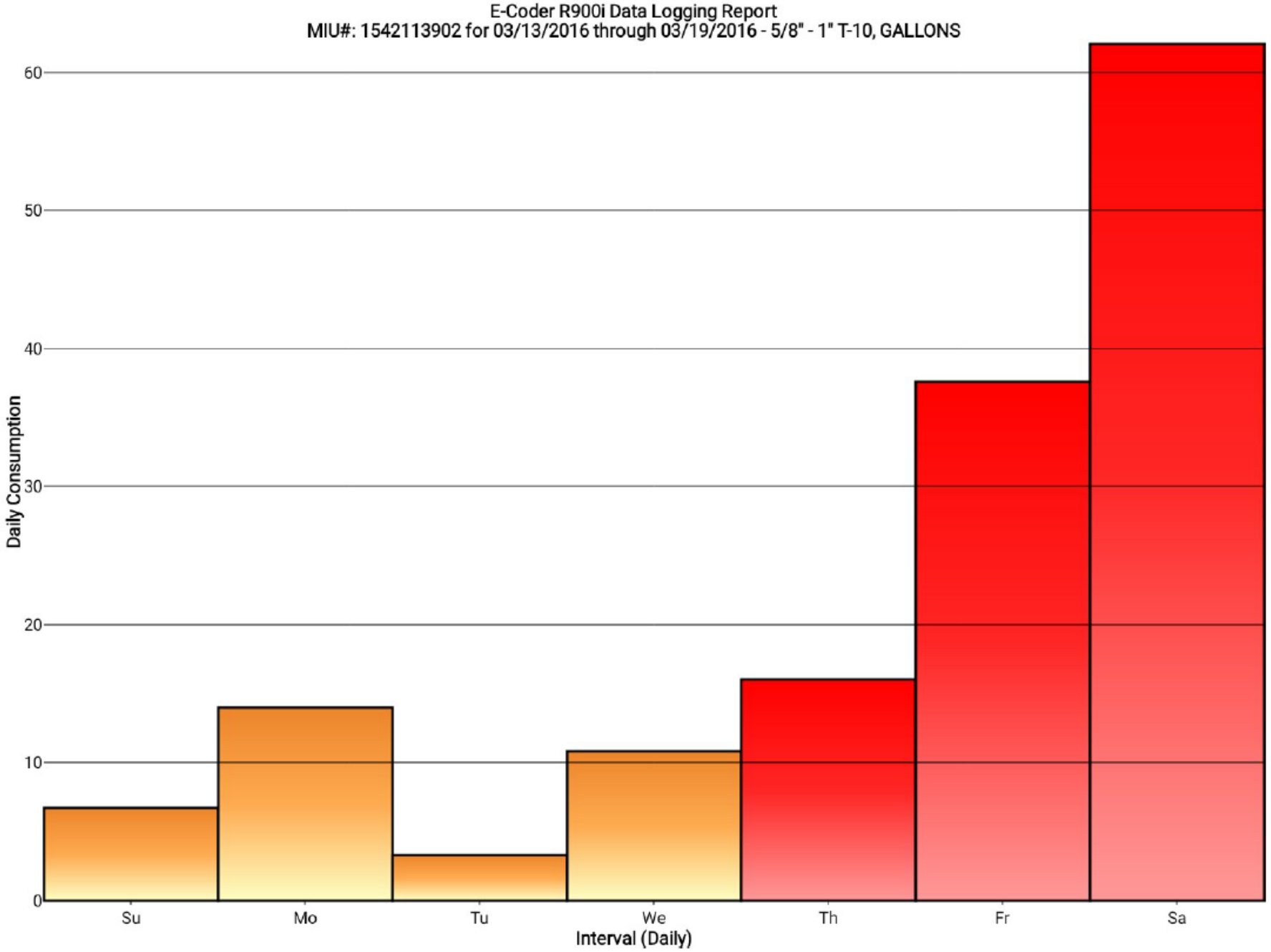
Summary

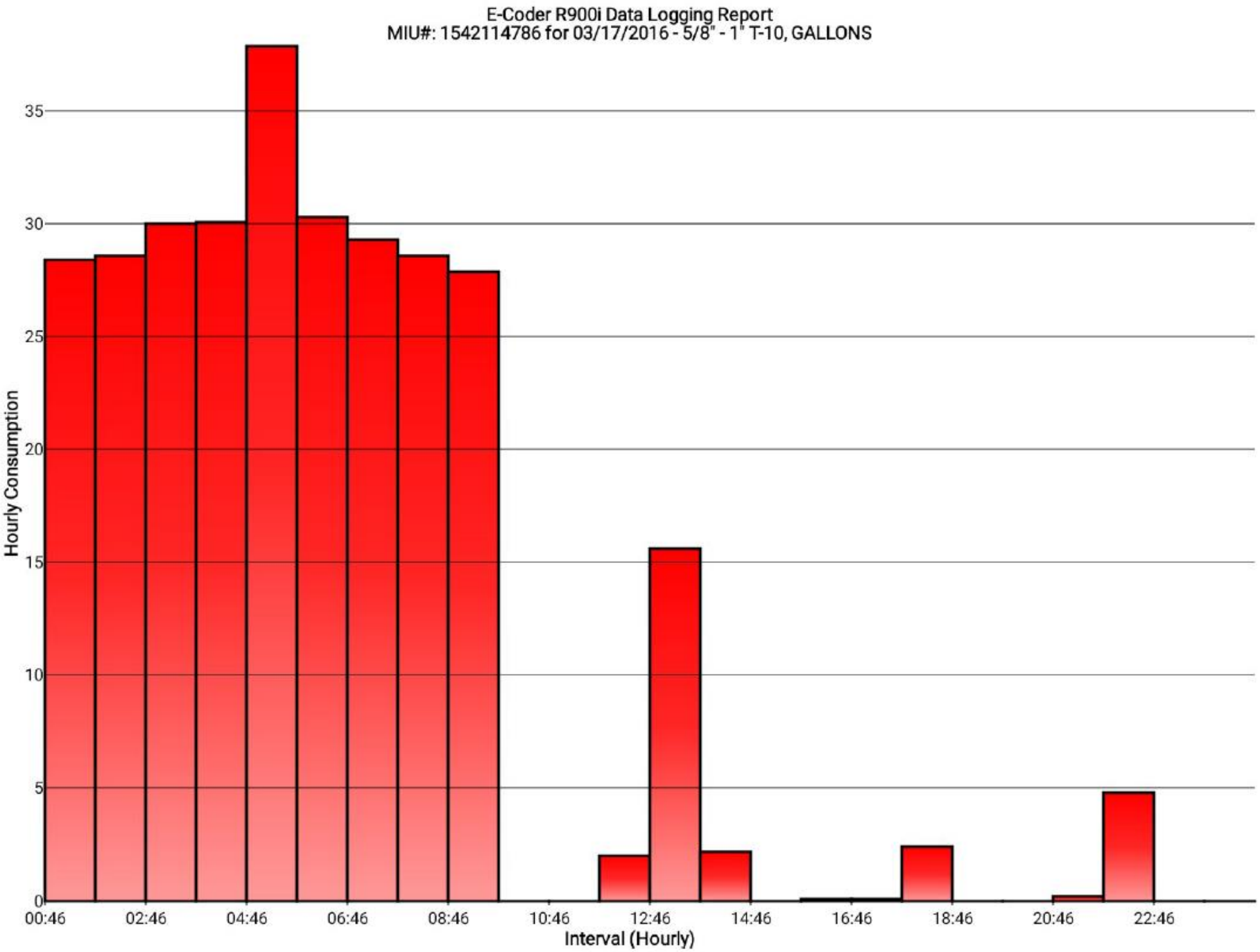
- Average household water usage is 100,000 gallons
- 1/16 gpm leak would equal 32,850 gallons of water per year
- 1/16 gpm water leak amounts to 30% more water consumed



Size	AWWA Low	T-10 Low	AWWA Normal
5/8"	95% @ 1/4 GPM	95% @ 1/8 GPM	± 1.5 % @ 1-20 GPM
3/4"	95% @ 1/2 GPM	95% @ 1/4 GPM	± 1.5 % @ 2-30 GPM
1"	95% @ 3/4 GPM	95% @ 3/8 GPM	± 1.5 % @ 3-50 GPM
1-1/2”	95% @ 1-1/2 GPM	95% @ 3/4 GPM	± 1.5 % @ 5-100 GPM
2”	95% @ 2 GPM	95% @ 1 GPM	± 1.5 % @ 8-160 GPM

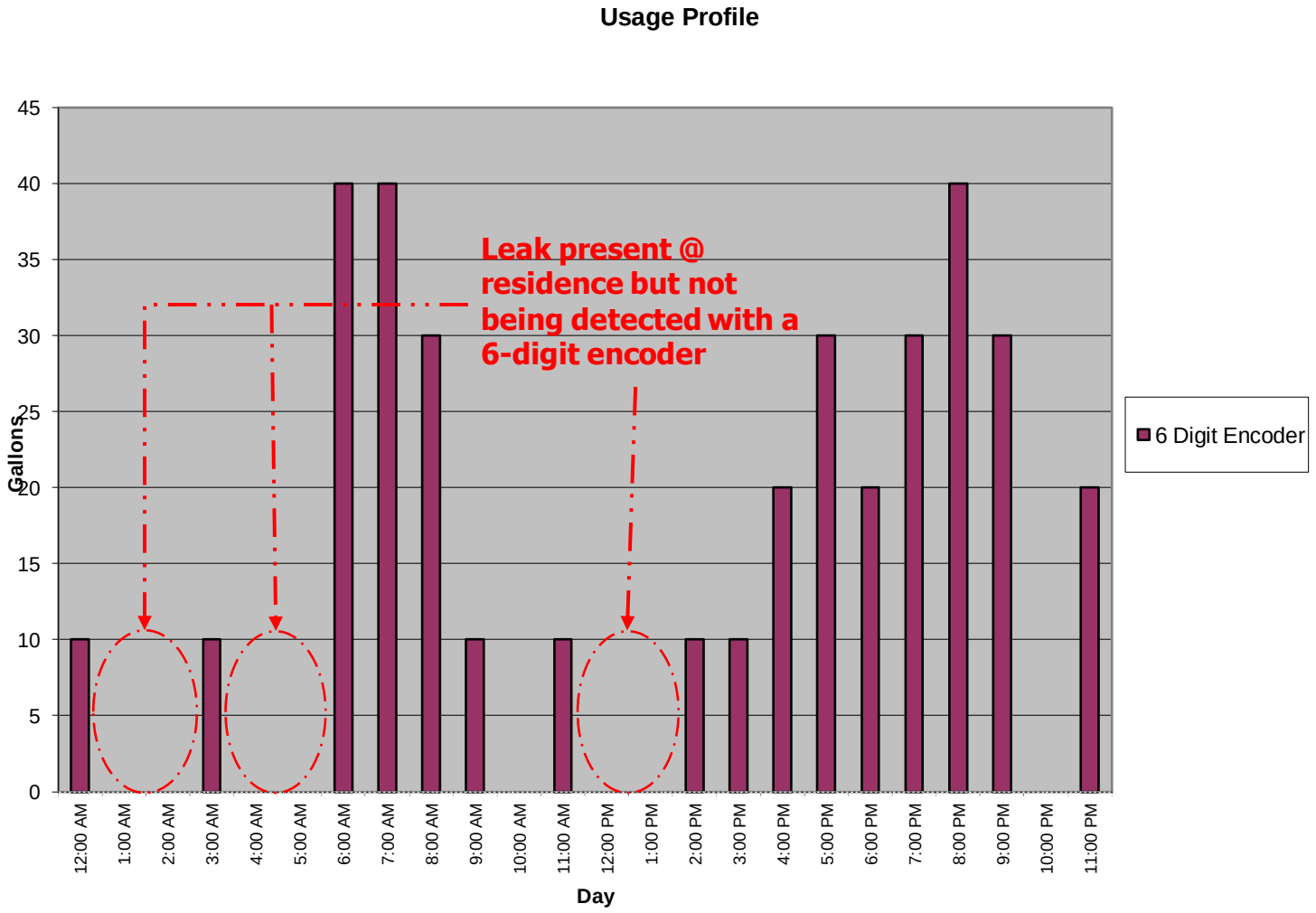



E-Coder R900i Data Logging Report
MIU#: 1542113902 for 03/13/2016 through 03/19/2016 - 5/8" - 1" T-10, GALLONS
60
50
40
30
20
10
0
Daily Consumption
Su
Mo
Tu
We
Th
Fr
Sa
Interval (Daily)


E-Coder R900i Data Logging Report
MIU#: 1542114786 for 03/17/2016 - 5/8" - 1" T-10, GALLONS
Hourly Consumption
0
5
10
15
20
25
30
35
00:46
02:46
04:46
06:46
08:46
10:46
12:46
14:46
16:46
18:46
20:46
22:46
Interval (Hourly)

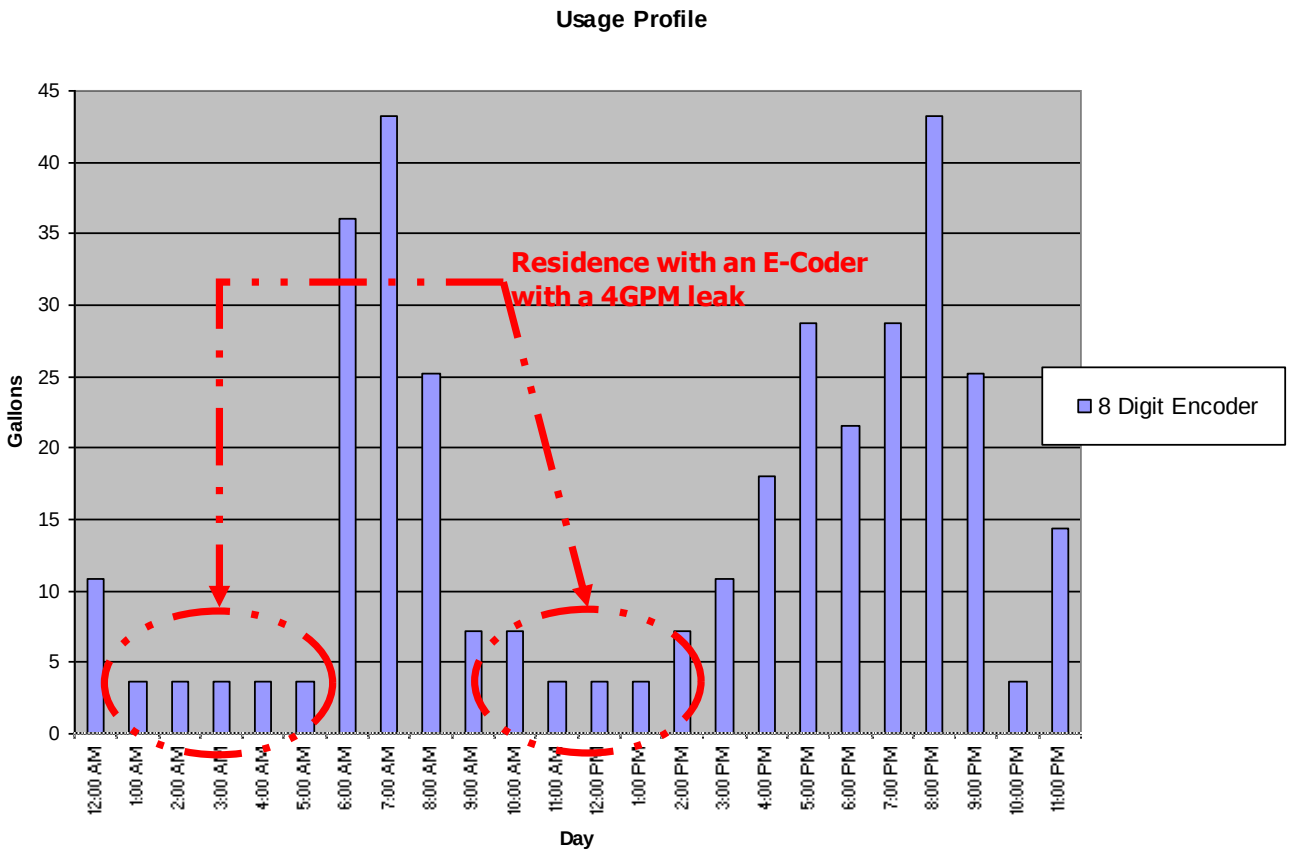
Leak Detection without High Resolution

- Undetected leak standard with 6-digit resolution



E-Coder 8-digit Resolution

- **8 Digit Resolution = 1/100 GPM**
- **True Leak Detection Demands High Resolution**



The Need for High Resolution

Meter Application	Conventional Encoder		Solid State E-Coder	
	Visual	Remote	Visual	Remote
Residential *(5/8" – 1" T-10)*	0.1 cubic foot	1 cubic foot	0.001 cubic feet	0.01 cubic feet
Light C&I *(1½" & 2" T-10; 1½" – 4" HTP)*	1 cubic foot	10 cubic feet	0.01 cubic feet	0.1 cubic feet
Large C&I *(6" – 20" HPT, HPPIII, & TF)*	10 cubic feet	100 cubic feet	0.1 cubic feet	1 cubic foot

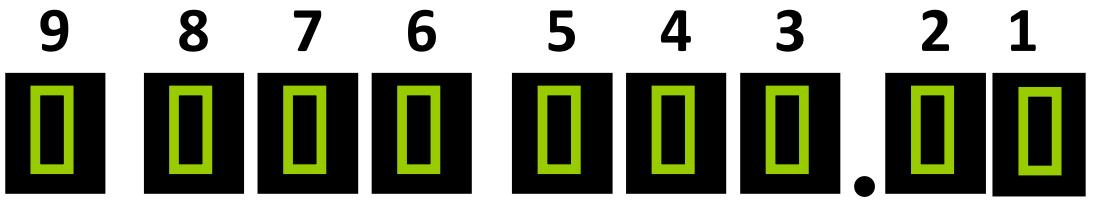
High Resolution = High Value

Encoder Comparison

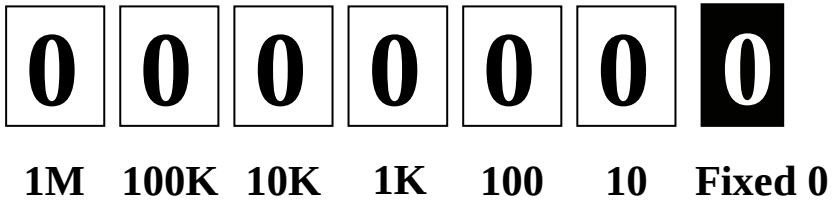
Typical Residential Register

E-Coder

9-digit



Typical
6-wheel



Smart Encoder: Value Throughout the Utility

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General Management

- Accurate bills
- Proactive water leak notification
- Financial accountability
- Resource conservation

Customer Service

- Improved operational efficiency
- High water bill complaint resolution

Finance

- Increased cash flow
- Reduced unaccounted-for-water
- Improved bottom line

Meter Reading Department

- Encoder technology
- Guaranteed accurate readings

Maintenance

- Service order reduction – leaks, tamper, backflow
- Enhanced trouble-shooting tools

How Do Daily Meter Readings Benefit Customer Service?

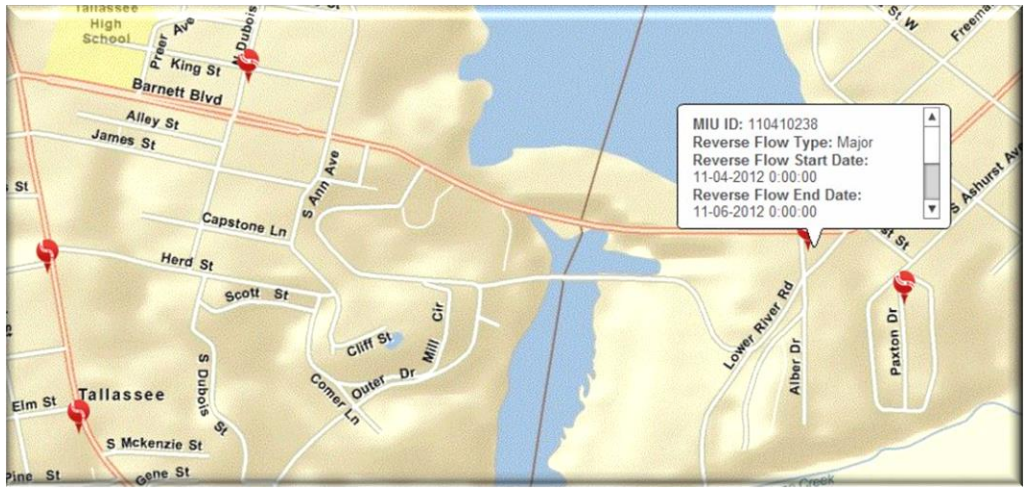
- Example
- 10,000 meter Utility
- Currently reading monthly – 9,000 x 12 months =
- 120,000 reading/per year

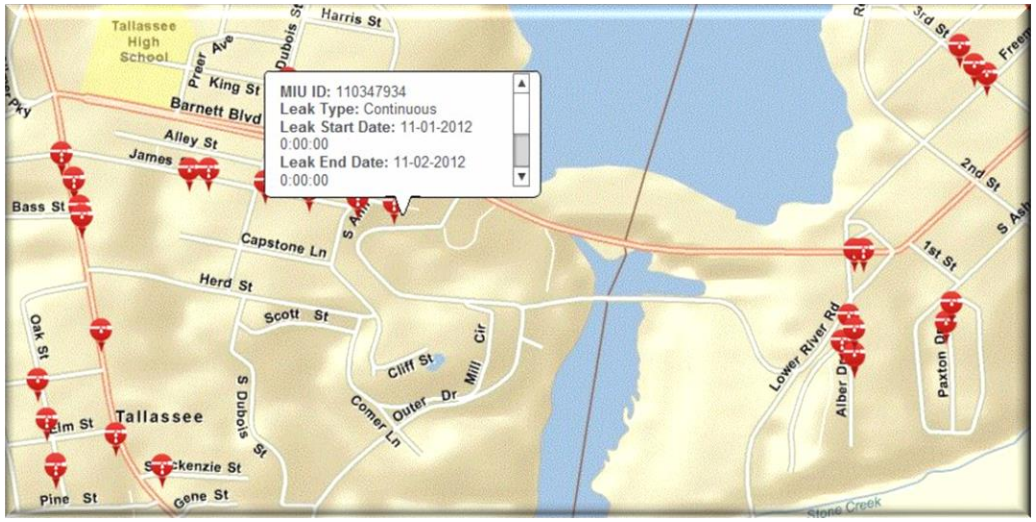
- With AMI Customer Service will have hourly meter reading data
- One customer - 8,760 meter readings/per year
- All customers - 87,600,000 meter readings/per year

Mapping

- Identify areas of concern or interest such as:

- Leak
- Reverse Flow
- Zero Consumption
- Soft-Disconnect
- Not Heard From
- Major Reverse Flows





- Missed
- Inactive with Usage
- Collector Types
- Collector Status
- All Endpoints
- Continuous Leaks
- Endpoint Groups

Things to Consider

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- Evaluate what type of system works best in for YOUR Utility
- What is the total real cost? Up-front and long-term
- Review a long-range plan with various departments (Distribution, Customer Service, IT)
- Determine if you want to use the existing assets (meters & existing mobile RF) or replace everything
- Compare the system offerings & weigh Pros and Cons
- Communicate with other Utilities who have systems installed
- Determine if you have personnel to evaluate the additional data

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QUESTIONS?

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Thank You for Your Time and Attention!

Kelly Byrd
NECO