FUNDAMENTALS OF LEAK DETECTION

Where is the leak?

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American Leak Detection

PNWS-AWWA Tacoma, WA May 2010

Fundamentals of Leak Detection

- Introduction and Overview
- Unaccounted for Water **Recent Changes!**
- Discussion of newest WA Regs
- Water Audit
- Leak Detection Characteristics
- Equipment Needed

Fundamentals of Leak Detection

- Factors and Equipment Choices
- “Leak Plan” for Testing
- Variables in Detection
- Practical Applications

Overview of
New WA Regs
Relevant to Leak Detection

UAW

WHAT IS IT?

(NOT UNITED AUTO WORKERS)

NOW BECOMES -

WUE

WATER USE EFFICIENCY in WA

WUE

Water Use Efficiency

WA State Requirements

- Set goals to use water efficiently
- Planning requirements
- Meter Installation
- Leakage standard
- Annual performance report

Leakage Formula

Percent DSL = [(TP – AC) / (TP)] x 100

DSL = % of distribution system leakage

TP = Total Water Produced & Purchased

AC = Authorized Consumption

Leakage Formula

Percent DSL = [(TP – AC) / (TP)] x 100

[(100,000 – 75,000)] / (100,000) x 100 = % DSL

25,000 / 100,000 = .025 x 100 = 25%

DSL = % of distribution system leakage
TP = Total Water Produced & Purchased
AC = Authorized Consumption

Ways to Comply with Leakage Standard

- 10% or less
- Numerical standard for alternative methods, (if published method)
- Develop & implement Water Loss Control Action Plan
- 20% or less if less than 500 connections

Water Loss Control Action Plan

- Show efforts to reduce water loss with control methods in place
- Show schedule to reach goals
- Budget to implement the plan
- List technical or economical issues that prevent compliance

If Present Loss is 11-19%

- Requires Quick Action
- Assess data accuracy
- Reconfirm methods

If Present Leakage is 20-29%

- Handle issue within 12 months
- Assess data accuracy
- Reconfirm methods
- Implement field activities

If Present Leakage is 30% or Greater

- Handle issue within 6 months
- Assess data accuracy
- Reconfirm methods
- Implement field activities & distribution system leak control methods

Various Methods of Control

- Conduct Water Audit
- Conduct Leak Detection Survey
- Repair Leaks and Storage Tanks
- Install, calibrate or replace meters

Distribution System Leakage

- Leaks contribute approximately 40% of a utility's
- (In most cases only 15% of these leaks will ever surface.)
- Additionally water meters contribute 30%
- 30% Loss through other causes.

Water Loss and Leak Detection

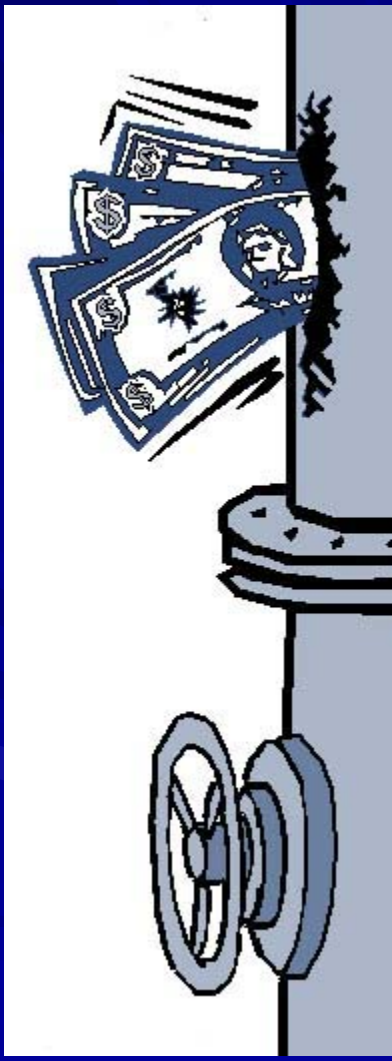
- Almost every water system has a problem with water loss. When water is under pressure in miles of buried pipes, you can be sure that water will be lost somewhere.
- Sometimes it is easy to find the reasons for water loss, and other times it can be very difficult.
- This training will give you ways of locating unaccounted for water loss and its benefits.

What are the types of water loss?

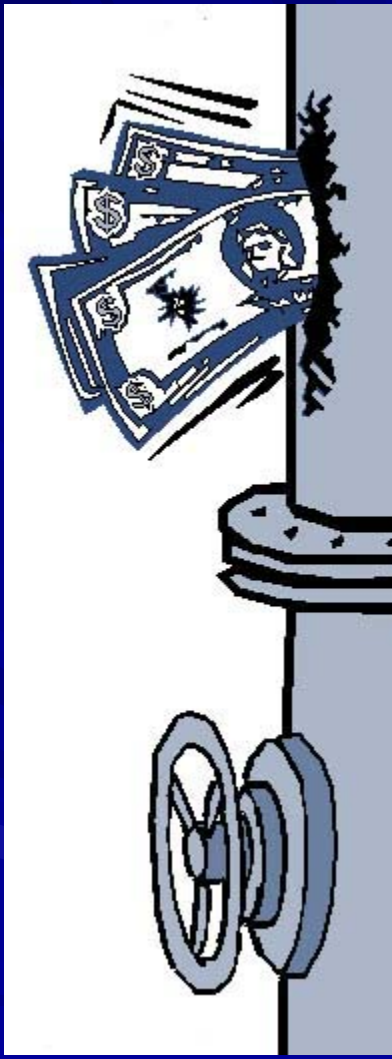
- Water loss is un-metered water that leaves a system. In some cases, water only seems to be missing because of human errors or other errors such as broken meters. Genuine water loss is generally caused by three things:
    1) Authorized un-metered accounts
    2) Theft
    3) And Leaks

Authorized, un-metered accounts may include:

- free accounts (elderly, low-income, special arrangements)
- city facilities
- water and wastewater plants
- fairgrounds
- parks
- golf courses
- cemeteries
- playgrounds
- landscapes
- swimming pools
- city shops, offices
- water fountains



- community facilities
- state and county offices
- schools
- churches
- hospitals
- rest homes
- fire fighting
- special events (fairs, construction)
- maintenance equipment and procedures
- water line flushing
- hydrant flushing
- sewer cleaning
- street cleaning
- storage tank drainage
- pump and turbine cooling
- filter backwashing



Leaks

- For most systems, leaks are the hardest form of water loss to control. A leak is any hole, crack, or flaw in the system that permits the uncontrolled flow of water. A leak can occur at any point in a water system.

- For example, a leak may be a hole in a pipe. A leak may be an overflowing storage tank. A leak can occur around worn pump packing or a damaged fire hydrant seat. A check valve that lets water drain back into a well is a type of leak, too.

HOW TO IDENTIFY LEAKAGE

- **WATER AUDIT**

Percent DSL = [(TP – AC) / (TP)] x 100

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25,000 / 100,000 = .025 x 100 = 25%

DSL = % of distribution system leakage
TP = Total Water Produced & Purchased
AC = Authorized Consumption

Benefits of a Water Audit

- Determines distribution system efficiency
- Helps water utility to select and implement programs to reduce water and revenue loss
- Creates performance history to quantify results

AIM FOR THE ZONE

30% AVERAGE LOSS FOR 160,000 US WATER SYSTEMS

15% POPULAR HISTORIC TARGET

10% AWWA SUGGESTED TARGET AS WELL AS WA STATE'S WATER USE EFFICIENCY RULE

5% EXCELLENT WATER CONSERVATION

0% HIGHEST PROFITS

Leak Detection Benefits

- Significant reduction water loss
- Reduction in costs (dry holes)
- Reduced property damage as a result of fewer serious leaks
- Reduced risk of contamination
- Reduced Pumping/Power Costs

Additional Benefits

- Deferred Construction of New Facilities
- Improved Public Relations and Awareness of Water Conservation
- Reduction in Waste Water Treatment Costs
- Recapture of Lost Revenue

Water Losses

Under Different Pressures Losses in Gallons per Minute

Diameter of Hole -Inch	0.1	1.0	1.4
40 psi	1.510	151.035	296.028
60 psi	1.850	187.979	362.559
80 PSI	2.136	213.596	418.648

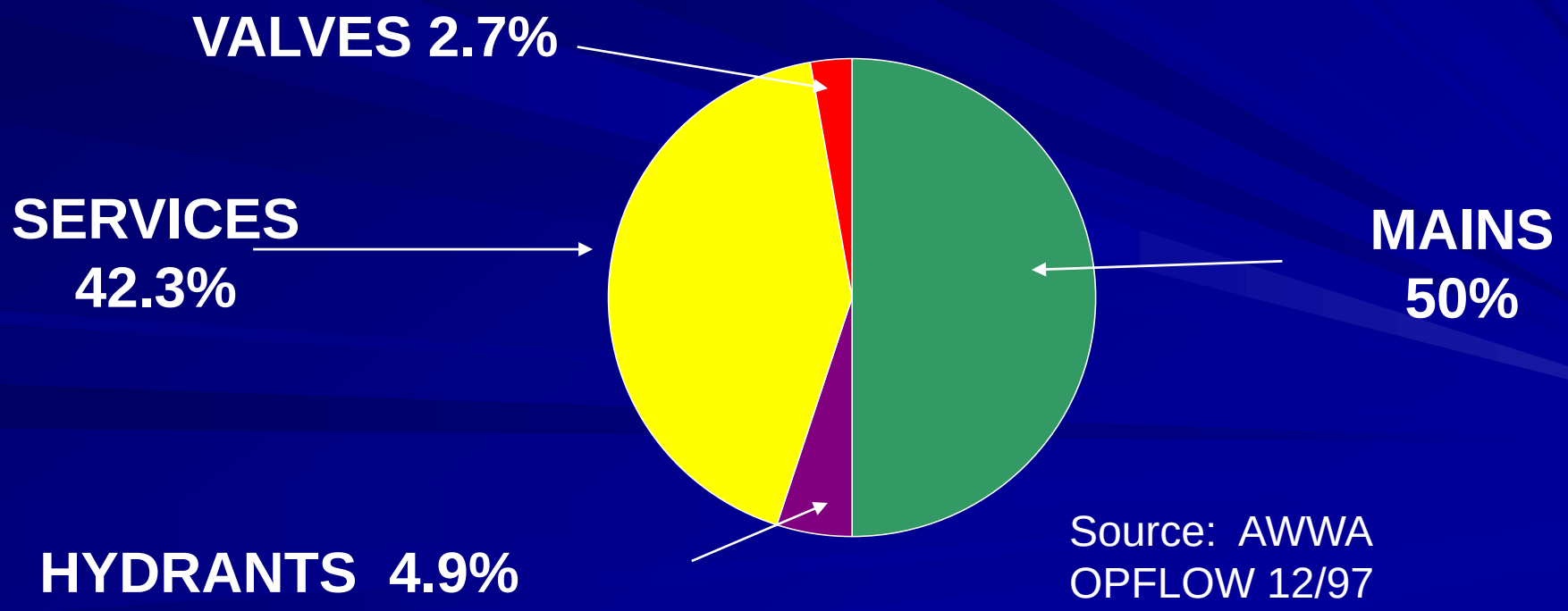
- The formula: Q=(30.394) (A) (Square Root of P) gal per minute;
- A: cross section area of the leak in sq. in. P: pressure in pounds per sq. in.

Leak Statistics

- A leaking toilet can lose 90,000 gallons of water a month.
- A dripping faucet/hose bib can lose up to 180 gallons a month, 2,160 gallons per year.
- Approximately one in every 318 homes or buildings has a leak.
- Approximately one in every 20 pools has a leak.

Distribution of Leak Sources

- Johnson City Water & Sewer, TN
- 720 miles of Water Lines
- 378 Leaks Located = 1,941 GPM Loss



Source: AWWA OPFLOW 12/97

Actual Loss in Identified Leak Sources

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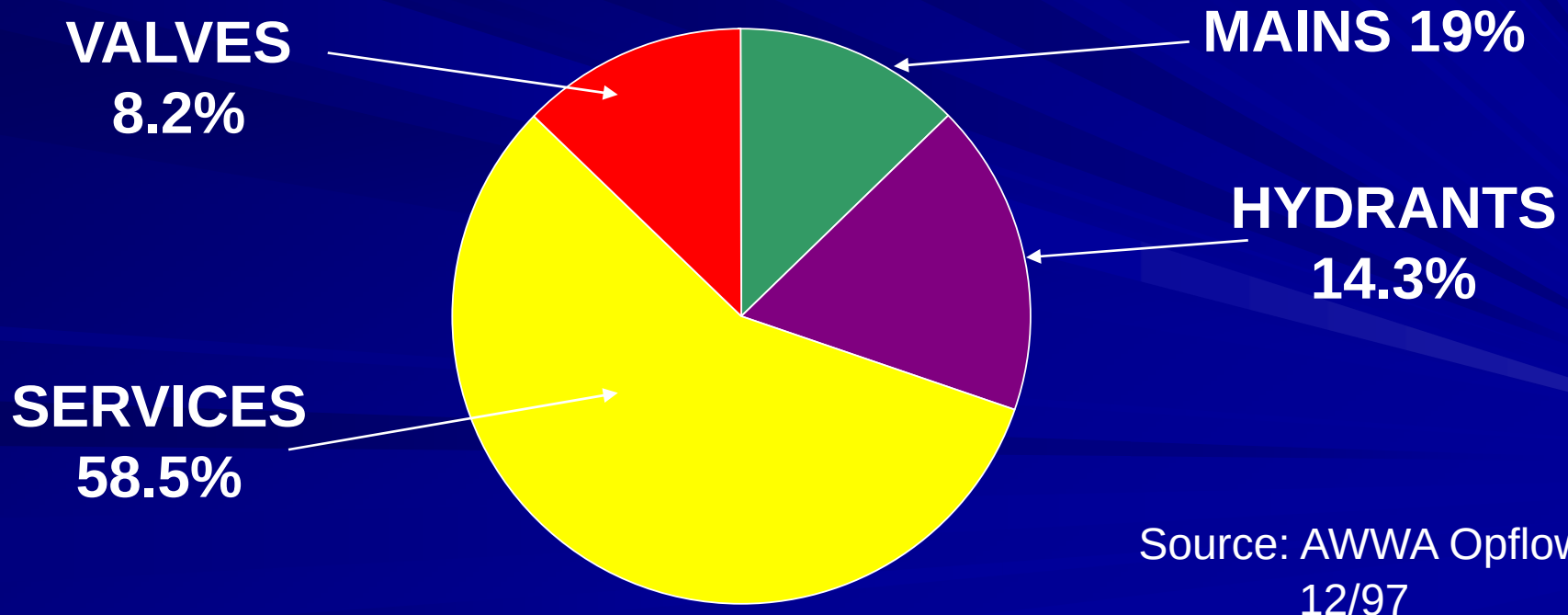


Source: AWWA Opflow 12/97

Making maps

- Some systems do not have complete or **up-to-date** maps. In this case, it may be necessary to make new maps. *You may not, however, need to create a map from a blank sheet of paper.* There are several possible sources of help.
- Contractors or engineers who installed the original system generally keep a file for each system they design. You might also obtain maps from inspectors, lending agencies, and other people and offices associated with your system's construction.
- Many state regulatory agencies require that a set of plans and maps be submitted for any original construction or upgrade. These maps are kept on file.

- All pipes should be identified according to type, size, and depth.
- Also, the exact distance from a reference point is useful.
- Information about valves and hydrants are sometimes kept on separate maps. This information includes the model type, installation date, **plus the direction and number of turns for opening valves.**

Measuring Water Loss in a Zone

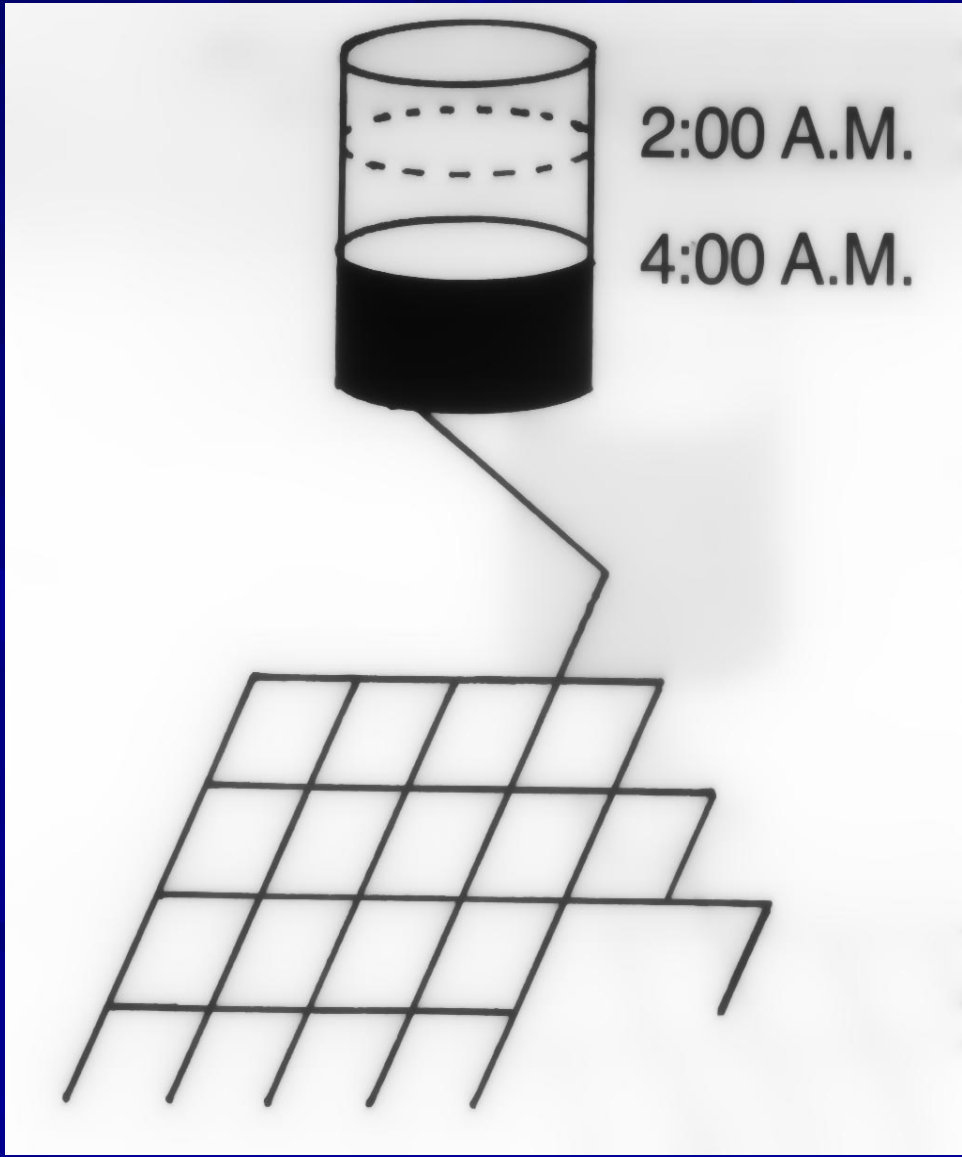
- If leaks are suspected, storage tank levels or meters can measure use within a zone.

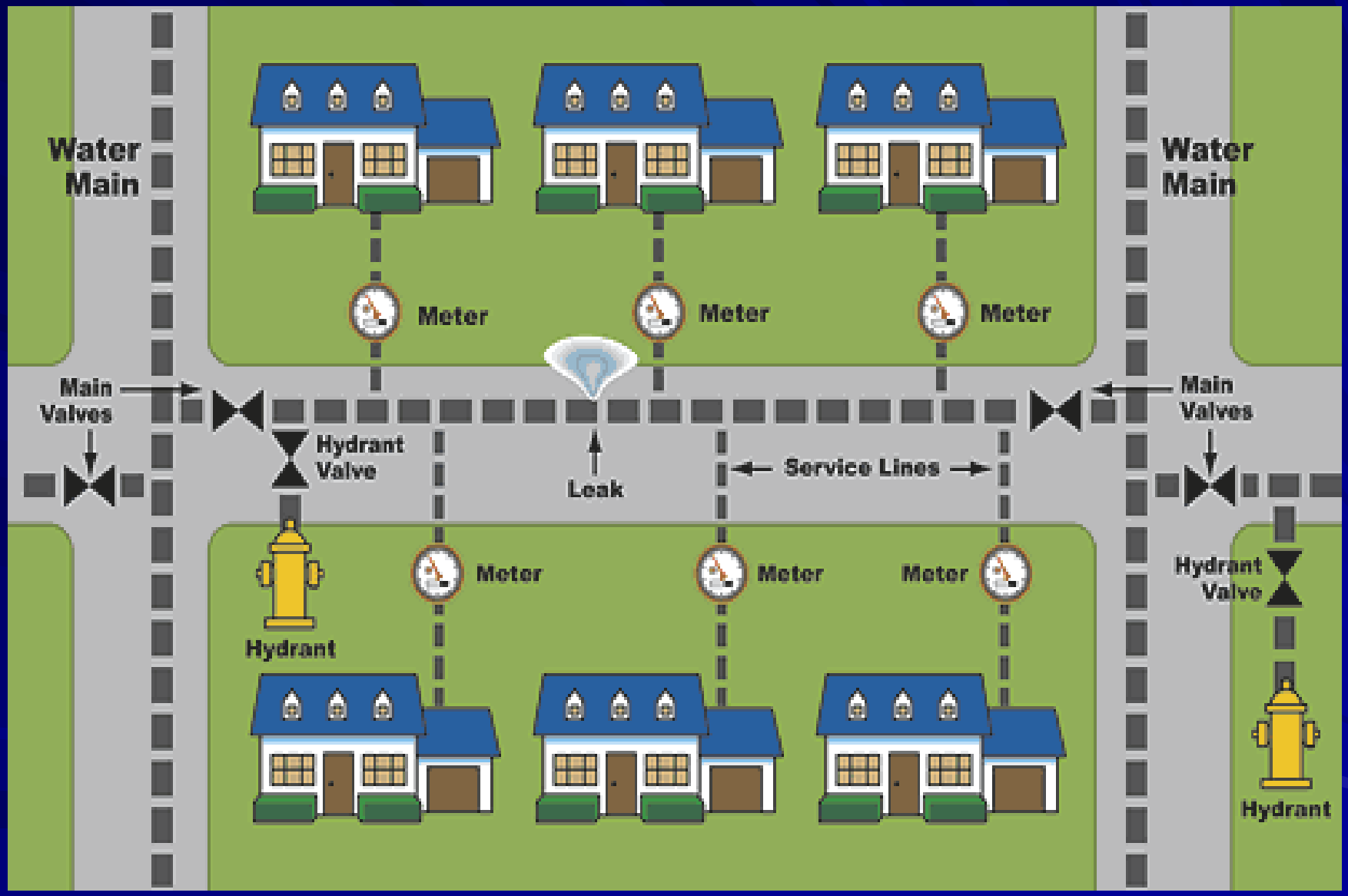
Zones and Zone Measurements

- Zone measurements are normally taken late at night when customer use is expected to be low. Usually, the best hours are between 2:00 AM and 4:00 AM. If there is no customer use, any running water you detect is probably caused by a leak.
- Zone measurements can save time and money by eliminating large portions of a water system from additional leak detection work.

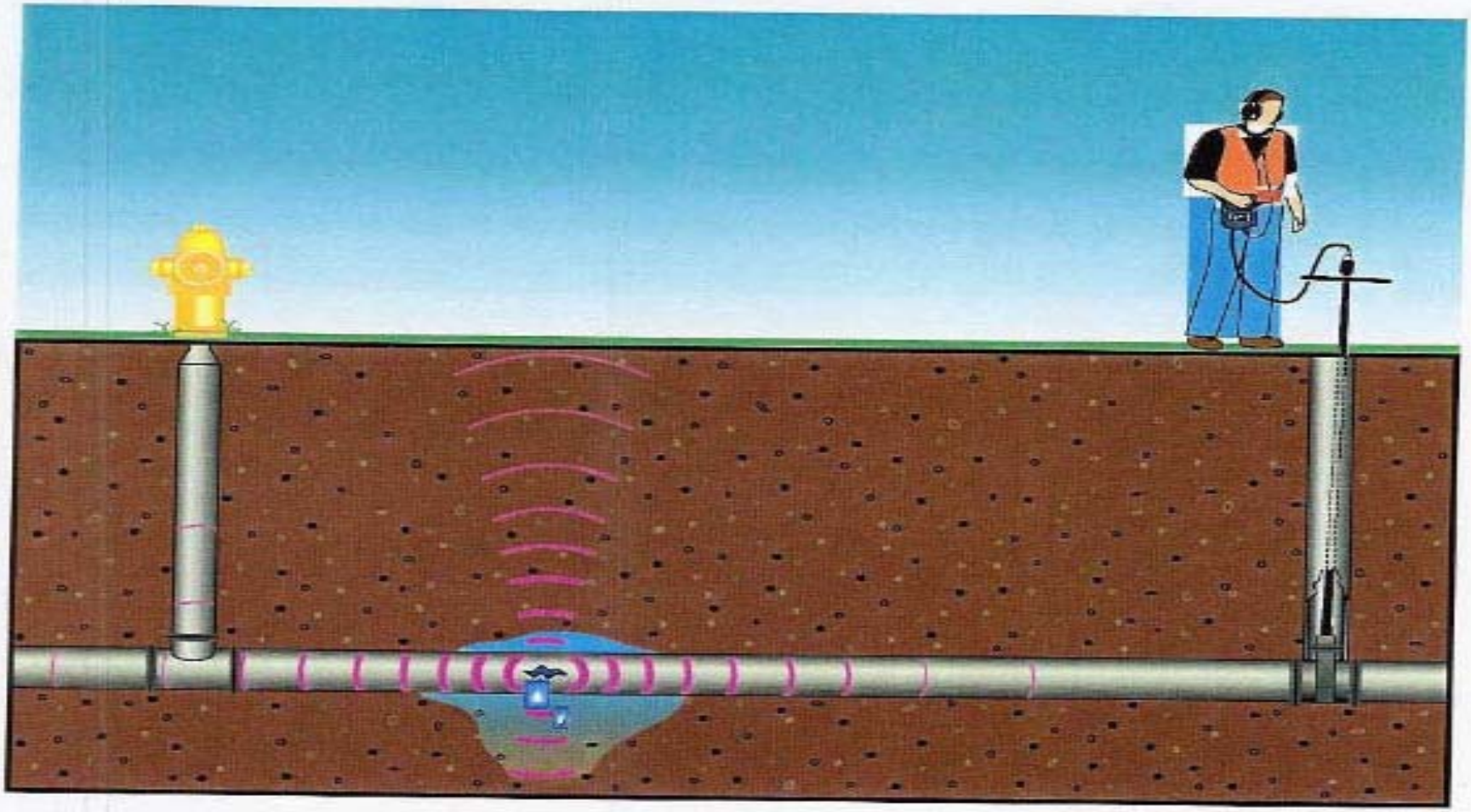
Storage Tank Levels

- One of the easiest ways to measure water use in a zone is to use storage tank levels. If a zone can be isolated to include a tank, water use can be measured by the drop in water level.




Water Main
Water Main
Meter
Meter
Meter
Main Valves
Main Valves
Hydrant Valve
Leak
Service Lines
Meter
Meter
Meter
Hydrant Valve
Hydrant
Hydrant

Science of Leak Noise
Acoustic Vibrations



Small Leak on Cast Iron Water Main

Acoustic Vibrations

- Factors
- Pressure in the line
- Size of the leak aperture
- Presence or absence of resonating cavities around leak
- Freedom with which the pipe can vibrate

How Do Leak Sounds Travel on Pipes?

Pipe Material and Diameter	Distance Sounds Travel for 2 GPM Leak at 60 PSI
6 inch Cast Iron Pipe	600 to 1000 feet
12 inch Cast Iron Pipe	400 to 800 feet
24 inch Cast Iron Pipe	200 to 400 feet
6 inch AC Pipe	400 to 800 feet
12 inch AC Pipe	300 to 500 feet
24 inch AC Pipe	100 to 300 feet
6 inch PVC Pipe	200 to 300 feet
12 inch PVC Pipe	100 to 200 feet
24 inch PVC Pipe	50 to 100 feet

Leak Detection Equipment

A variety of equipment is available for leak detection. Equipment can range in cost from a few dollars to thousands. Most leak detection devices have one thing in common, though. ***Each depends on the sound (vibrations) leaks make.***

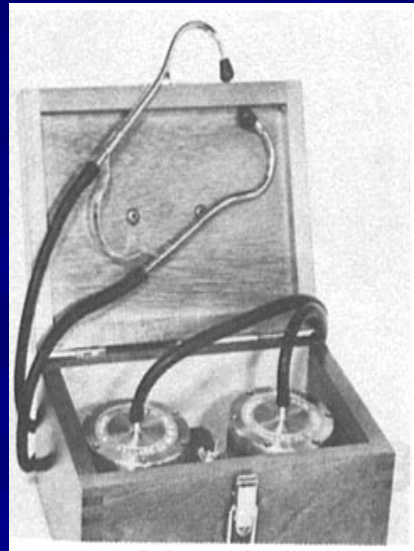
The simplest listening device is a screwdriver or wrench.

Equipment

- Mechanical $50 - $300
  - Probe Rod
  - Geophone
- Electronic $1200 - $4,000
  - Heath Aquascope
  - Fuji - Tecom/Schonstedt
  - FCS S-30 Fluid Conservation Systems
  - Metrotech
  - Palmer MK-4

Simple Devices

- ***A hydrophone*** *is* an inexpensive device that works the same way, but is designed for more comfortable and convenient listening.
- ***Geophones*** are another inexpensive listening device. Geophones are similar to the stethoscope a doctor uses.



Joseph G. Pollard Co., Inc. Used by permission.

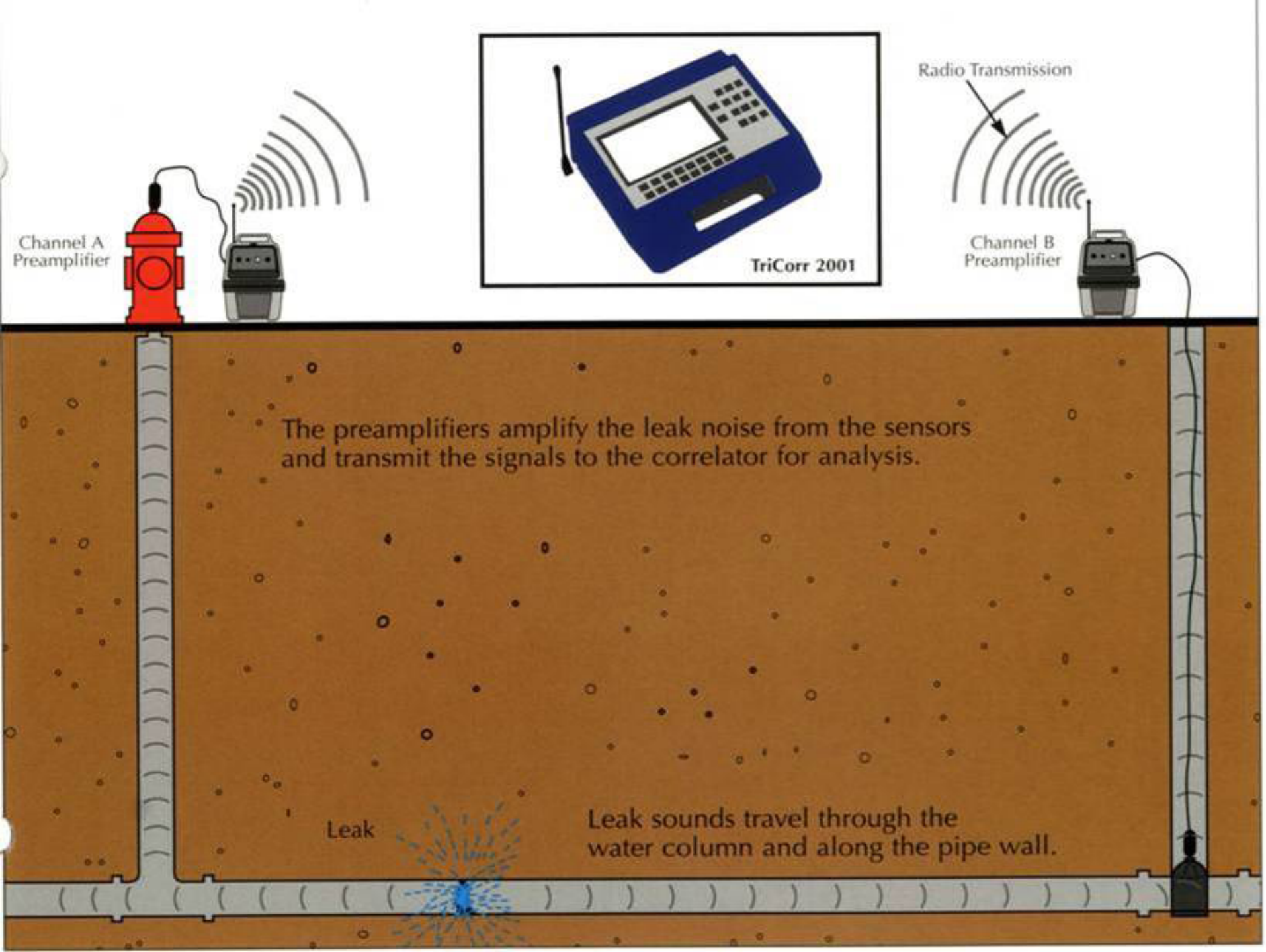
Geophones are similar to a doctor's stethoscope.

Electronic Leak Detectors

Electronic leak detectors are much more sophisticated and complex than geophones. These electronic devices amplify sound caused by the vibrations of leaking water.

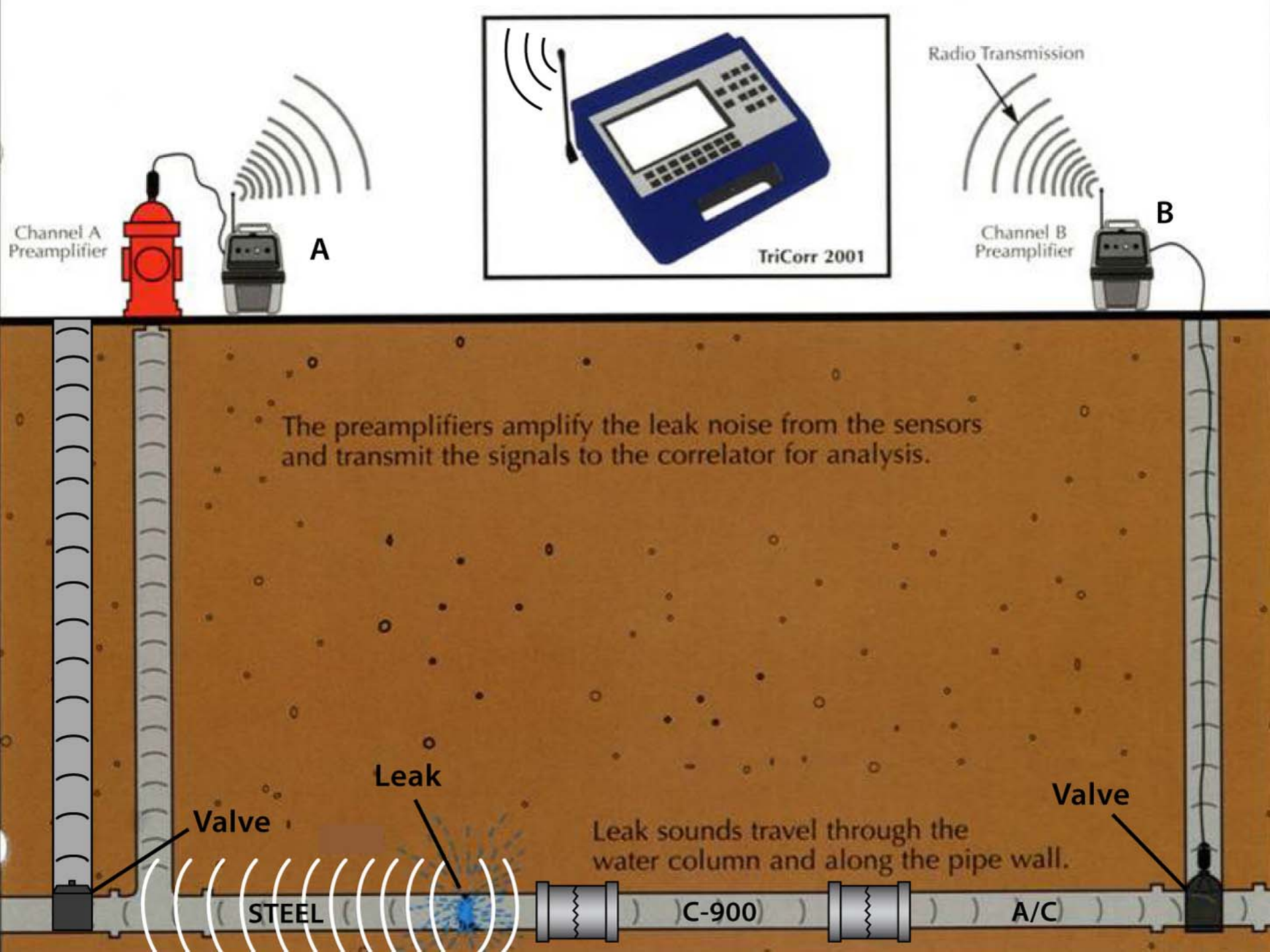
Equipment

- Correlator $18,000 - $37,000
  - Flow Metrix
  - Severn
  - Fuji - Tecom
  - Fluid Conservation Systems
  - Palmer Environmental
  - SEBA/Metrotech
  - SubSurface Leak Detection


Radio Transmission
Channel A
Preamplifier
TriCorr 2001
Channel B
Preamplifier
The preamplifiers amplify the leak noise from the sensors
and transmit the signals to the correlator for analysis.
Leak
Leak sounds travel through the
water column and along the pipe wall.

This long term leakage was located on a 30” reinforced concrete water main.

As always, the reason was?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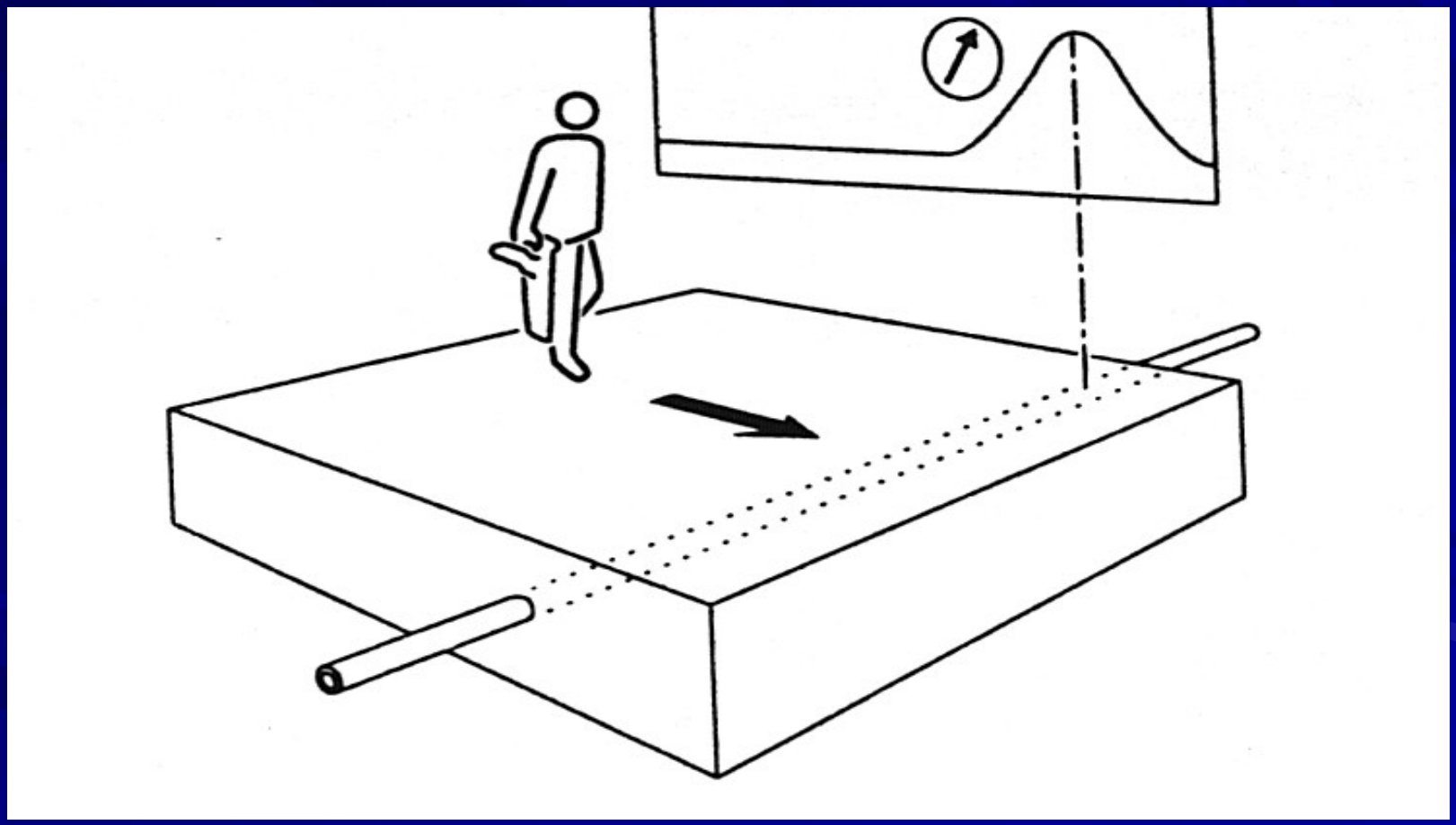
STEEL
C-900
A/C

Detection Equipment Factors Effecting Usage

	Ground Mic	Correlator
Soil Composition	Yes	No
Surface Conditions	Yes	No
Traffic Noise	Yes	No
Wind & Rain Noise	Yes	No
Size of Leak	Yes	Yes
Access Points	No	Yes
Pipe Diameter	No	Yes
Pipe Length	No	No
Pipe Material	No	Yes

LINE LOCATION
Peak Mode



AGONY

NOT ALL PAIN IS GAIN.

www.despair.com

Leak Detection is Problem Solving

- Requires:
  - Knowledge of Existing Lines
  - Systematic Approach
  - Attention to Detail
  - Common Sense
  - Experience is Beneficial

Common Detection Methods

- Passive Leakage Control
- District Metering
- Waste Metering
- IR Thermography
- Ground Penetrating Radar
- Traditional Leak Detection
- Correlation

Leak Detection Process

Two Elements of Success

<u>Elimination</u> <u>Discovery</u>

Leak Detection Requirements

- Systematic Approach
- Attention to Detail
- Common Sense
- Experience

Leak Detection
Test Plan

Detection Test Plan

- Verify
- Parameter
- Locate
- Pressure

Detection Test Plan

- Locate lines
- Confirm whenever possible
- Mark accurately and clearly
- Establish test area
- Assume nothing (valves)
- Unknown laterals

Detection Test Plan

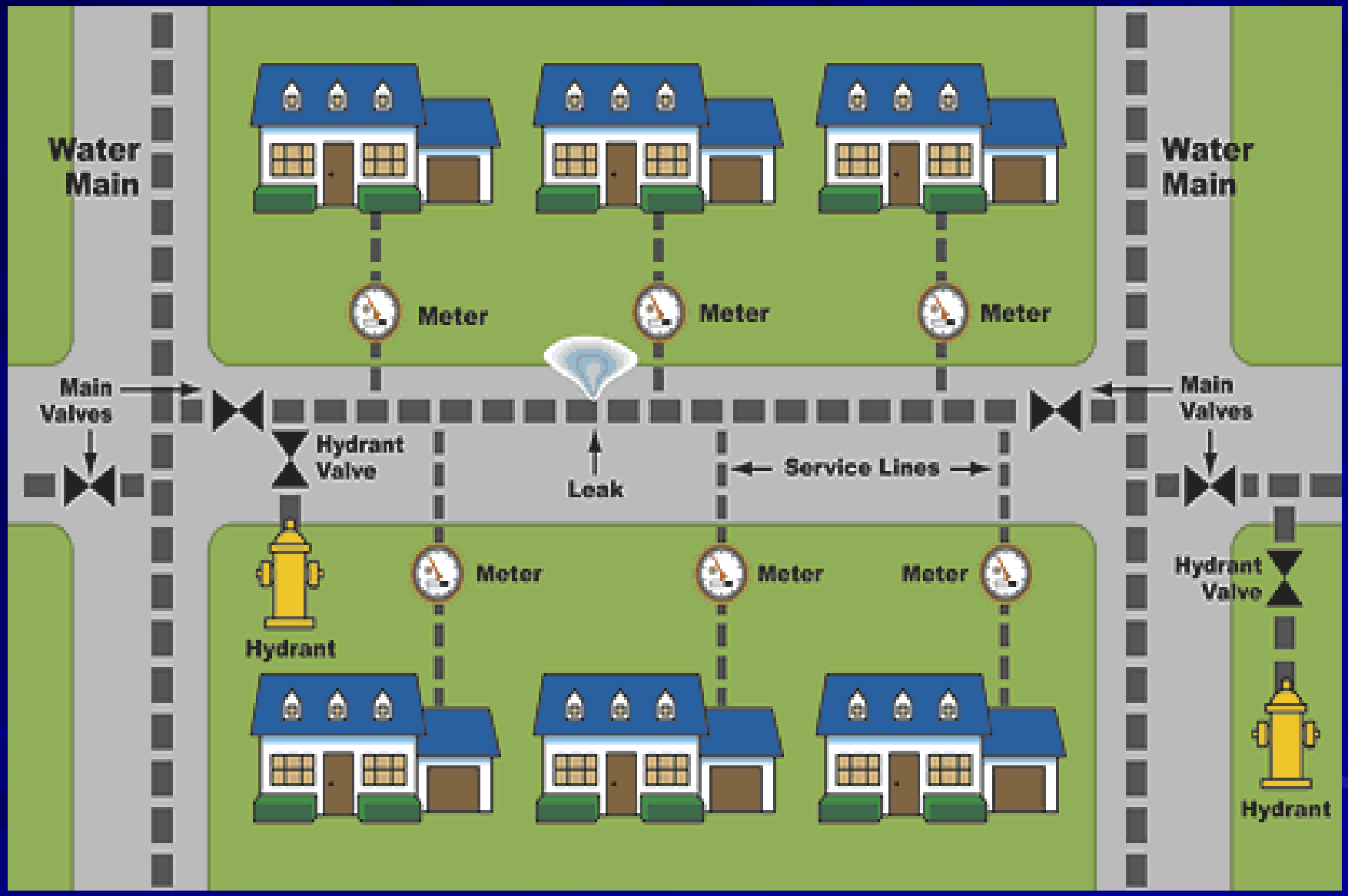
- Locate any valves
- Other test points
- Determine type of line and/or lines
- Services
- Laterals

Detection Test Plan

- Customer usage
- Presence of PRV’s
- Pumps in Area

Leak Detection Process

- Detection Variables
- Test Points
  - Main Valves
  - Hydrants
  - Curb Stops
  - Meters
  - Blow - Offs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Leak
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Meter
Meter
Meter
Hydrant Valve
Hydrant
Hydrant

Leak Detection Process

- Detection Variables
- Line Types Variables: (Conductivity)
  - Steel (Galvanized)
  - Copper
  - AC
  - PVC/Poly
- Line Size Variables:
  - Test Point Interval
  - PSI

Leak Detection Process

- Equipment Variables
- Ground Miking Variables
  - Location
  - Surface Material
    - Asphalt/Concrete
    - Gravel
    - Dirt, Loose and Compacted
- Ambient Noise Variables:
  - Traffic
  - Weather
  - Wind & Rain

Spokane Co. Dist #3

50 miles of line:

Various sizes & material

Metered Services

HIGH UAW: 35 – 40%

FOUND 7 LEAKS UAW 18%

SAVING $500 MON. ON POWER

Spokane Co. Dist #3

DEC 2001

BACK UP AGAIN

35 – 40%

ISOLATION PLAN

FOUND 2 LEAKS

PRESENT UAW BELOW 5%

PLUS POWER SAVINGS

TOWN OF SPANGLE

HIGH PER CAPITA WATER USAGE

350 GALLONS PER PERSON PER DAY

250 RESIDENTS USING 3 MILLION GALLONS PER MONTH

TOWN OF SPANGLE

ISOLATED & CLEANED OUT ALL VALVES

3 POTENTIAL AREAS

ONE SURFACED LIKE ARTESIAN WELL ADJACENT TO SPANGLE CREEK

ABANDONED SERVICE LOSING

35 GPM

TOWN OF SPANGLE

REPAIR WAS HANDLED

RIGHT AWAY

PUMP DROPPED FROM 9 – 11 HRS/PER DAY

TO 2 HRS/PER DAY

CHLORINE USE REDUCED

SAVED $235.60 ON POWER

1ST MONTH

City of East Hope

- 135 Conn/un-metered system
- Gravity-fed System
- Daily Water Production at Peak Levels
- Unable to Maintain Storage Levels
- Filtering Capabilities Maxed
- Fire Reserves at Critical Level
- Daily Water Usage 200,000

City of East Hope

3 miles of line:

Galvanized 2” - 8”

Steel 4” - 6”, some PVC

135 un-metered connections

Services:

Galvanized & Copper

City of East Hope
Summary of Repairs

Repairs	**Costs**
Gate Valves (4)	$984
Main corp. (1)	$425
Service Lines (2) 1 metal & 1 PVC	$227
TOTAL Repair Costs	**$1,636**

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