

# Workshop 1– Warm up

Check our skills

- Using the pitchers of water on the table for your samples
- Measure free chlorine using your portable colorimeter
- Record your result on the workshop 1 data sheet (Yellow)
- Measure total chlorine
- Record your results on your workshop 1 data sheet (Yellow)
- Give your data sheet to Kay or Charese



We work with others to protect the health of the people of Washington State by ensuring safe and reliable drinking water.



CHLORINE RESIDUAL MONITORING  
LAB SKILLS

**Presented By**

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Southwest Regional Operations

# Objective

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- Provide water system professionals with a better understanding of good free chlorine measurement techniques and why good techniques matter.
- Provide water system professionals with hands on lab skills to answer the questions:
  - How do I know my instrument is working?
  - How do I know my results are accurate?



# Accuracy vs Precision

**Accuracy** is the closeness of a measure value to a known standard.

If you weigh a 5-lb weight and get 10-lb, you are not accurate

**Precision** is the closeness of two or more measurements to each other.

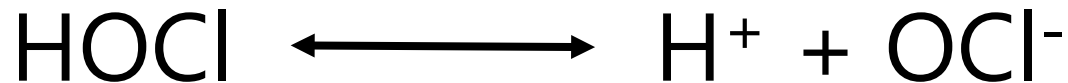
If you weigh a 5-lb weight multiple times and get 10-lb each time, you are precise



# Chlorine Chemistry

- Chlorine is added to the water as sodium hypochlorite in most cases

Sodium Hypochlorite:

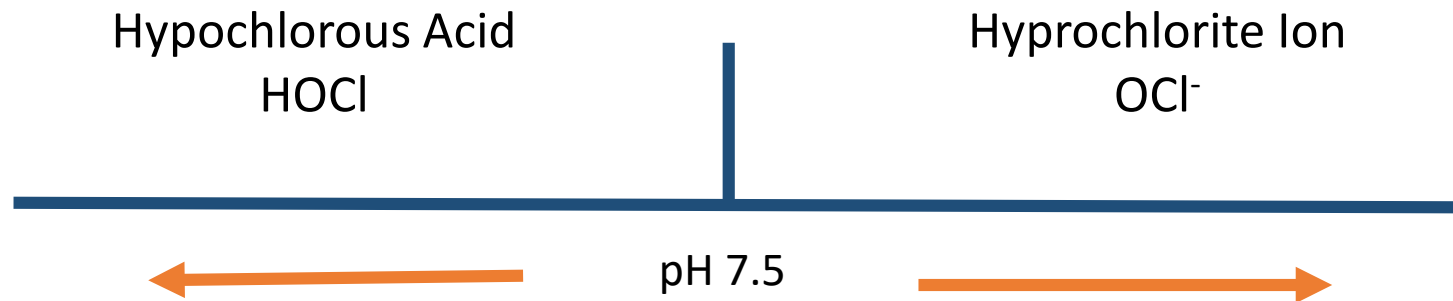


Hypochlorous Acid

Hypochlorite Ion

# Chlorine Chemistry

- Hypochlorous Acid is much stronger disinfectant than hypochlorite ion
- Chemical species formed is related to the pH





# Free vs Total Chlorine

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- Free Chlorine =  
Hypochlorous Acid + Hypochlorite Ion
- Combined Chlorine =  
Chloramines + other chloro-organic species
- Total Chlorine =  
Combined Chlorine + Free Chlorine





# Combined Chlorine - Chloramines

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- Chloramines are formed when free chlorine reacts with ammonia present in the water
  - Monochloramine ( $\text{NH}_2\text{Cl}$ )
    - One chlorine with an amine group
  - Dichloramine ( $\text{NHCl}_2$ )
    - Two chlorines with an amine group
  - Trichloramine ( $\text{NCl}_3$ )
    - Three chlorines with an amine group



# Why Do Systems Disinfect Their Water?

- Prevent microorganism growth in the distribution system
  - Detectable residual – Defined at 0.2 mg/L
- Inactivate pathogenic microorganisms in a source
  - CT6
  - 4-log
- Added as part of another process
  - Iron and Manganese removal
  - Others



# Why Does an Accurate Measurement Matter?

- Effective source disinfection depends on it
  - Small changes can have large impacts
  - Inactivation levels must be met or pathogens may get into your distribution system
- Chemicals cost money
  - Inaccurate measurements often mean more chemicals are used than are needed
  - Lowering the dose to the appropriate level saves chemicals, which saves money

# Knowing Is Half The Battle...

- Where is the point of compliance?
  - CT6 and 4-log: at the first connection (compliance point)
  - Distribution disinfection: in the distribution system at representative sites
- How do I collect a sample?
  - Are there written SOPs?



# Knowing Is Half The Battle...

*(Continued)*

- Are you sampling the distribution system or the premise plumbing?
  - Sinks must run until the water is from the distribution system, when temperature has stabilized
  - Remove the aerator from the faucet
  - Don't use hot water sinks

# MATH!

Pipe Diameter (in)	Flow Rate (gpm)	Sample Delay (sec/ft)
½	2.2	0.28
1	2.2	1.11
1.5	2.2	2.50
2	2.2	2.45

$$Delay \left( \frac{sec}{ft} \right) = \pi * \frac{(Diameter)^2 / 77}{Flow Rate (gpm)} * \frac{60 sec}{min}$$

Diameter 1	Length 1	Diameter 2	Length 2	Delay
1 in	100 ft	½ in	50 ft	124 sec



## ...Then There's The Other Half

- Sampling Technique is vital
  - Clean sample cells
  - Reagent – what's the expiration date
  - Is the reagent “pillow pack” the correct packet for my sample cell
  - Do you have the user manual that came with your device? Have you read it?



## Pop Quiz

How long after adding reagent should you read the sample when testing for free chlorine?



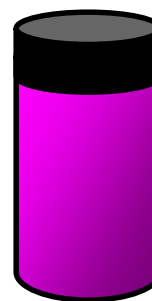
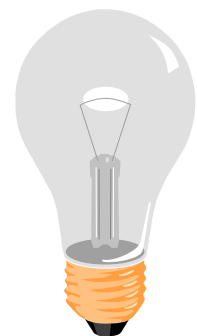


## Pop Quiz

Is there a difference between the glass and funny shaped plastic sample cells that come with the meter?



# Basic Spectrophotometer



Lamp

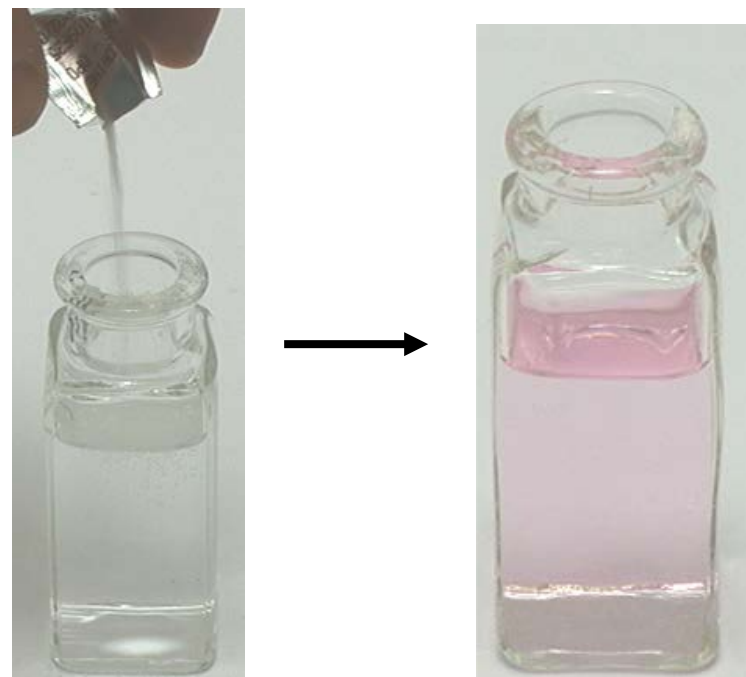
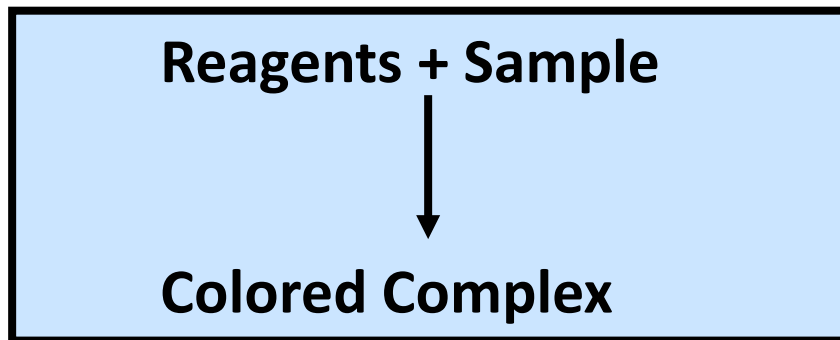
Monochromator  
or Filter

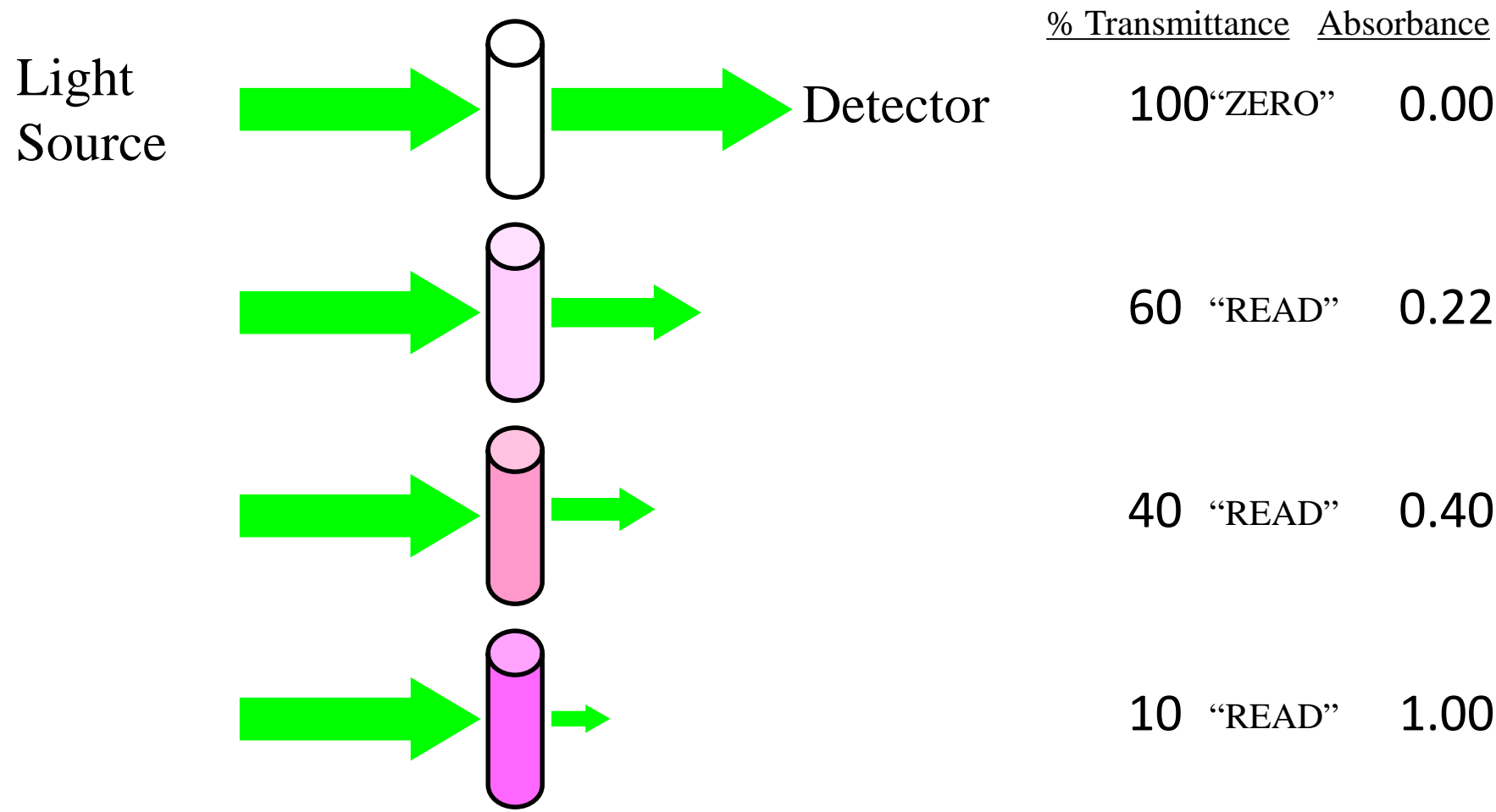
Lens

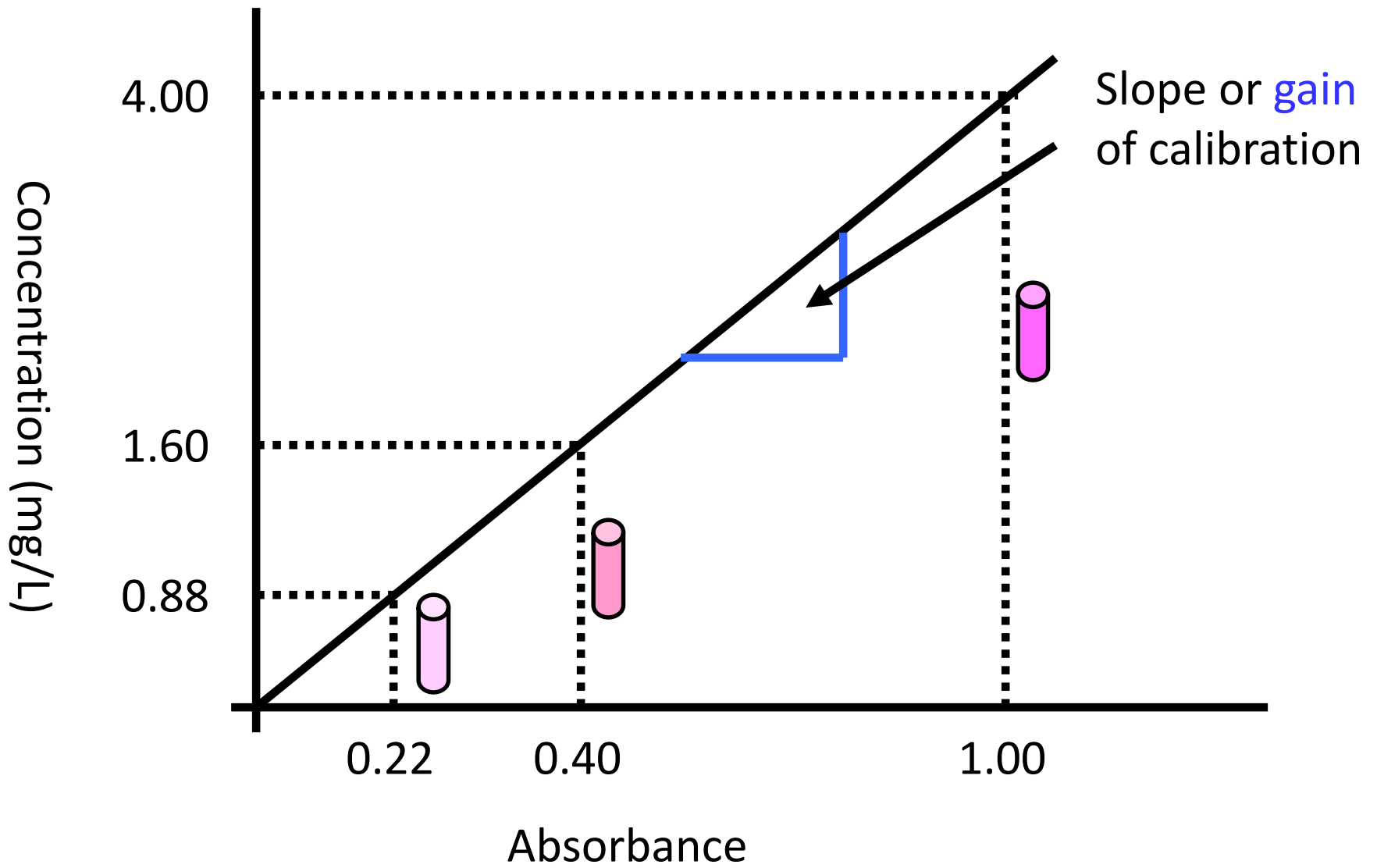
Sample

Detector

# What do the Reagents Do?









# Sample Cell

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A sample is measured by comparing the difference in intensity between the blank and the sample

Light passes through the sample cell, so it is important that the cell is clean.

- Clean inside - acid or reagent
- Clean outside - lint free cloth
  - No dust, fingerprints, scratches
- Cells are sufficiently filled





# Your Colorimeter

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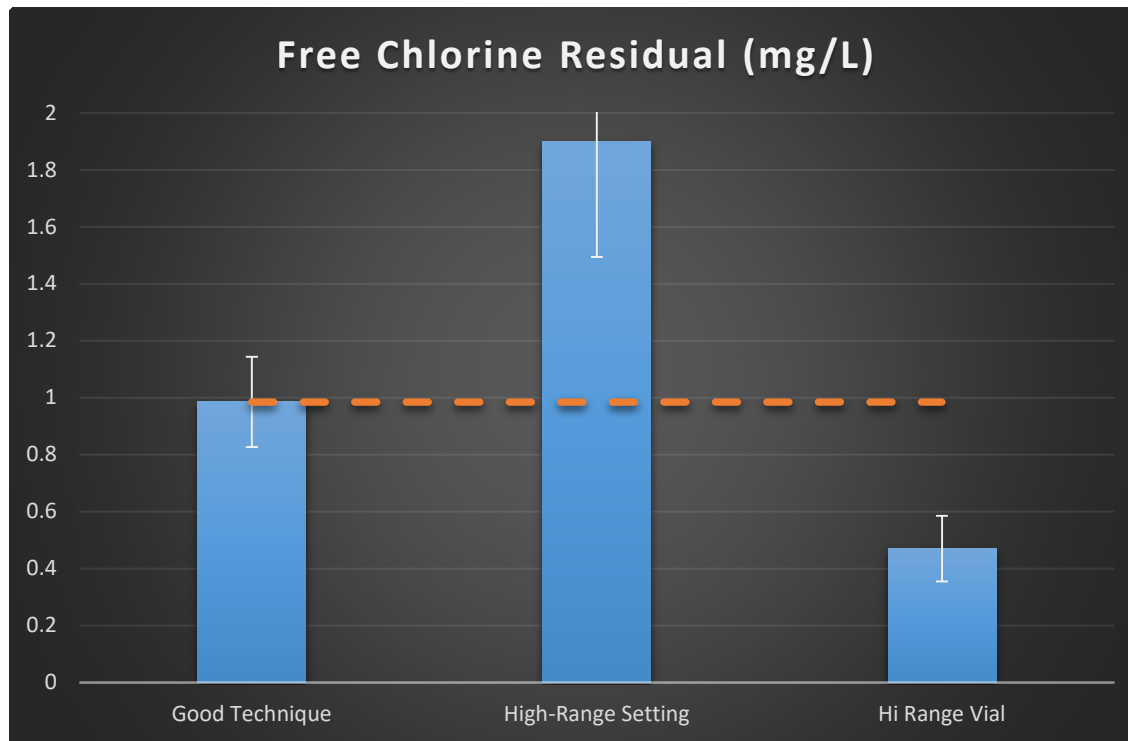
- Did you know that your meter has different ranges?
  - High and Low Range Chlorine Levels
    - Low Range – 0.02 to 2.0 mg/L
    - High Range – 0.1 to 8.0 mg/L
  - Some meters measure High Range Chlorine and pH

**READ YOUR USER MANUAL**



# Equipment Constraints

- Free Chlorine Residual data from Day with DOH in Mt. Vernon





# Summary of common mistakes

- Using different vials for blank and sample measurement
- Incorrectly aligning the sample vial in the instrument
- Using wrong vial
- Measuring sample with condensation on the outside of vial
- Leaving the vial cap off
- Leaving the instrument cover off
- Storing sample vial with sample and reagent
- Using stained, discolored, or scratched vial
- Selecting the wrong instrument parameter (High Range)
- Not enough reagent
- Wrong reagent (total instead of free)
- Waiting too long, or not long enough, to read the measurement. (inconsistent procedure and/or inaccurate procedure)



# Standard Operating Procedures

**A tool to ensure that everyone does it the right way every time**

They need to be —

- Written down
- Up-to-date
- Consistent with industry best practices
- Aligned with regulatory requirements

# Example SOP - Low Range Free Chlorine

0.01 to 2.0

1. Rinse sample cell and lid 3 times
2. Fill sample cell with water 10 mL
3. Clean with lab wipe
4. Insert cell with diamond toward key pad, secure lid
5. Press blue zero button
6. Remove sample cell and add "free" reagent (10mL reagent packets)
7. Swirl for 20 seconds. Clean cell with lab wipe
8. Insert immediately & press green read button



# Example SOP High Range Free Chlorine

0.1 to 10

1. Rinse sample cell and lid 3 times
2. Fill sample cell plastic sample cell with water 5 mL
3. Clean with lab wipe
4. Insert cell with diamond toward key pad, secure lid
5. Press blue zero button
6. Remove sample cell and add 2 – 10mL or 1 – 25 mL “free” reagent packets
7. Swirl for 20 seconds. Clean cell with lab wipe.
8. Insert immediately & press green read button



# When should you test for Total Chlorine?

- You have high ammonia in your raw water
- Unexpected low free chlorine result
- Investigating backflow or contamination event
- Verify chlorine dosage

# Total Chlorine Measurement

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- Use a separate sample cell for free and total chlorine samples
  - Iodine in “total” reagent packet can interfere with free chlorine test

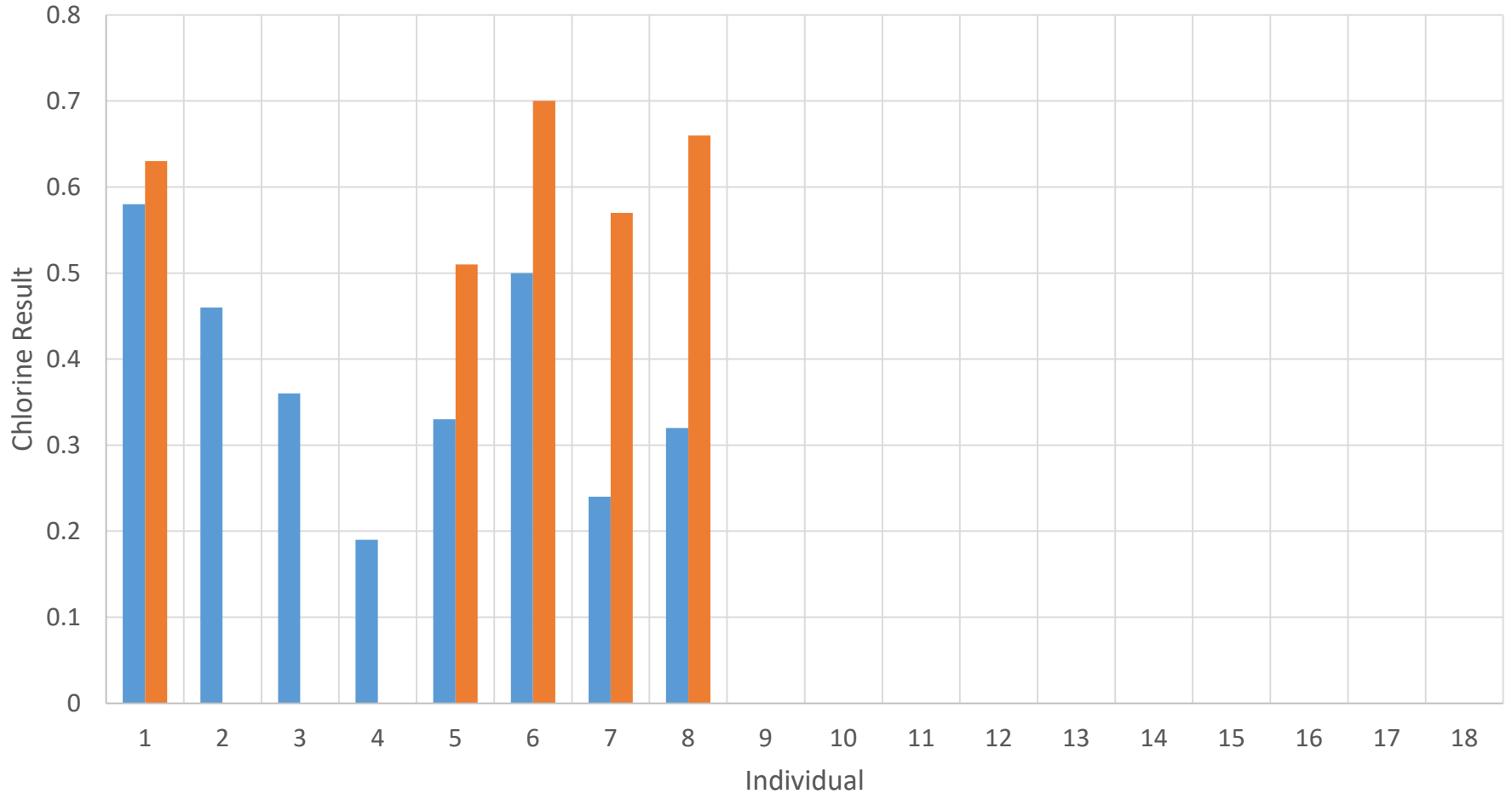


## Example SOP - Low Range Total Chlorine

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- Rinse sample cell and lid 3 times
- Fill sample cell with water 10 mL
- Clean with lab wipe
- Insert cell with diamond toward key pad, secure lid
- Press blue zero button
- Remove sample cell and add "total" reagent (10mL reagent packets)
- Swirl for 20 seconds, Clean cell
- Set timer for 3 minutes. Insert & press green read button

# Workshop 1 Results – How Good Are We





## Workshop 2 – Common Mistakes

- Good Technique
- Wrong Range or Parameter Setting (High Range)
- Leave the cover off the instrument
- Use total reagent instead of free
- Wrong Vial



# Is the Instrument Correct?

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- Primary Standards – Uses Standard Solution and checks the reagents, instrument, and the analyst's technique
  - Make standards by spiking
- Secondary Standards – Uses gel standards that simulate specific chlorine values
  - Used the check calibration of meter
  - Cannot be used to calibrate instrument

# Summary

- Accuracy matters, it effects—
  - Compliance
  - Economics
- Location matters
  - Does the sample represent the system or the plumbing?
- Technique matters
  - Sample confidently, respond confidently



# Questions





# Contact Information

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