INVESTIGATION OF COPPER PITTING CORROSION IN WSSC SERVICE AREA

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Overall Goals

- Big Picture Perspective on Pitting Corrosion

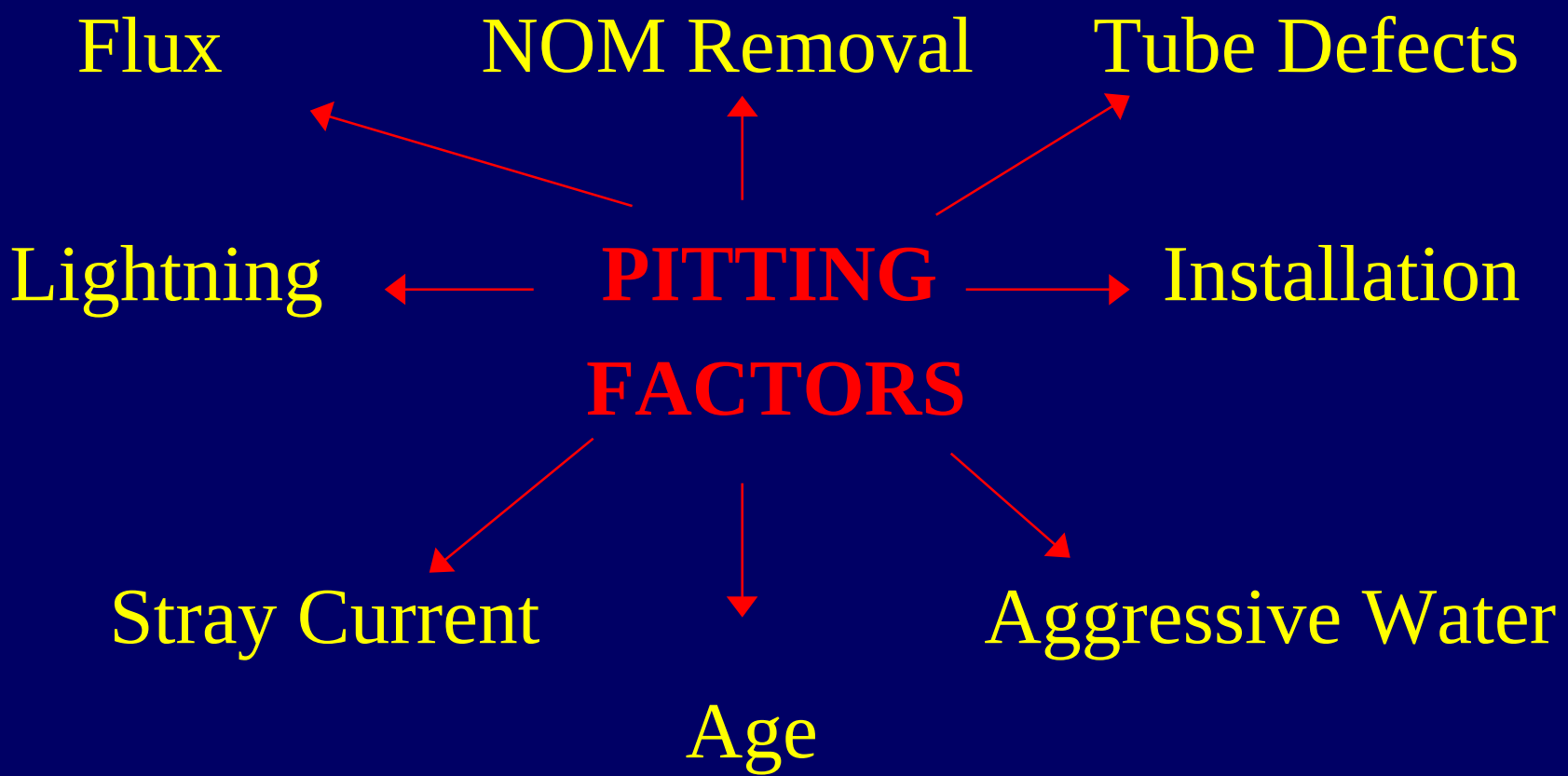
- What have we learned at WSSC?

Perspectives on Cu Pitting

- What are pinhole leaks?

- What can be done?

What is responsible?



WHO IS GENERALLY EXPECTED TO FIND SOLUTIONS TO PITTING PROBLEMS?

AMERICA ---> UTILITY

Appropriate water chemistry modifications can minimize most pitting corrosion

GERMANY--> PLUMBERS

Some waters are simply not suited for copper plumbing

UK/FRANCE--> MANUFACTURER

Most pitting caused by tube defects

What can be done?

While we do not know what causes pitting, utilities have sometimes identified water chemistry changes that can reduce pitting frequency.

Possible solutions include:

- increase or decrease pH and alkalinity
- increase or decrease disinfectant dose
- dosing of corrosion inhibitors

Strategy

Short-term: A water treatment enhancement is the only way to minimize the problem for all customers at a reasonable cost

Longer-term: Identify cause(s) and eliminate it

Pit Frequency = (Water)x(Pipe)x(Other Factors)

What have we learned at WSSC?

- Literature review

- Experiments to examine possible role of chlorine and aluminum

- Experiments to identify possible approaches to minimize leaks

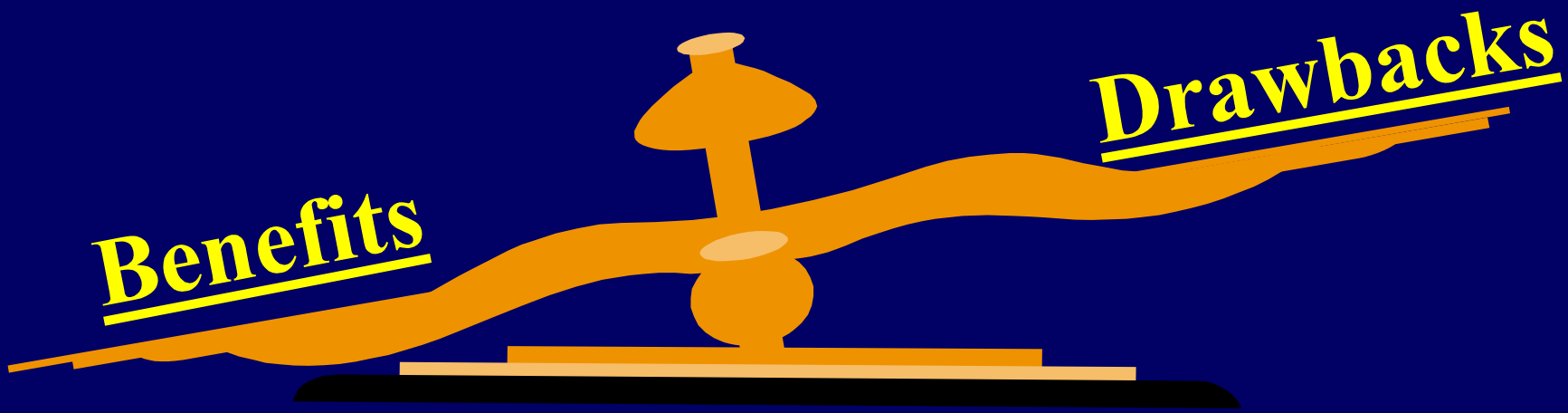
Aluminum (Al)

- Has been linked to hot water copper pitting
- Frequently found near pits at WSSC
  - aluminum deposits are on WSSC pipes with and without pitting
  - Al deposits alone do not cause pits
- Al sources include raw water, water treatment process and distribution system
- Potomac Plant level - 1/3 below national avg.
- Patuxent Plant level - 2/3 below national avg.

Chlorine (Cl_2)

- WSSC and other utilities nationwide use chlorine to safely clean and disinfect water.
- Chlorine is believed to have caused some cases of hot water pitting.
- Chlorine alone is unlikely to cause pits

Chlorine In Water Treatment



Save Lives

Taste, Odor, Disinfection By-Products, Possible Corrosivity

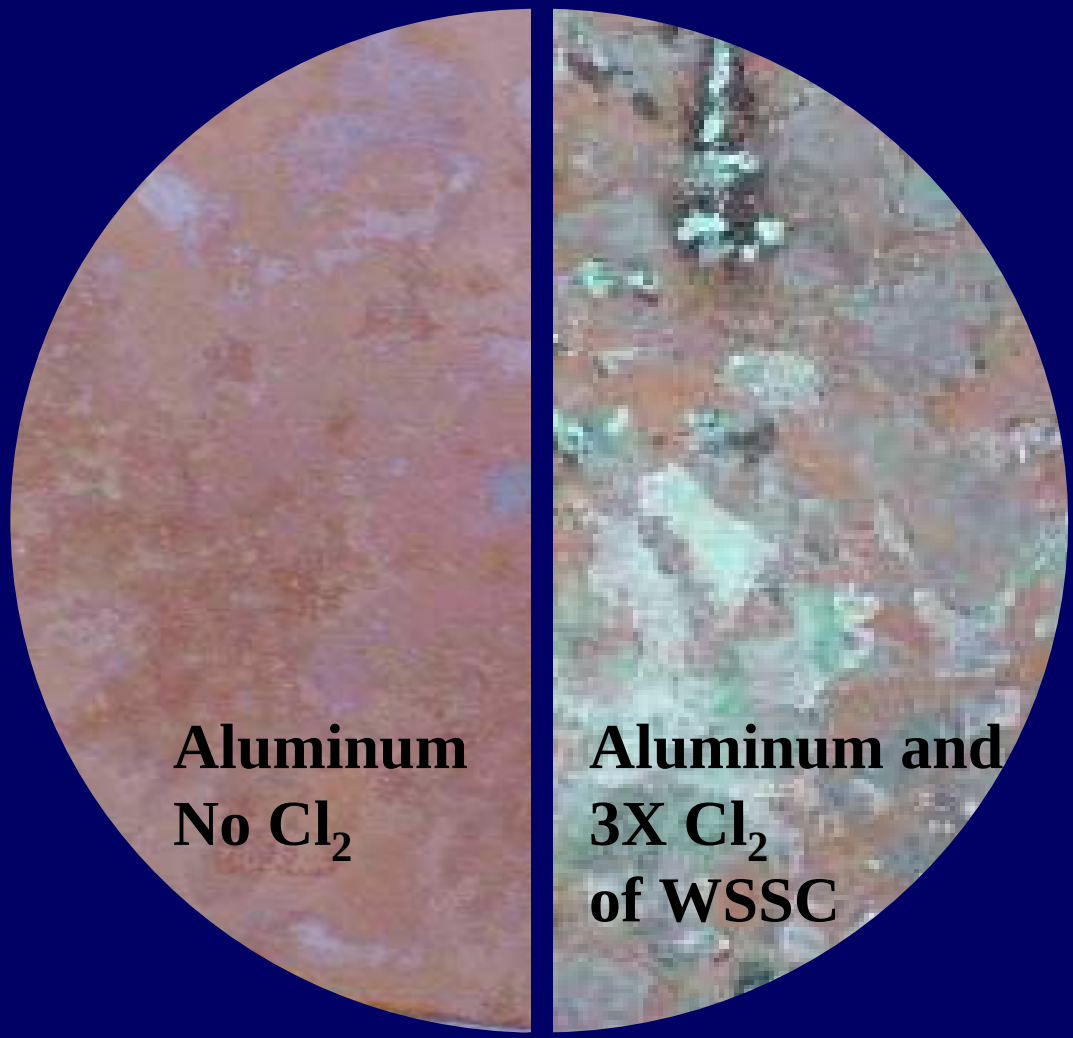
Alternatives to chlorine available, but all have drawbacks.

Experiment

- Examined effects of chlorine alone, aluminum alone, and effect of aluminum and chlorine on copper corrosion in WSSC water
- 97 day test duration

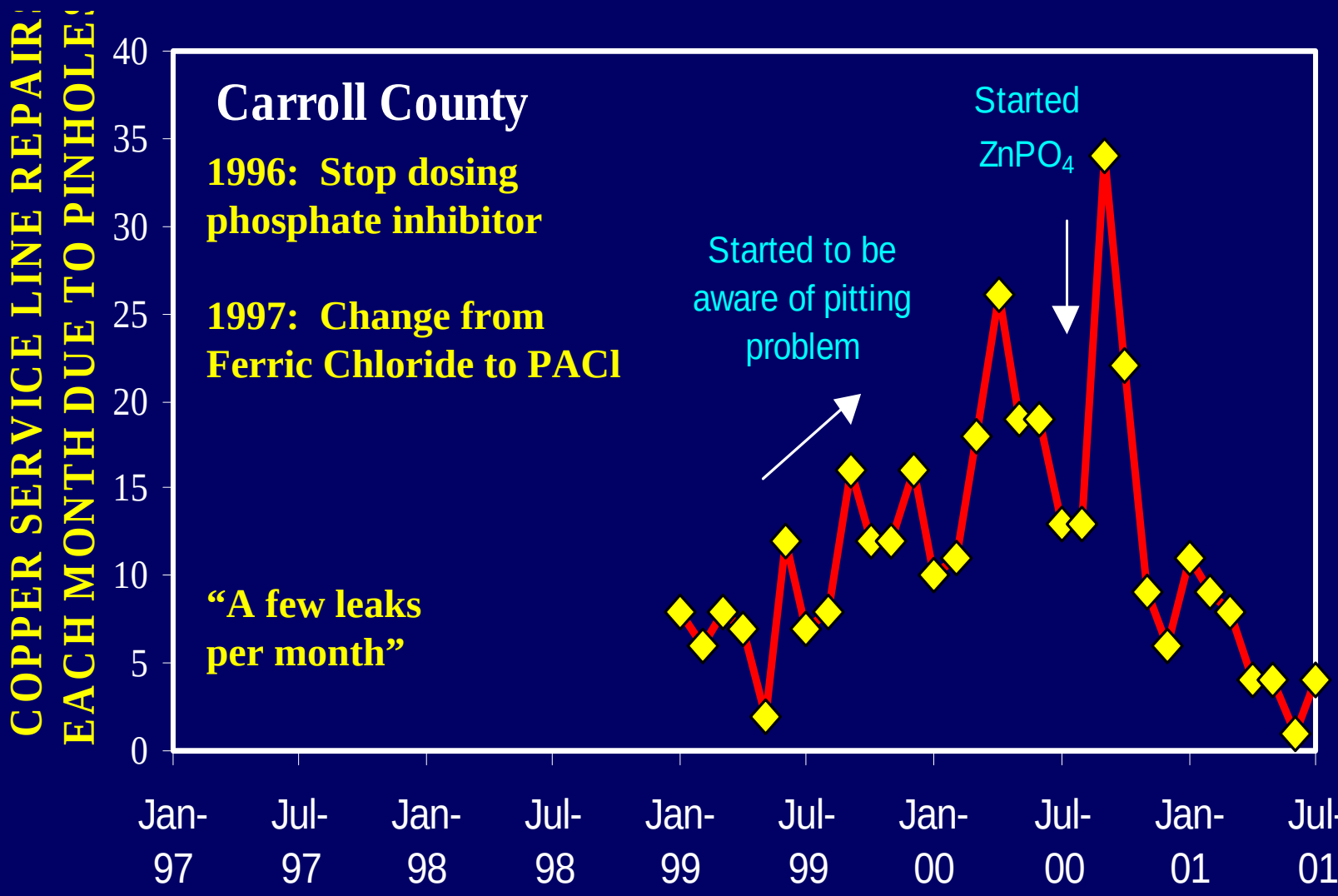
Probably takes > 500 days to form true pits in homes of WSSC customers

Combined Effect of Al and Cl_2



What might help? Corrosion Inhibitors

- Corrosion “inhibitors” are safe chemicals that can be added to water and which influence corrosion
- Corrosion inhibitors **do not** necessarily inhibit corrosion
- Most common are silicates and phosphates
- ≈ 50% of all utilities use phosphates


COPPER SERVICE LINE REPAIR
EACH MONTH DUE TO PINHOLE
40
35
30
25
20
15
10
5
0
Carroll County
1996: Stop dosing phosphate inhibitor
1997: Change from Ferric Chloride to PACl
"A few leaks per month"
Started to be aware of pitting problem
Started $ZnPO_4$
Jan-97
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01

Tests by Dr. Steve Reiber

- **Electrochemical testing of pitting activity using pits from WSSC system**
- **Silicates did not "kill" active pits**
- **Orthophosphate or polyphosphate did "kill" pits**
- **Orthophosphate versus Polyphosphate**

  - more possible detriments with poly-P (discolored water, dissolution of metals)
  - concern that poly-P would more actively dissolve "plugs" formed in earlier pinholes

Short-Term Recommendations

- Examine effect of phosphate on discolored water from iron mains
- Consider introduction of orthophosphate into the water treatment process