Georgia Tech
Water Treatment Program

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Chemical treatment of water for cooling & heating systems

- System data
  - Equipment
  - Water source
  - Chemical requirement
- Monitoring Result
  - (Sample of GT program data)
- Cost Analysis & Saving

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Equipment

- 40 Chillers
- 12 Main Plant Cooling Towers
- 12 Satellite Cooling Towers
- 47 Boilers
- 61 Hot Closed Loop systems
- 25 Cold Closed Loop systems.
- 2 Wells

Water source

Source

- City water
- 10th st. well water
- Power Plant Dr. well water

Hardness

30.2 PPM

118 PPM

116 PPM

Water consumption

- 10th St. Cooling Towers
  - Up to 72% well water consumption
- Holland Plant Cooling Tower
  - Up to 45% well water consumption

Chemical Requirement

System data

- Langelier Saturation Index (LSI) is purely an equilibrium index and deals only with the thermodynamic driving force for calcium carbonate scale formation and growth.
- LSI should be < 2.5
- Predict the calcium carbonate stability of water
- Predicts the tendency of scaling or corrosion
- LSI increases with Usage cycles
- How does LSI relates to hardness
  - If LSI is negative: No potential to scale, the water will dissolve CaCO3
  - If LSI is positive: Scale can form and CaCO3 precipitation may occur
  - If LSI is close to zero: Borderline potential to scale. Water quality or changes in temperature, or evaporation could change the index.
    - **LSI = pH (measured) – pHs (saturation)**
      - **pHs = (9.3 + A + B) - (C + D)**
      - **A = (Log10 [TDS] - 1) / 10**
      - **B = -13.12 x Log10 (deg”C” + 273) + 34.55**
      - **C = Log10 [Ca2+ as CaCO3] - 0.4**
      - **D = Log10 [alkalinity as CaCO3]**

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Chemical Requirement

Cooling Tower Loop

- Inhibitor
  - Phosphonate: HEDP 3-30%, Polymer 5-30%, TTA 2-15%
  - Molybdate: 1-5%

- Biocide 1: (Liquid Bromine)
  - 11% Bromine/Chlorine 90PPM
  - Applied twice per week

- Biocide 2: (Glutaraldehyde)
  - 45% Glutaraldehyde 120PPM
  - Applied once per week

Chemical Requirement

Chilled water Loop

- Inhibitor:
  - *Main Campus Loop*:
    - Silicate 10%-50% 20 PPM
    - TTA 10%-50% 4-5PPM
  - *Other Campus Loops*:
    - Moly 2-15% 50 PPM
    - TTA 2-5% 4-5 PPM
    - Borate 2-10%
    - Polymer 1-5%
- Biocide 1:
  - Glutaraldehyde 45% 120 PPM
- Biocide 2:
  - Isothiazoline 1.5% 240PPM

Hot water Loop

- Inhibitor:
  - 15-30% Sod. Nitrite
  - 3-10% Borate
  - 1-5% TTA
  - 1-5% Polymer
- Biocide 1:
  - 1.5% Isothizoline 120 PPM

Chemical Requirement

STEAM BOILER

- Oxygen Scavenging Program
  - According to ASME guidelines for boiler Water treatment
  - Inhibitor
    - Catalyzed Liq. Sodium Bisulfite 25-50%
- Feed water Treatment
  - Inhibitor
    - Phosphate 10-30%, Polymer 10-50%, Caustic 1-5%
- Steam condensate Treatment
  - Inhibitor
    - Bulk: DEAE 5-30%, Cyclohexylamine 10-30%
    - Alternate: Morph. 10-15%, Cyclo. 10-25%, DEAE 10-25%
    - Caustic as needed. Sodium Hydroxide 50%

Monitoring Results
(Sample of GT program data)

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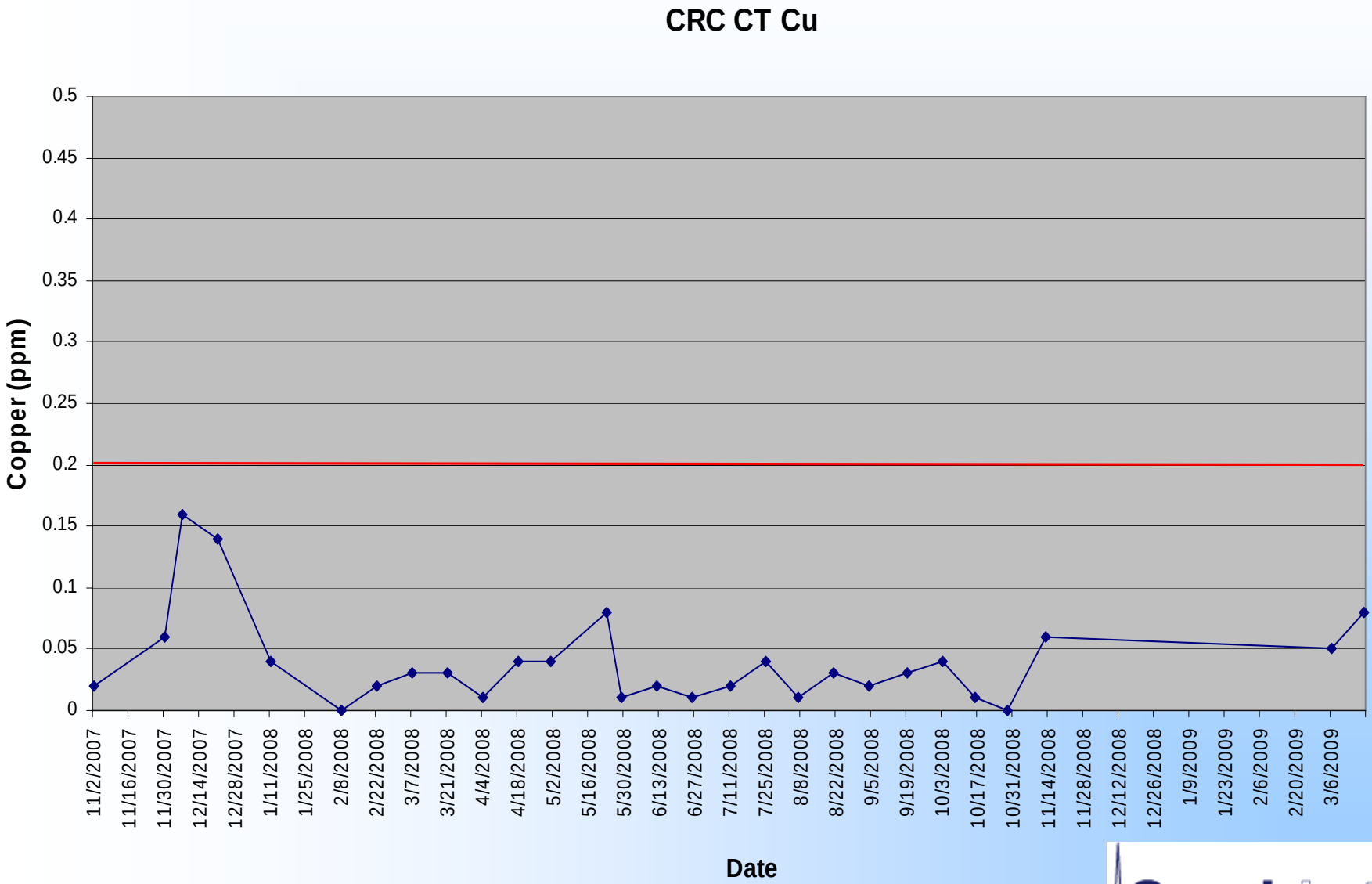
Cooling tower water chemistry analysis

Date	Molybdenum	Conductivity	Free Halogen	pH	Azole	Copper	Phosphonate	Bacteria
Range	0.80-1.20 ppm	850-1050 umhos	0.5-1.0 ppm	7.5-8.5	1.0-3.0 ppm	<0.2 ppm	3-5 ppm	<10,000 cells/ml
11/2/2007	8.4	708	0.01	7.9	3.2	0.33	8	100
11/9/2007	1.14	619	0.09	8.2	1	0.33	8.5	100
11/12/2007	1.01	601	0.56	8.2	1.5	0.20	6.9	100
11/30/2007	0.98	825	0.69	8.3	1.8	0.12	5.2	100
12/21/2007	1.2	813	0.4	7.9	2	0.09	5.7	1000
1/11/2008	0.98	885	0.66	8.3	2.9	0.03	5.5	100
2/8/2008	2.1	880	0.23	8.4	3.5	0.02	6	0
2/22/2008	1.6	853	0.66	8.3	3.1	0.01	5.1	0
3/7/2008	1.5	875	0.65	8.28	3.3	0.01	5	0
3/21/2008	1.4	908	0.15	8.41	2.9	0.02	5.1	0
4/18/2008	0.08	1215	0.97	8.5	0.2	0.2	0.5	0
5/1/2008	0.63	2353	1.6	8.62	1.3	0.21	3.3	0
5/23/2008	0.75	1035	0.05	8.51	1.1	0.15	3.2	0
5/29/2008	0.85	795	0.89	8.1	1.7	0.07	3.3	0

Cooling tower water copper (Cu) control chart



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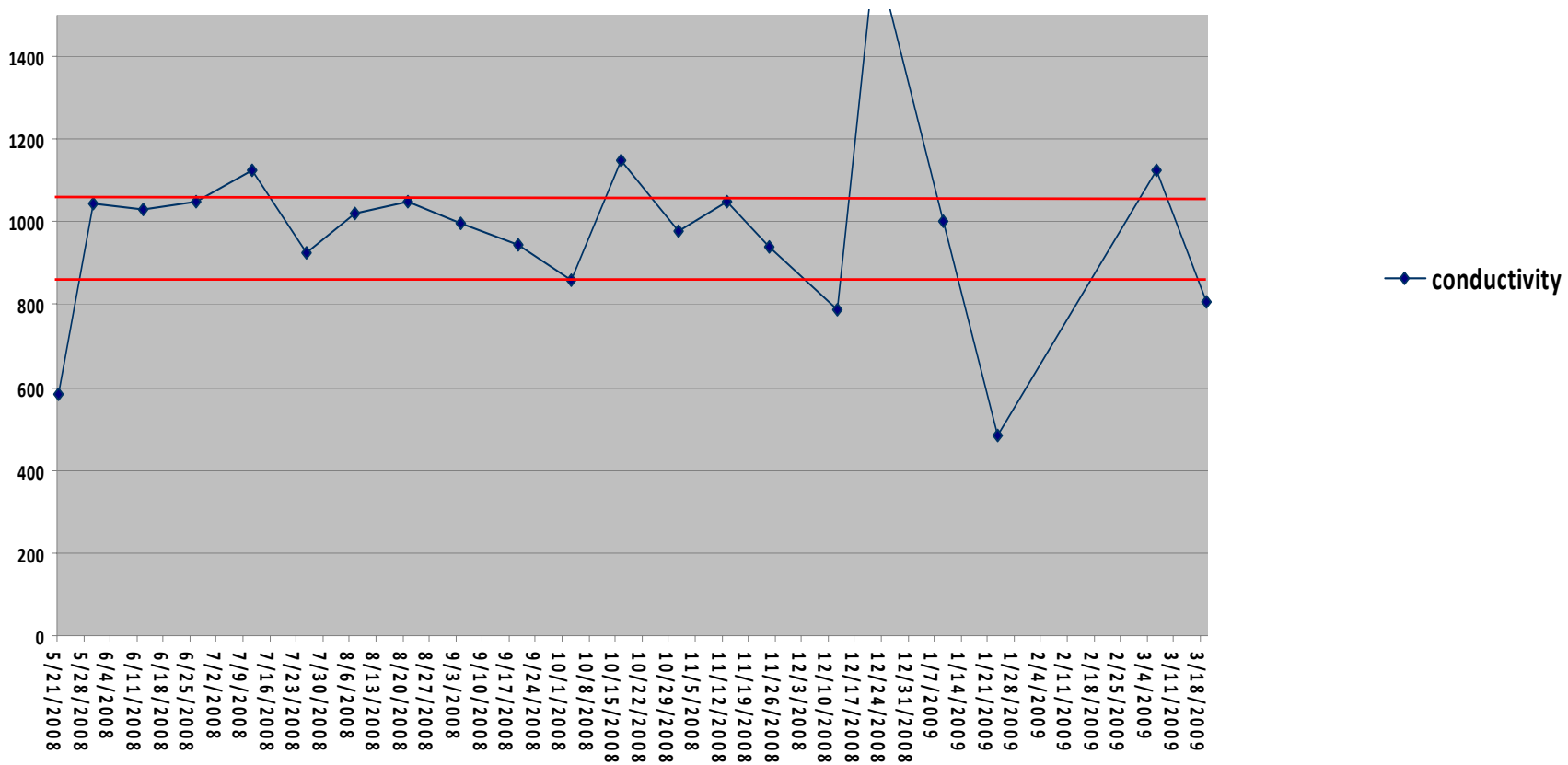
Cooling tower water conductivity control chart (umhos)



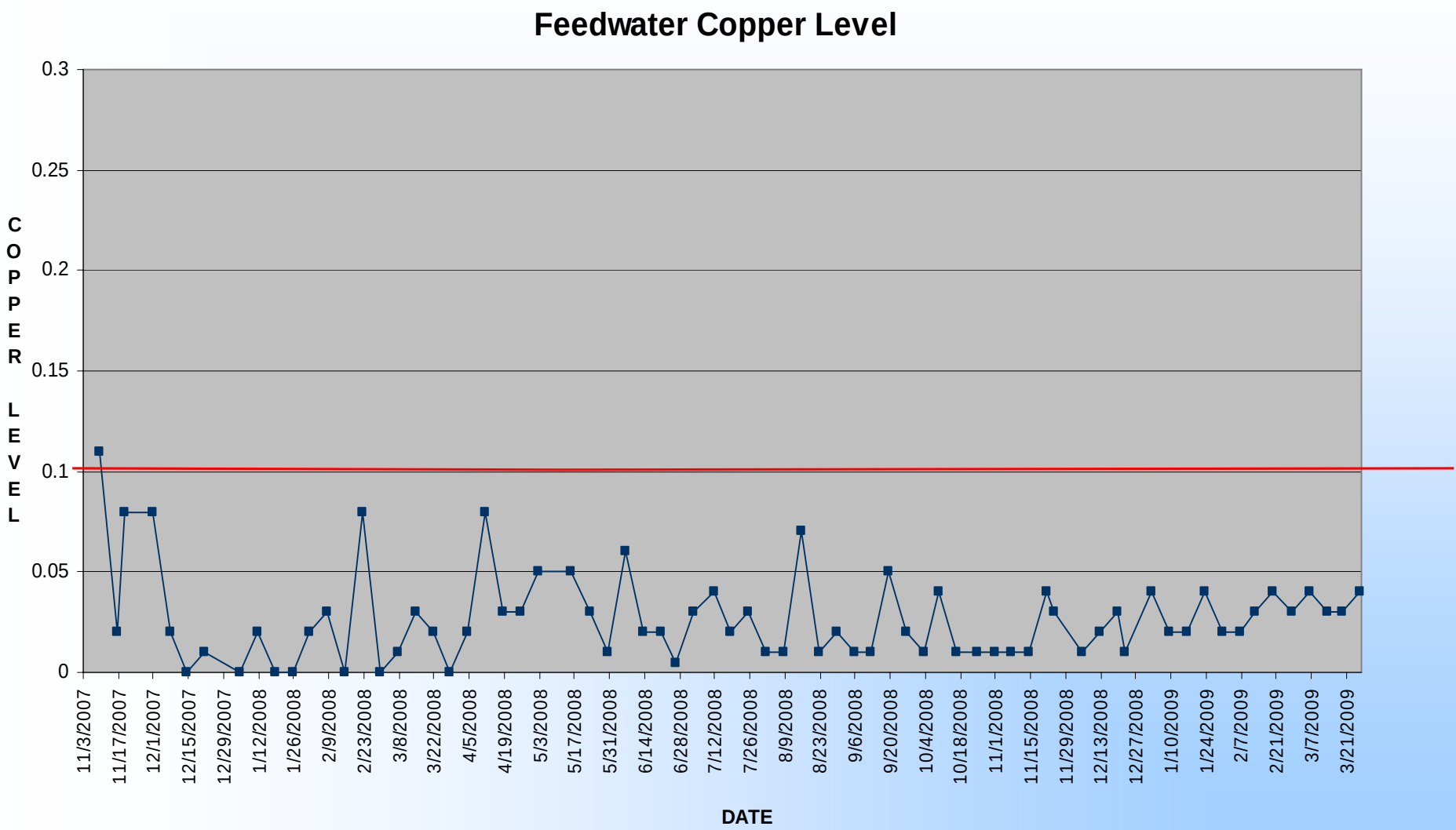
Boiler water chemistry analysis

Following test are performed for each Boiler

Alexander Coliseum #2

Date	P Alk 450 - 600 ppm	M Alk 500 - 800 ppm	OH Alk 350-450 ppm	Phosphate 30 - 50 ppm	Sulfite 30 - 50 ppm	Conductivity 2400 - 3200 mhos	pH 10.5 - 11.5
11/12/07	738	1100	376	2.1	100	5500	11.8
11/30/07	650	900	400	25	55	3600	11.5
01/04/08	500	600	400	16	20	4840	12.2
01/18/08	750	900	600	12	80	6600	11.3
02/01/08	800	1000	600	50	40	7562	11.7
02/15/08	550	800	300	168	50	3724	11.7
02/22/08	300	350	250	80	30	1400	11.2
03/14/08	450	550	350	40	20	2160	11.2
03/28/08	350	500	200	50	30	2630	10.9
04/11/08	300	400	200	50	30	5400	11.1
04/25/08	800	950	650	68	30	4650	11.6
05/09/08	800	1300	300	250	70	5597	11.6
05/23/08	850	1350	350	68	70	5075	11.6

Boiler Water copper (Cu) control chart



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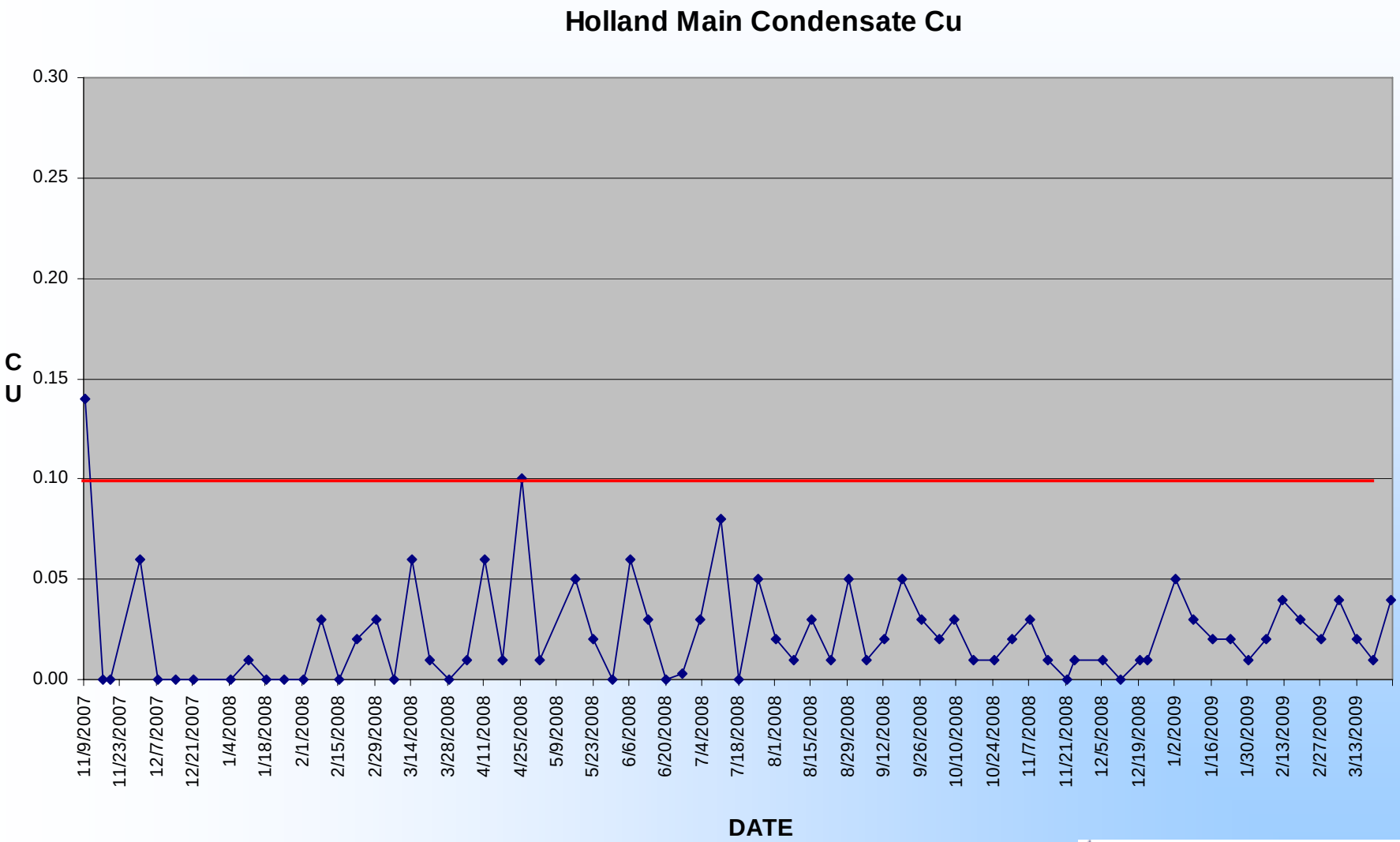
Boiler condensate copper (Cu) control chart



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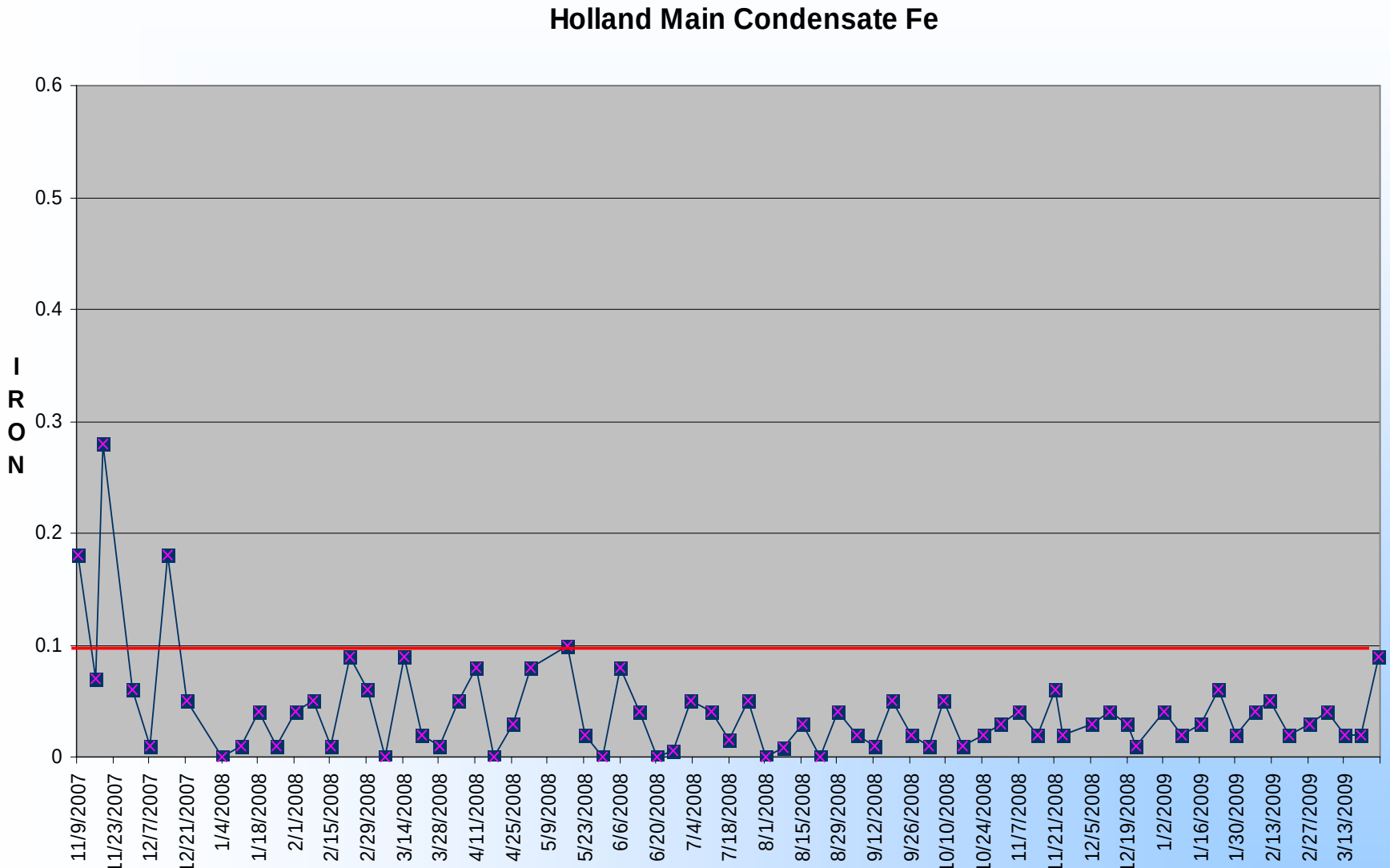
Boiler condensate iron (Fe) control chart



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The corrosion control/ monitoring

	1ST QUARTER RESULTS		2ND QUARTER RESULTS	
SAMPLE LOCATION	MILD STEEL RATE (target is < 1.0)	COPPER RATE (target is 0.1)	MILD STEEL RATE (target is < 1.0)	COPPER RATE (target is 0.1)
10TH TWR 1	0.4	<0.1	0.1	<0.1
10TH TWR 2	0.9	<0.1	0.2	<0.1
10th TWR 3	0.1	<0.1	0.1	<0.1
10th TWR 4	0.4	<0.1	0.3	<0.1
10th TWR 5	3.2	<0.1	4.2	<0.1
10th TWR 6	------	-------	<0.1	<0.1
TECH SQUARE	0.3	<0.1	0.3	<0.1
HOLLAND	-------	-------	0.1	<0.1
MARC TOWER	0.1	<0.1	0.1	<0.1
CRC TOWER	0.3	<0.1	0.3	<0.1
VAN LEER	0.2	<0.1	0.2	<0.1
PETITT	0.2	<0.1	0.2	<0.1
IPST PROCESS	<0.1	<0.1	<0.1	<0.1
IPST TOWER	0.3	<0.1	2.3	<0.1
AEROSPACE COMB.	0.2	<0.1	0.3	<0.1
GCATT	<0.1	<0.1	0.1	<0.1
O'KEEFE	<0.1	<0.1	0.2	<0.1
RICH	<0.1	<0.1	0.7	<0.1
MARC TOWER II	<0.1	<0.1	0.1	<0.1
WEBER	<0.1	<0.1	0.6	<0.1
CARNEGIE	NO RACK	NO RACK	NO RACK	NO RACK
STRUCTURE LAB	NO RACK	NO RACK	NO RACK	NO RACK
490 10TH ST	NO RACK	NO RACK	NO RACK	NO RACK

$ Saving
Cost Analysis

Contract Cost

Type (System)	Number of Systems	Number of Tests per visit	Frequency of visit for each equipment (annually)	Total Visits (Annually)	Total Tests (Annually)
Boilers (Feed Water)	1	5	26	26	130
Boilers (Condensate)	1	5	26	26	130
Boilers (Softener)	1	5	26	26	130
Boilers	47	7	26	1170	8190
Satellite Cooling Towers	15	8	52	780	6240
Main Cooling Towers	12	8	52	624	4992
Closed Loop (Hot)	61	2	4	244	488
Closed Loop (Cold)	25	4	4	100	400
Processed Loop	5	3	12	60	180
Cooling Towers (Corrosion Control)	24	2	4	96	192

Visits (Annually)	Tests (Annually)	Contract Price
3152	21072	$115821 per year

Price per Visit = $ 37.00

Price per Test = $ 7.00

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Management Cost

Person	Number of Hours	Rate $/hr	Total hours (yearly)	Total price (yearly)	Actual price (total + 15%)
Manager	5 hrs/week	28	260	**$7,280.00**	**$8,372.00**
Leader	4 hrs/week	27	208	**$5,616.00**	**$6,458.40**
Worker	80 hrs/week	19	3840	**$72,960.00**	**$83,904.00**
Student	10 hrs/week	10	520	**$5,200.00**	**$5,980.00**

Total Management cost	**$104,714.40**

Calculated Saving sample from Scale Treatment

- **Energy Saving by scale control**
  - **Boiler**
    - Fuel consumption = 450,000 million Btu of fuel
    - Operating time = 8,000 hrs
    - Rated Capacity = 45,000 lb/hr of 150 psig steam
  - **Scale formed**
    - 1/32nd of an inch thick
    - Normal Composition
    - Results in fuel loss of 2%
  - Savings
    - Price of energy = $8.00/MMBtu
    - Annual Operating Cost saving
    - **=** 450,000 MMBtu/yr x $8.00/MMBtu x 0.02
      =$72,000

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Thank You !!!