Controlling Condensate & Feedwater Dissolved Oxygen & Air Inleakage

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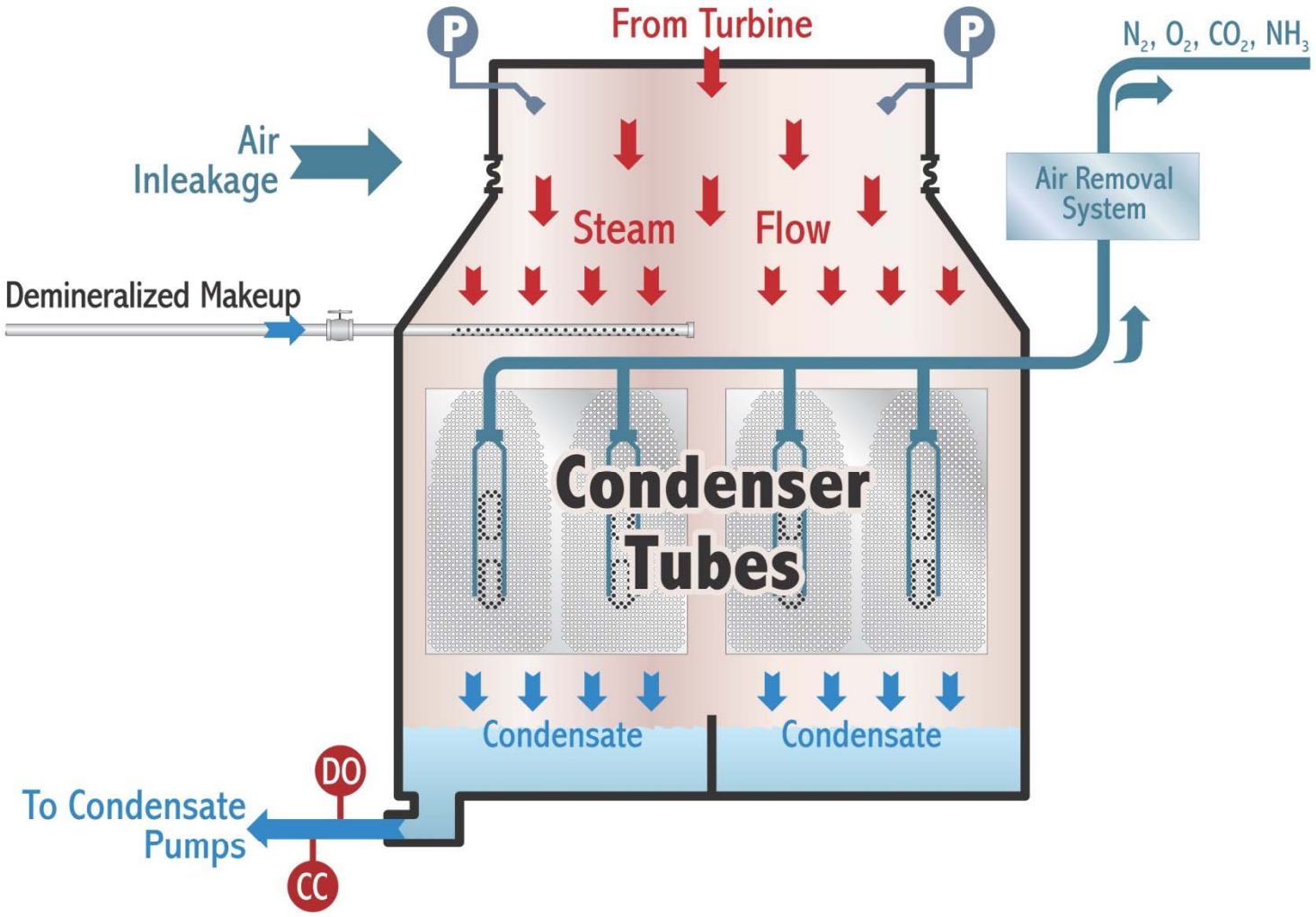
Air Inleakage/Oxygen Control Strategy

- Focus #1: Find It (Monitoring)
- Focus #2: Eliminate or Reduce Sources (Air & Makeup)
  - Oxygen in Air: 20.9% O_2 By Volume or 23.1% O_2 By Mass
  - CO_2 in Air: 0.04% By Volume
  - DO in Air Saturated Makeup: 8,000-14,000 ppb O_2
  - CO_2 in Air Saturated Makeup: <0.8-1.0 µS/cm Cation Conductivity
- Chemical Removal – Not Covered in Presentation

Steam Surface Condenser



SLIDE 3

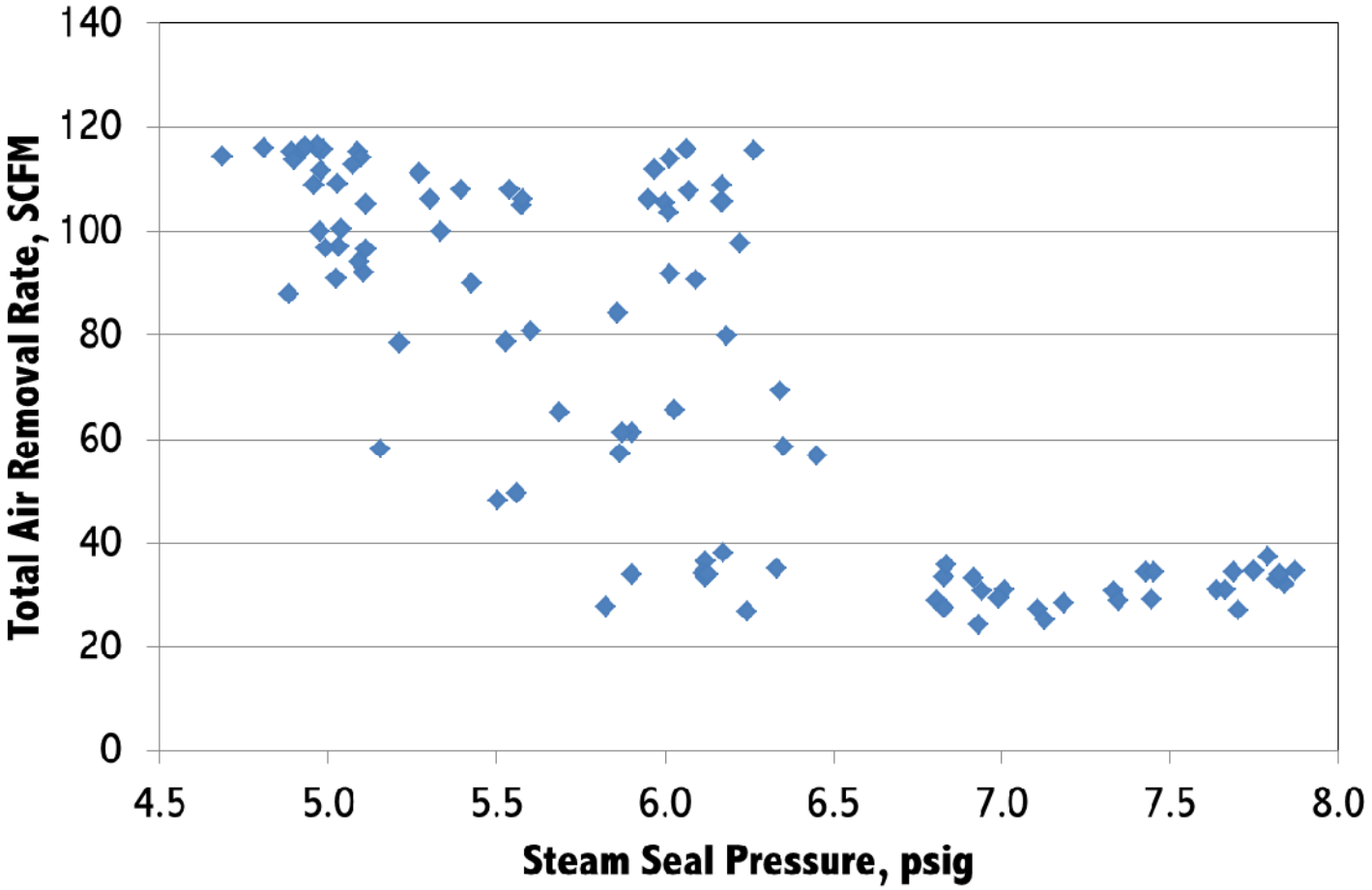
Ways to Monitor Air Intrusion

- Flow In: Air Inleakage
  - SF_6, Helium
  - Water/Steam Leaks During Operation & Shutdown
- Flow Out:
  - Air Removal Flow From Vacuum System: Total (cfm), Air (scfm),
  - Condensate CC (from CO_2) and DO (from O_2)
- What's Left Behind: Condenser Back Pressure

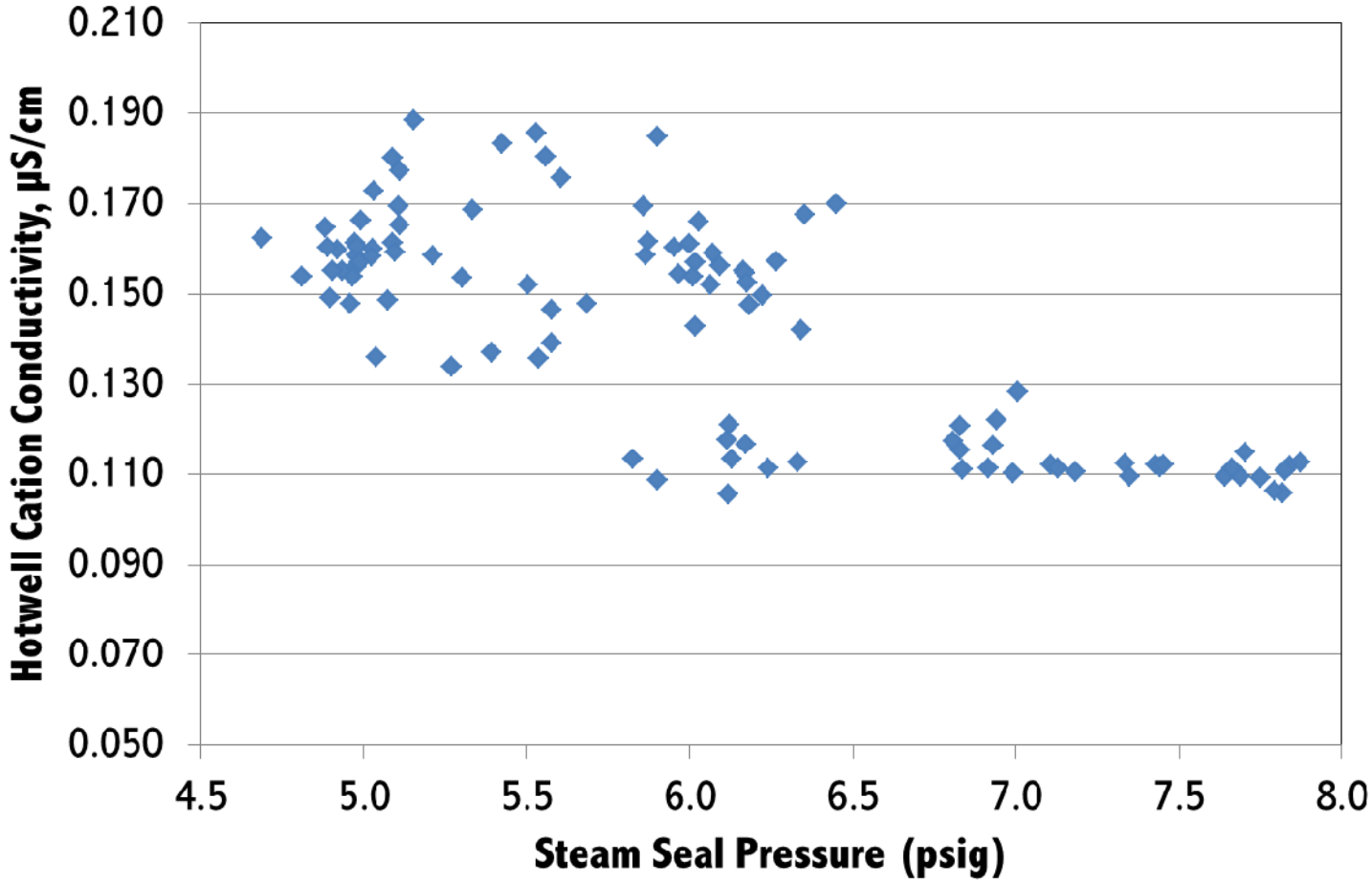
Justify Finding & Fixing Air Leaks

- Heat Rate Penalty Per Inch of Back Pressure For 520 mW Turbine (Example)
  - 116.5 BTU/kwh
  - ~$108,180 Per Month (Based On $2.48 Per MMBTU)
- Determining Your Penalty
  - Calculate Base Line Heat Rate
  - Induce Air Leak Until Back Pressure Rises Or Until Chemistry Limit Is Reached
  - Recalculate Heat Rate
- Use Heat Rate Justify Cost of Finding and Fixing Air Leaks

Total Air Removal Rate Vs. Steam Seal Pressure (daily cycling 40-100% load)



Steam Seal Pressure & Hotwell Cation Conductivity



Top View of Steam Seal Line

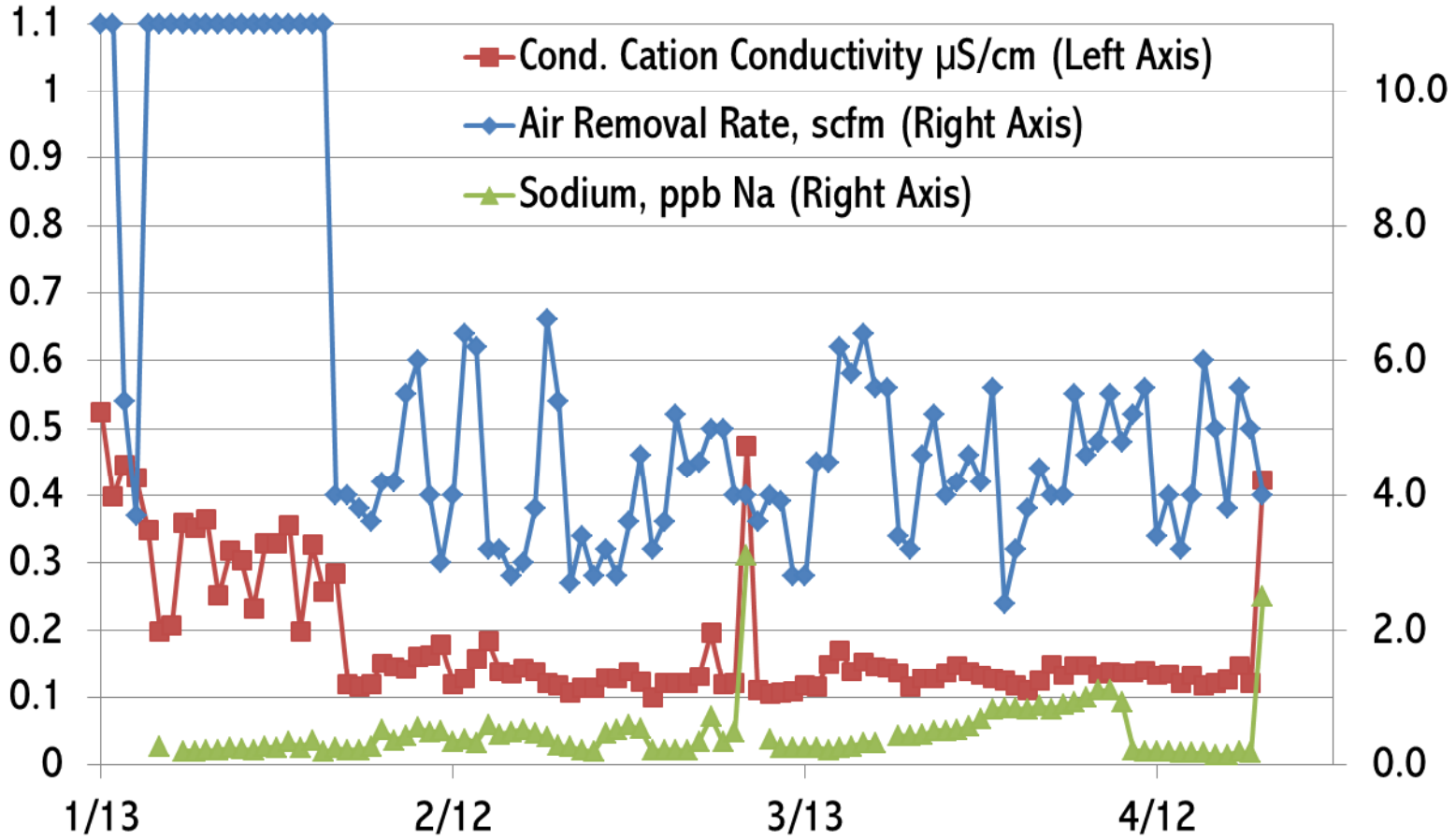
Bottom View of Steam Seal Line

Perforated Slop Drain

Dissolved Oxygen & Cation Conductivity Due to Air Leaks

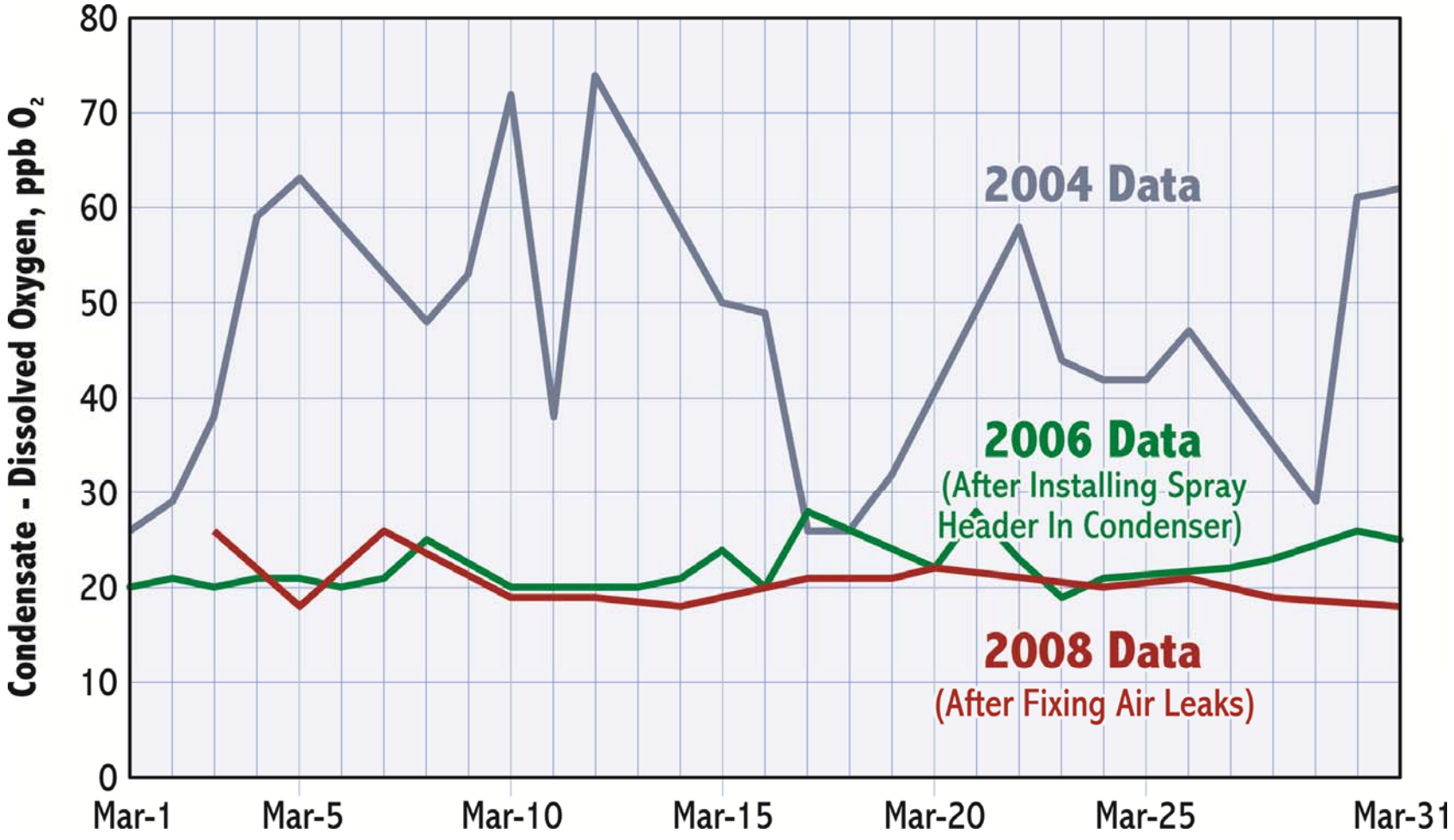
Condition	Air Removal Rate	Condenser Back Pressure Due To Air Inleakage	Hotwell / CPD Sample		
			Cation Conductivity	Hotwell Dissolved Oxygen	
				Not Subcooled	Subcooled
Air Inleakage Above Water Level	>2-3 scfm/100 mW (of Design Capacity)	Normal to High	High	Normal to High	High
	<1-3 scfm/100 mW (of Design Capacity)	Normal	Normal to Moderate	Normal	Normal to High
Air Inleakage Below Water Level	~0.01 scfm/Million pph of Condensate Flow	Unaffected	Unaffected	~10 ppb Increase	~10 ppb Increase
Reduced Vacuum Pump Capacity	Normal to Moderate	Possibly High	Normal to Moderate	Normal to Moderate	High

Effect of Air & Cooling Water Inleakage



SLIDE 12

Effect of Makeup Spray Header



SLIDE 13

Summary of Air Inleakage Tips

1. Inspect for Steam or Water Drips on Shutdown as well as during Operation
2. Use Heat Rate to Justify Air Leak Testing & Repairs
3. Raise Steam Seal Pressure to Reduce Air Leaks
4. Inspect Steam Seal Supply Lines & Slop Drains
5. Keep Air Removal Rate <2-3 scfm/100MW
6. Eliminate Air Leaks in Flooded Areas:
   0.01 scfm/million pph ~10 ppb O_2
7. Modify Makeup Water Distributor in Condenser