

# Power Plant Pumps

Mcllvaine Company  
Hot Topic Hour  
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# Presentation Overview

- Pump sales sold into power gen are second only to pumps in Water & Wastewater
- According to McIlvaine “Pumps World Market” report, the total pump market for power was \$2.6-B in 2011
- This presentation covers pumps in coal fired power plants, primarily, but is largely applicable to nuclear and combined cycle, as well.
  - Nuclear would not include pumps for flue gas scrubbing systems and ash and gypsum dewatering, or startup fuel pumps, among several others
  - Gas turbine combined cycle would not include ash dewatering, and certain components in scrubbing systems, among several others

# Major Pump Systems

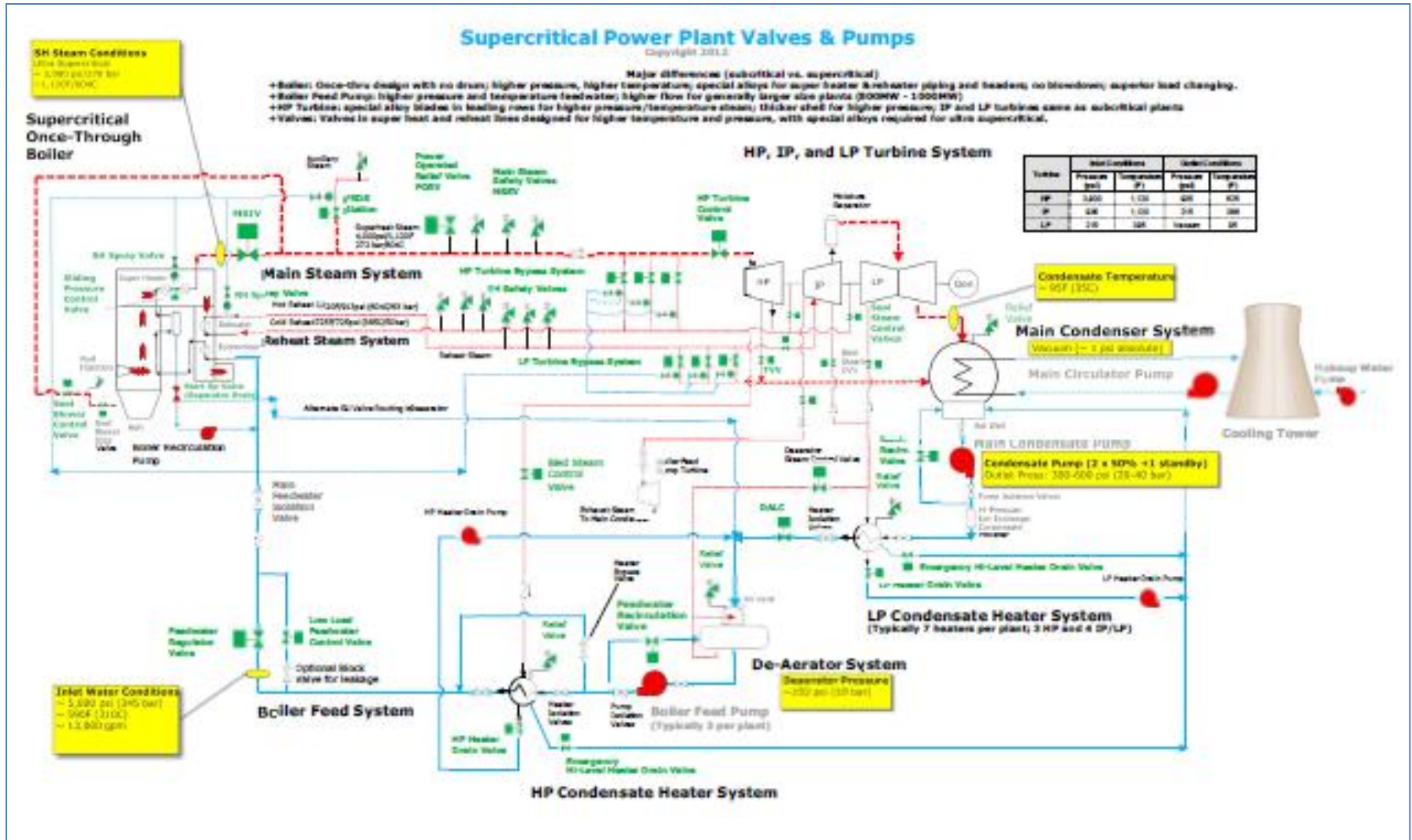
- For discussion purposes, a power plant can be segmented into two basic systems in terms of pump applications
  - **Primary systems** (prime movers of water in the water/steam cycle), and
  - **Secondary systems** (fuel and chemical transfer and injection, FGD slurry pumping, de-watering, service water, waste water, lubrication pumps, and other ancillary systems)

# Primary Pumps

# Primary Systems

- Primary pump systems include
  - Boiler feed pumps (primary and startup)
  - Condensate pump
  - Cooling water circulation pump
  - Cooling water make-up pump
  - Heater drain pumps

# Primary Pump Overview [\(hyperlink\)](#)



# Primary Pumps

- **Boiler Feed Pumps**
  - High pressure, high flow barrel type multi-stage centrifugal pumps rated ~ 5000 gpm and 2400 psi for major utility power plant systems (pressures will vary for subcritical vs. supercritical)
- **Condensate Pumps**
  - High flow centrifugal pumps rated ~5000 gpm to move condensate from the condenser hot well to a de-aerator and back to the feed water stream ahead of the boiler.



# Primary Pumps

- Cooling Water Systems
  - Hyperboloid (natural draft)
  - Forced or Induced Draft
  - Once-through
- Purpose
  - To remove heat from cooling water that has been circulated through the condenser system.

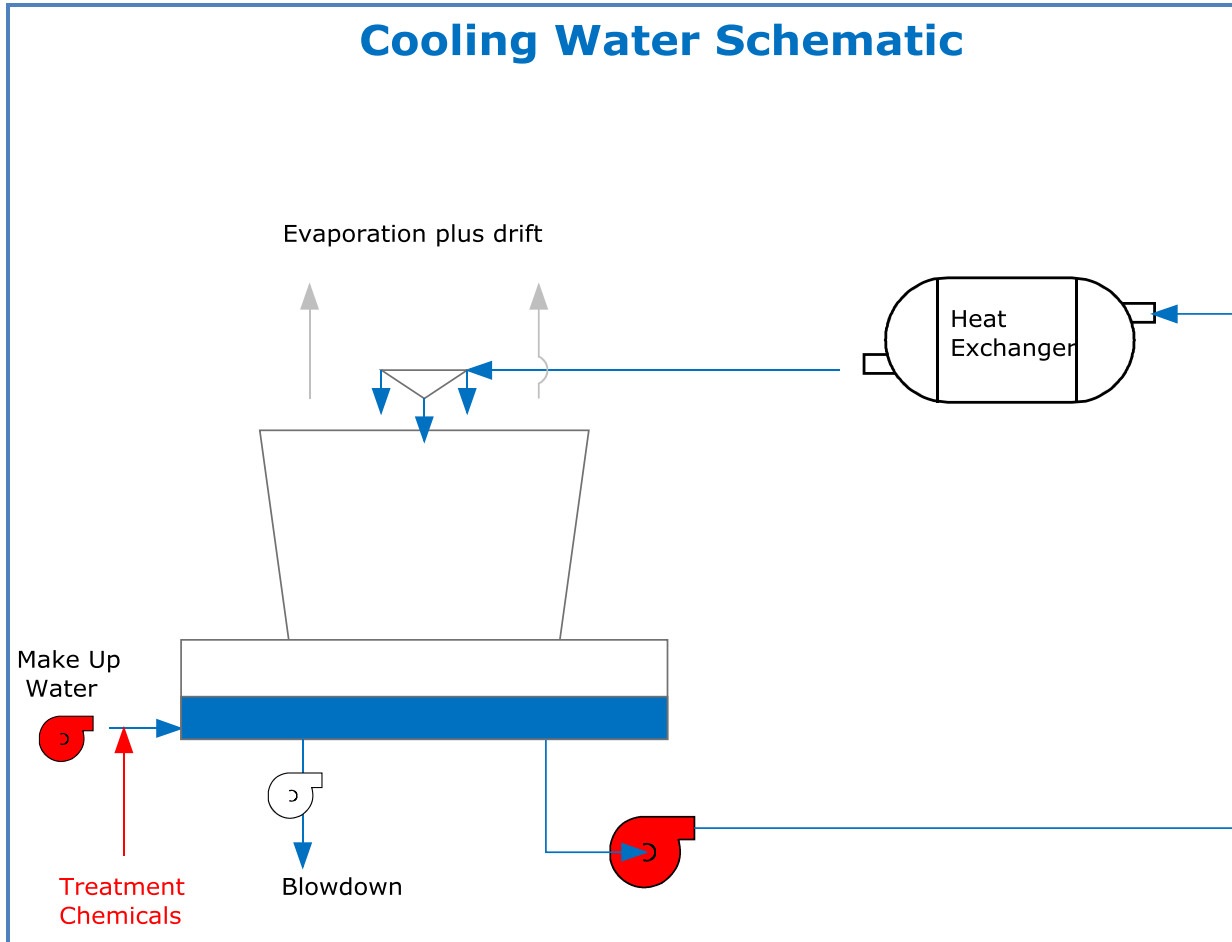




# Primary Pumps

- Once-Through systems
  - Pump surface water through cooling unit and directly back to source (lake, river, or ocean)
- Loop Systems
  - Circulating pumps
    - Large centrifugals rated 100,000 gpm or more. Total coolant flow more than 200,000 gpm for a 400MW plant.
  - Makeup water pumps
    - Large centrifugals rated 5,000 gpm. Makeup is typically 2% to 3% of total flow, and is required to replace water lost to windage, evaporation, and blowdown.

# Primary Pumps

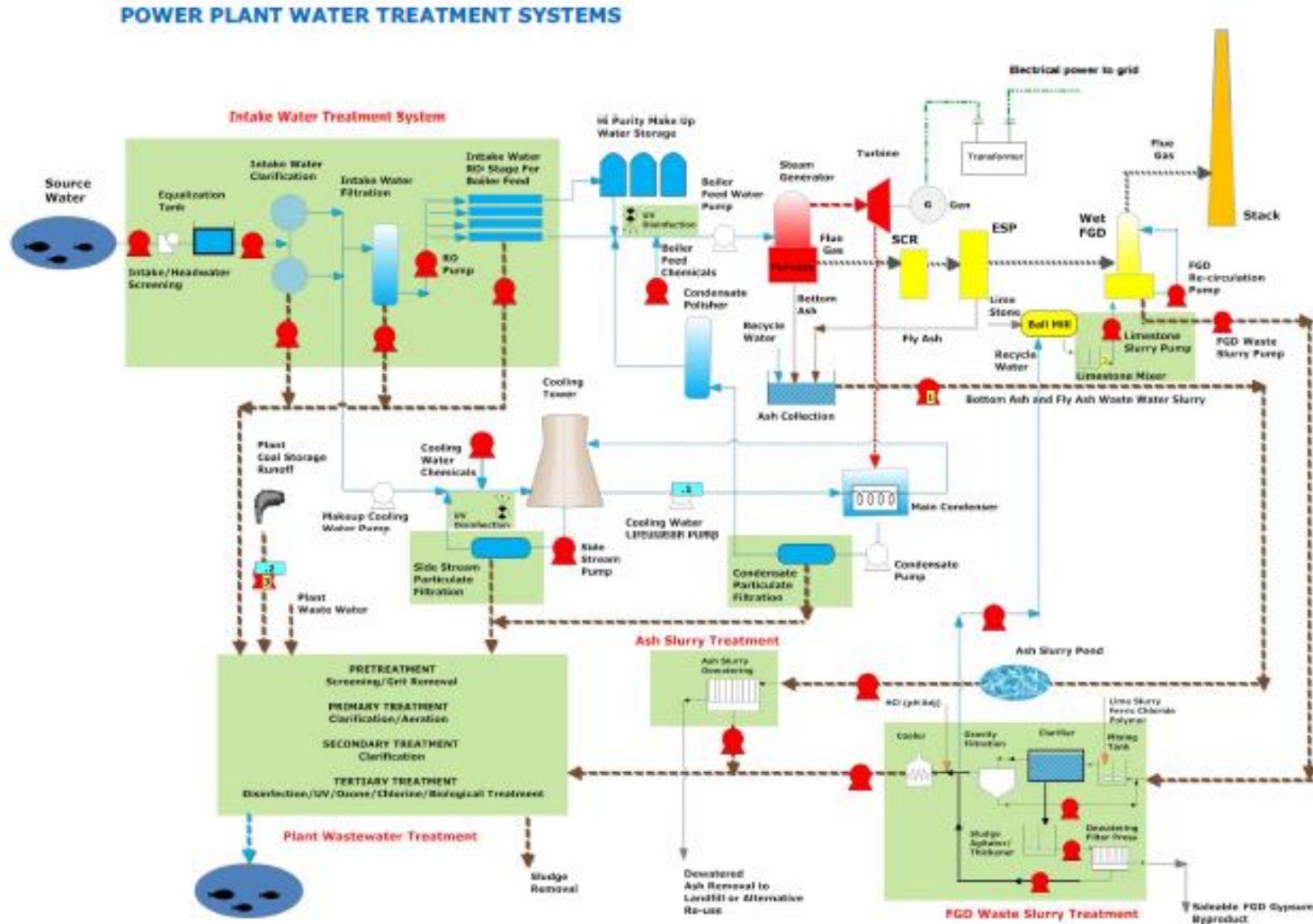


# Secondary Pumps

# Secondary Pumping Systems

- Secondary pumps include
  - Chemical feed pumps
  - Chemical transfer pumps
  - Fuel transfer pumps
  - Fuel injection pumps
  - Slurry pumps and de-watering pumps
  - Lubrication pumps
  - Service water pumps, fire service pumps, others

# Secondary Pump Schematic [\(hyperlink\)](#)



# Secondary Pumps

- **Metering pumps for boiler treatment and cooling water treatment**
  - Typically diaphragm metering pumps rated < 20 gph and < 600 psi. Solenoid operated.
    - Ammonia (ph control), hydrazine (oxygen scavenging), Phosphate (hardness), other chemicals
  - A complete set of injection pumps (frequently skid or panel mounted) is provided for each boiler
  - Total injection pumps for water treatment is on the order of 24 per plant, including backups for these critical front-end systems.



# Secondary Pumps

## Boiler Feedwater Treatment

Broad Function	Specific Function	Chemical Agent	Comments	
Corrosion Inhibitor	Oxygen Scavenger	Sodium Sulfite	Most commonly used for boilers up to 35 Bar (500 psi)	
		Hydrazine	Rarely used except occasionally for high pressure boilers	
		Diethylhydroxylamine (DEHA)	Organic - used for high pressure boilers up to 85 Bar (1200 psi)	
		Methylethylketoxime (MEKO)	Organic - used for high pressure boilers up to 85 Bar (1200 psi)	
	Neutralizing Amine (pH Control)	Morpholine	For injection in feedwater or steam header to neutralize carbonic acid	
		Diethylethanoethanal (DEAE)	For injection in feedwater or steam header to neutralize carbonic acid	
		Cyclohexylamine	For injection in feedwater or steam header to neutralize carbonic acid	
	Film-Forming Amine (Precipitating Inhibitor)	Octadecylamine (ODA)	Usually injected in steam header to protect condensate piping	
		Ethoxylated soya amine (ESA)	Usually injected in steam header to protect condensate piping	
	Passivating Agent (Anodic Inhibitor)		Nitrite	For use with low pressure boilers below 20 Bar (300 psi)
			Chromate	Not commonly used for environmental/health reasons
			Molybdate	Considered more environmentally acceptable than chromate or zinc
Orthophosphate			Commonly used for passivating metal surfaces.	
Diethylhydroxylamine (DEHA)			For injection in feed water to promote protective oxide layer	
Scale Inhibitor	1st-stage treatment	Lime (calcium hydroxide)	Added in the clarifier stage to precipitate calcium, magnesium, silica	
	Precipitate soft sludge	Phosphate (Mono, di- or trisodium phosphate)	Injected after feed pump to precipitate calcium and magnesium in soft sludge removed in boiler blowdown.	
	Form soluble compounds	Chelates [Nitrilotriacetic acid (NTA) and ethylenediamine tetraacetic acid (EDTA)]	Injected after feed pump. Removes hardness by forming soluble compounds that are purged in boiler blowdown.	
	Form soluble compounds	Polymers	Injected after feed pump. Polymers used with chelates for maximum effectiveness.	

# Secondary Pumps

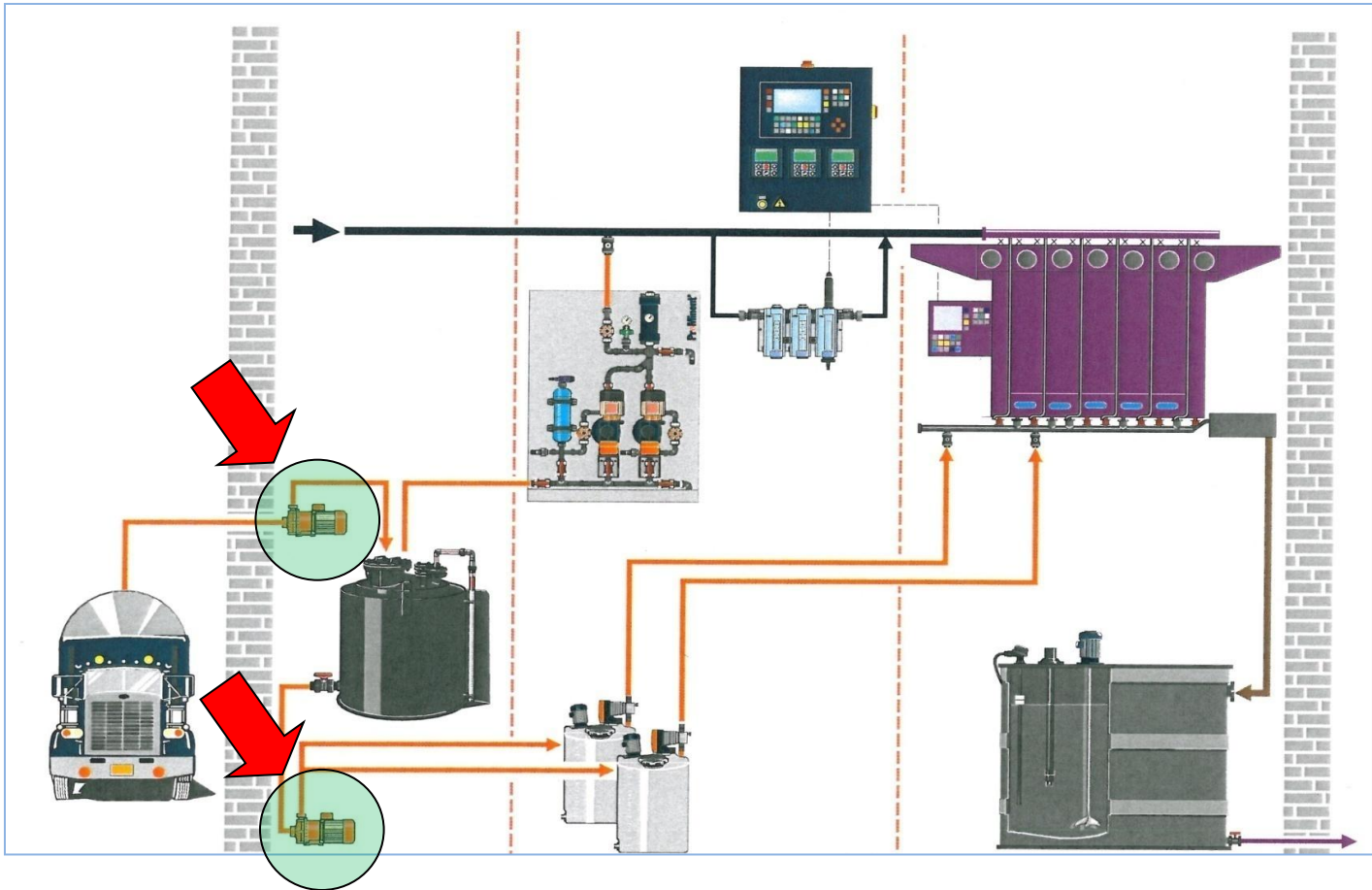
## Cooling Water Treatment

Broad Function	Specific Function	Chemical Agent
Biocide	Disinfection	Chlorine/bromine
Corrosion Inhibitor	pH Control	Sulfuric acid
	Film-forming inhibitor	Ortho/polyphosphate
Scale Inhibitor	Prevent insoluble precipitates	Phosphonate
	Prevent insolubel precipitates	Polymers

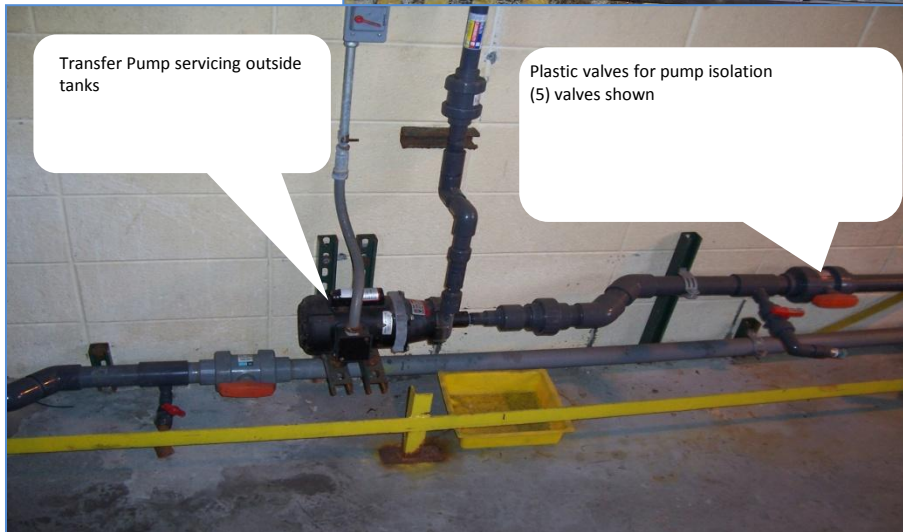


# Secondary Pumps

**Transfer Pumps** from bulk storage to day tanks (chemicals & fuels)



# Transfer Pump Systems



# Secondary Pumps - Lubrication

- Main turbine
  - Skid systems for cooling and filtration
    - Gear or progressive cavity pumps
- Other rotating equipment
  - Coal & limestone pulverizers , conveyors
    - Gear-type pd pumps.
- Transformers
  - Main step up transformer
    - Load tap changers with gear-type pd pumps



Skid-mounted lube oil conditioning system for turbines



Load Tap Changer filtration unit by Oil Filtration Systems, Inc.

# Secondary Pumps- Fire Service

- Fire Service pumps and other service water pumps for equipment cooling, equipment washdown, etc



# Summary of Secondary Pumps

<b>Power Plant Secondary Pumping Systems</b> (Information abstracted from the Pump Handbook by Igor J. Karassik, Joseph P. Messina, Paul Cooper, and Charles C. Heald)	
<b>Chemical Feed Systems</b> Amine pumps Hydrazine pumps Phosphate pumps Caustic feed pumps Acid feed pumps Ammonia pumps Regeneration waste pumps Demineralizer pumps Neutralizing metering pumps Acid bulk pumps Caustic bulk pumps Inlet and effluent de-mineralizer waste tank pumps	<b>HVAC System</b> Hot water circulating pumps Chilled water pumps
	<b>Service Water System</b> Service water pumps Air preheater wash pumps Cooling water booster pumps Primary air heating coil condensate return pump Sump pump Closed cooling water system pump
<b>Fuel Oil System</b> Fuel oil transfer pumps Secondary fuel oil pumps Secondary fuel oil heater drip pumps Ignitor oil pumps Auxiliary boiler fuel pump Warm-up oil pumps Hi-temperature oil circulating pumps Low-temperature oil circulating pumps Distillate oil unloading pump Fuel oil additive unloading pump Fuel oil additive transfer pump Fuel oil additive metering pump Fuel oil hose drain pump	<b>Lubrication Oil System</b> Lubricating oil transfer pumps Starting oil pump Wash oil pump Emergency oil pump
	<b>Fire Protection System</b> Fire pumps Jockey pumps Foam proportioning pump
	<b>Miscellaneous Pumps</b> Ash sluice pumps Slurry pumps Hydrostatic pressure test pump Transfer pumps

# Summary

# Overview

- Primary Pumping Systems
  - Feed water pumps, condensate pumps, cooling water pumps
- Secondary Pumping Systems
  - Chemical feed pumps
  - Chemical and fuel transfer pumps
  - Slurry and sludge pumps, de-watering pumps
  - Lubricating system pumps for turbines, conveyers, pulverizers, and other rotating equipment
  - Service water pumps, fire service pumps
  - Drainage pumps and other misc pumps

# Major Pump Types

- Most pumps in a power plant are centrifugal, which mirrors the general pump market
- Other types are used for specific applications
  - AODD or lobe (slurry and sludge)
  - Diaphragm, peristaltic, progressive cavity (chemical metering)
  - Vane, progressive cavity, screw (fuel handling)
  - Others



# Continued Growth Market

- The most active regions for new power plant construction are China and India. In China, despite the recent economic cool-off, it is estimated that approximately 1.0 to 1.5 new power plants are brought on line per week.
- Japan can be expected to engage in new power plant construction as it moves to de-commission its fleet of nuclear power plants
- Germany and Italy could likewise see power plant construction as they proceed with de-commissioning nuclear power plants
- The United States and western Europe continue to build “latent” demand for new power plants to replace the aging fleet of existing coal and nuclear plants, currently on life extension due to financial and environmental roadblocks to new construction.