

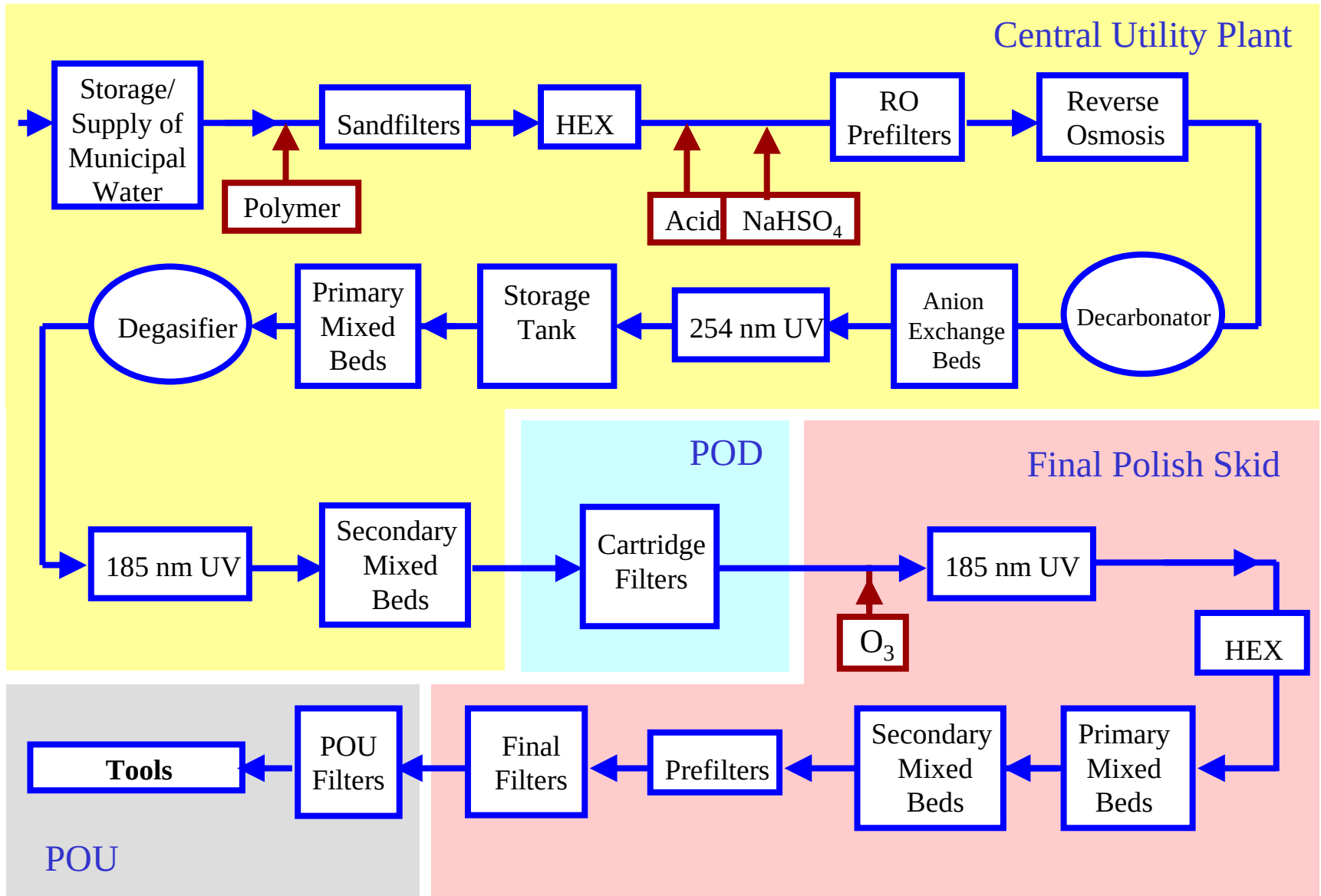
UPW Production and Quality Analysis at IBM DI Water Facility (Burlington, VT)

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Site UPW Production Process Schematic



UPW Quality Control

Critical Points for UPW Quality Control

- CUP Effluent Flow
- POD Effluent Flow
- Final Polish Skid Effluent Flow

Criteria

• Resistivity	- 1 & 5	• Silica	- 1 & 4
• TOC	- 1 & 5	• Oxygen	- 1 & 5
• Bacteria	- 4	• Nitrogen	- 1 & 5
• Particles		• Pressure	- 1 & 5
- Trend	- 1, 2 & 5	• Temperature	- 1 & 5
- Quantity -	- 3		
• Metals	- 4		
• Cations	- 4		
• Anions	- 4		

Technique

1. Online, real-time data collection and trending
2. Laser Measurement for quick ID of process fluctuations
3. Routine SEM for quantification
4. Routine Laboratory Analysis
5. Statistical Process Control



Statistical Process Control

Definitions:

Quality is inversely proportional to variability.

Quality Improvement is the reduction of variability in processes and products.

(Montgomery D., *Introduction to Statistical Process Control*)

SPC is a technique that quantifies quality of a product or population based on an analysis of the information contained in sample from that population. SPC defines specific formulas by which a product is sampled, tested, and evaluated, and the information in those data is used to control and improve the manufacturing process.

$$\bar{X} = \frac{\sum_{i=1}^n x_i}{n}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{X})^2}{n-1}}$$

$$\sigma_x = \frac{\sigma}{n}$$

SPC Control Limits:

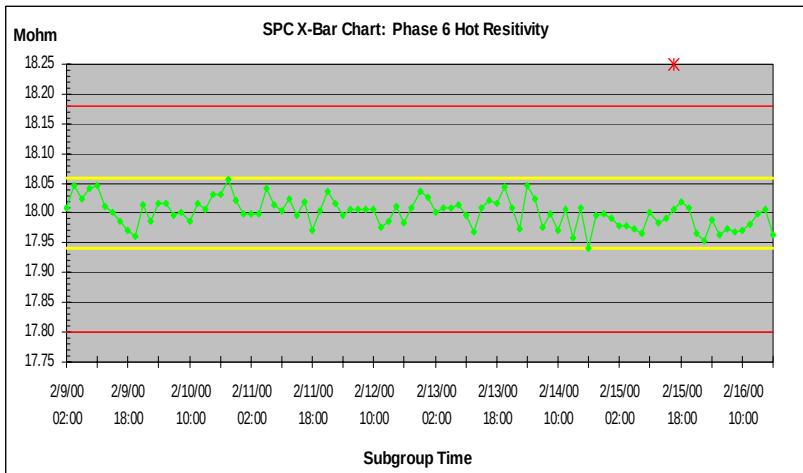
$$UCL = \bar{X} + 3\sigma_x$$

$$LCL = \bar{X} - 3\sigma_x$$

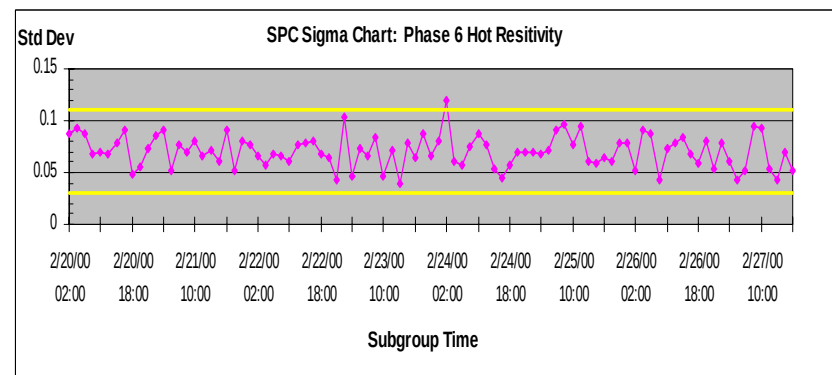
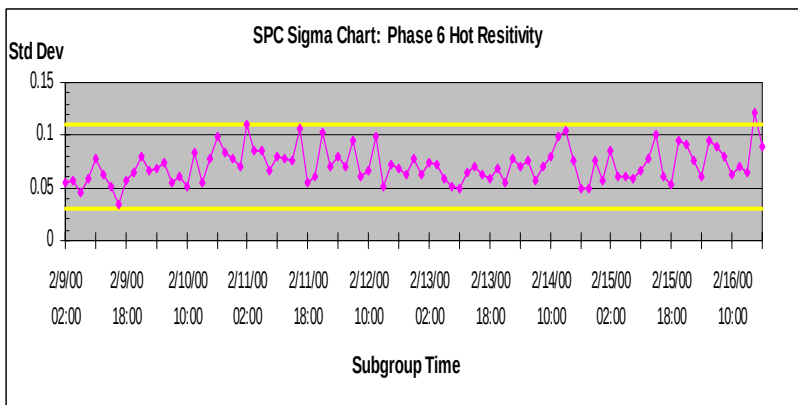
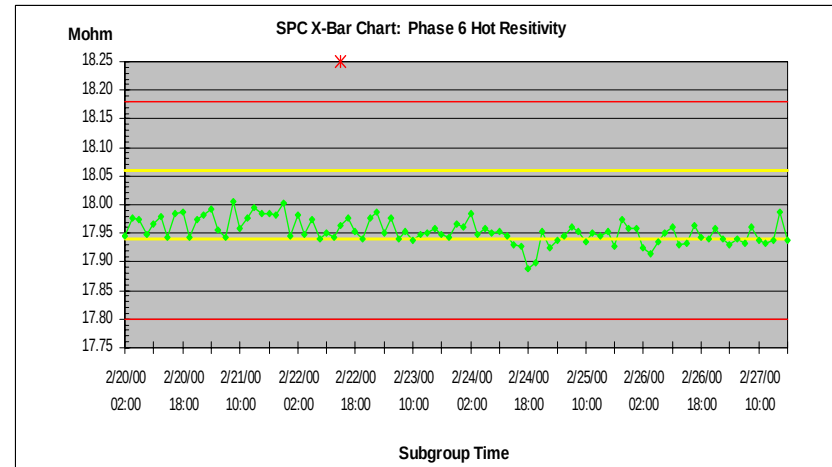


On-line SPC as a primary tool in detecting Process Shifts

Process is in control



Process is out-of-control



On-line SPC as an Instrumentation Diagnostic tool

Low Precision Instrumentation

