

| Process Variable  | Source of Noise  | Control Band  | Noise P-P Amplitude <sup>1</sup> |
|---|--|---------------|----------------------------------|
| <b>Inline Effluent pH<sup>3</sup></b>                   | Radial instead of axial mixing - amplified by a steep titration curve and aggravated by “insufficient distance” <sup>2</sup> and bubbles | 2%<br>20%     | 0.5%<br>50%                      |
| <b>Vessel Effluent pH<sup>3</sup></b>                   | Imperfect axial mixing - amplified by a steep titration curve and aggravated by “insufficient distance” <sup>2</sup> and bubbles         | 2%<br>20%     | 0.1%<br>10%                      |
| <b>Vessel Product pH<sup>3</sup></b>                    | Imperfect axial mixing - amplified by a steep titration curve and aggravated by “insufficient distance” <sup>1</sup> and bubbles         | 0.02%<br>0.2% | 0.01%<br>0.1%                    |
| <b>Desuperheater Temperature</b>                        | Imperfect axial mixing - aggravated by “insufficient distance” <sup>2</sup> and water droplets   | 0.1%<br>1%    | 0.02%<br>2%                      |
| <b>Incinerator, Dryer, and Kiln Draft Pressure</b>      | Imperfect mixing, velocity effects, and burner pulsing - amplified by sensitive measurement range (e.g. -0.25 to 0.25” wc)               | 1%<br>10%     | 0.1%<br>10%                      |
| <b>Boiler Drum and Column Sump Level</b>                | Boiling, shrink and swell, and “insufficient distance” <sup>2</sup> (surface level measurements affected the most)                       | 5%<br>20%     | 1%<br>10%                        |
| <b>Column Reflux Drum and Reactor Level<sup>4</sup></b> | Bubbles, foam, and turbulence (surface level measurements affected the most) and fluctuations in purge rate for bubblers                 | 0.1%<br>1%    | 0.05%<br>5%                      |
| <b>Storage or Raw Material Tank Level</b>               | Turbulence (surface level measurements affected the most) and fluctuations in purge rate for bubblers                                    | 0.2%<br>2%    | 0.02%<br>2%                      |
| <b>Dissolved Oxygen</b>                                 | Imperfect mixing and bubbles   | 1%<br>5%      | 0.5%<br>5%                       |
| <b>Liquid Flow</b>                                      | Erratic velocity profile, bubbles, and rangeability limit particularly for differential head meter                                       | 0.1%<br>5%    | 0.2%<br>20%                      |

Note 1 - peak to peak amplitude min and max percent of scale depends upon source, sensor type, and installation effects

Note 2 - “insufficient distance” for sensor in pipelines pertains to distance from inline equipment (e.g. static mixer, exchanger, or desuperheater) outlet and for sensor in vessels pertains to distance from entry of streams (e.g. dip tubes and downcomers).

Note 3 - effluent pH and product pH setpoints tend to be on the steep and flat parts of titration curves, respectively

Note 4 - these levels are important for “direct material balance control” in column and “residence time control” in reactor