# CONSTANTS FOR CONTROL CHARTS

Revised 13 March 2004

1. Average Range Chart

| $\bar{x}$ chart | R chart | |
|---|---|---|
| $UCL = \bar{\bar{x}} + A_2\bar{R}$ | $UCL = D_4\bar{R}$ | $\hat{\sigma} = \frac{\bar{R}}{d_2}$ |
| $LCL = \bar{\bar{x}} - A_2\bar{R}$ | $LCL = D_3\bar{R}$ | |
| $CL = \bar{\bar{x}}$ | $CL = \bar{R}$ | |

| $n$ | $A_2$ | $D_3$ | $D_4$ | $d_2$ |
|---|---|---|---|---|
| 2 | 1.880 | 0 | 3.267 | 1.128 |
| 3 | 1.023 | 0 | 2.575 | 1.693 |
| 4 | 0.729 | 0 | 2.282 | 2.059 |
| 5 | 0.577 | 0 | 2.115 | 2.326 |
| 6 | 0.483 | 0 | 2.004 | 2.534 |
| 7 | 0.419 | 0.076 | 1.924 | 2.704 |
| 8 | 0.373 | 0.136 | 1.864 | 2.847 |
| 9 | 0.337 | 0.184 | 1.816 | 2.970 |
| 10 | 0.308 | 0.223 | 1.777 | 3.078 |

2. Average Sample standard deviation chart

| $\bar{x}$ chart | s chart | |
|---|---|---|
| $UCL = \bar{\bar{x}} + A_3\bar{s}$ | $UCL = B_4\bar{s}$ | $\hat{\sigma} = \frac{\bar{s}}{c_4}$ |
| $LCL = \bar{\bar{x}} - A_3\bar{s}$ | $LCL = B_3\bar{s}$ | |
| $CL = \bar{\bar{x}}$ | $CL = \bar{s}$ | |

| $n$ | $A_3$ | $B_3$ | $B_4$ | $c_4$ |
|---|---|---|---|---|
| 2 | 2.659 | 0 | 3.267 | 0.7979 |
| 3 | 1.954 | 0 | 2.568 | 0.8862 |
| 4 | 1.628 | 0 | 2.266 | 0.9213 |
| 5 | 1.427 | 0 | 2.089 | 0.9400 |
| 6 | 1.287 | 0.030 | 1.970 | 0.9515 |
| 7 | 1.182 | 0.118 | 1.882 | 0.9594 |
| 8 | 1.099 | 0.185 | 1.815 | 0.9650 |
| 9 | 1.032 | 0.239 | 1.761 | 0.9693 |
| 10 | 0.975 | 0.284 | 1.716 | 0.9727 |
| 11 | 0.927 | 0.321 | 1.679 | 0.9754 |
| 12 | 0.886 | 0.354 | 1.646 | 0.9776 |

**Reference:** Montgomery, Douglas C., "Introduction to Statistical Quality Control Third Edition", John Wiley & Sons Inc, New York, 2001.