

INDIVIDUAL AND RANGE CHARTS

In certain situations variable control charts for average and range may not be suitable and in these cases individual and range charts may be useful.

Examples of such cases are:-

- a. Time consuming inspections and destructive tests where inspection costs prevent large groups of data from being collected.
- b. Chemical or other continuous flow processes, where any readings taken at the same time would probably be identical.
- c. Administrative processes where, for instance, a single daily reading or total may be generated.

CONSTRUCTION OF CHARTS

- (i) Record individual reading at regular intervals.
- (ii) Choose the number of individual readings (n) in each moving range (usually 3 to 6).
- (iii) Calculate the moving range between the individuals in each sample.
- (iv) Select suitable scales and plot on the chart.
- (v) After at least 100 individual readings calculate $\bar{X}$ and $\bar{R}$ values and draw on chart.
- (vi) Calculate control limits.

Control limits for the range chart are set at $D_4 \bar{R}$ as before.

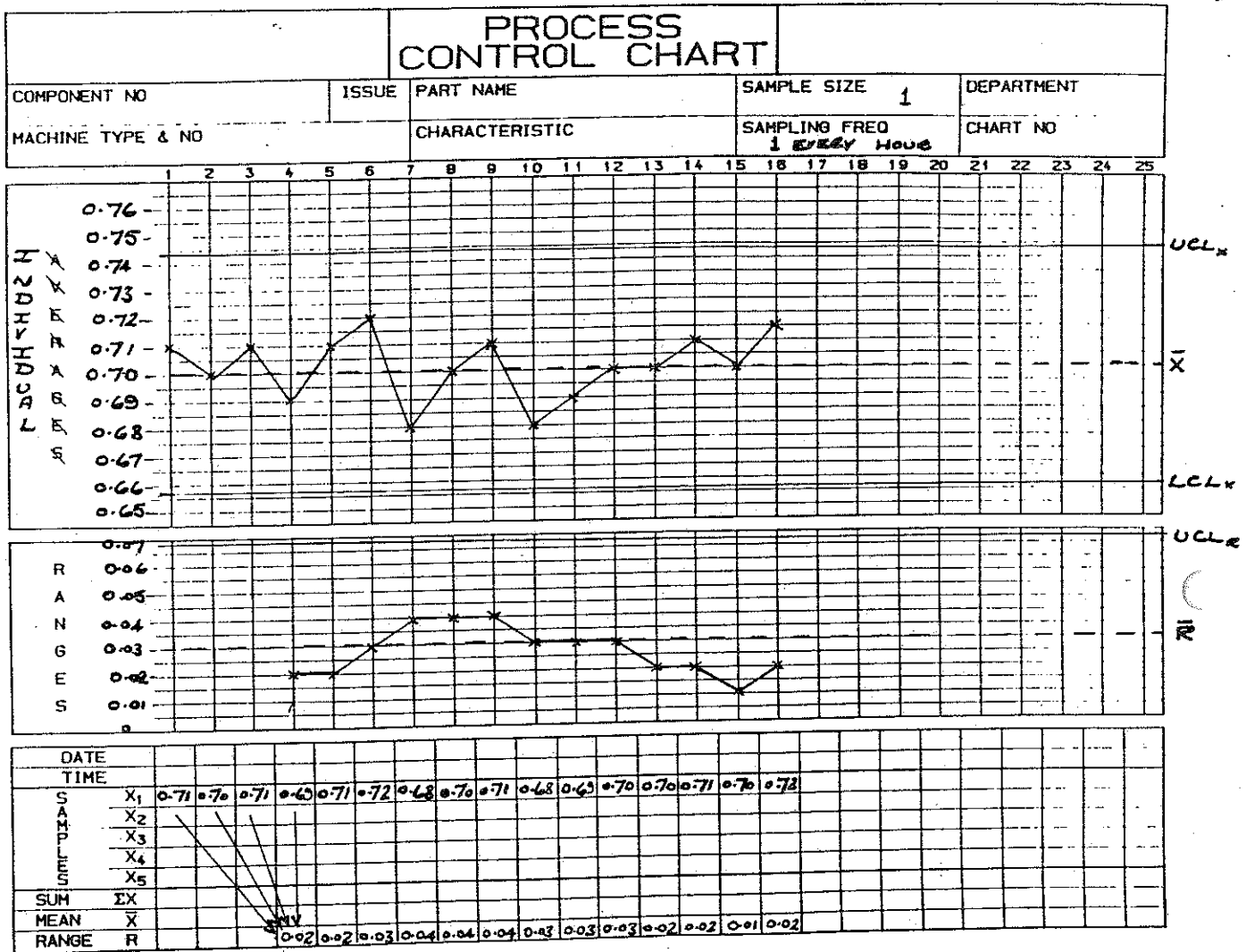
Control limits for the individual chart are set at:

$$\begin{aligned} \text{UCL}_x &= \bar{X} + 3\sigma \\ \text{LCL}_x &= \bar{X} - 3\sigma \end{aligned}$$

$$\text{when } \sigma = \frac{\bar{R}}{d_2}$$

The constants D_4 and d_2 can be obtained from the data sheet.

NOTE: Since the top chart is dealing with individual readings it is acceptable to put specification limits on if required.



Moving range sample size = 4

After 100 readings $\bar{X} = 0.70$ $\bar{R} = 0.03$

$$\sigma = \frac{\bar{R}}{d_2} = \frac{0.03}{2.059} = 0.0145$$

CONTROL LIMITS

Range chart $UCL_R = D_4 \bar{R} = 2.282 \times 0.03 = .068$

Individual Chart $UCL_X = \bar{X} + 3\sigma = 0.70 + 3 \times .0145 = 0.7435$

$$LCL_X = \bar{X} - 3\sigma = 0.70 - 3 \times .0145 = 0.6565$$

MOVING AVERAGE AND MOVING RANGE CHARTS

An alternative to the individual and moving range chart is where the average is also calculated on a moving basis, and control limits calculated according to the number of individual readings in each sample.

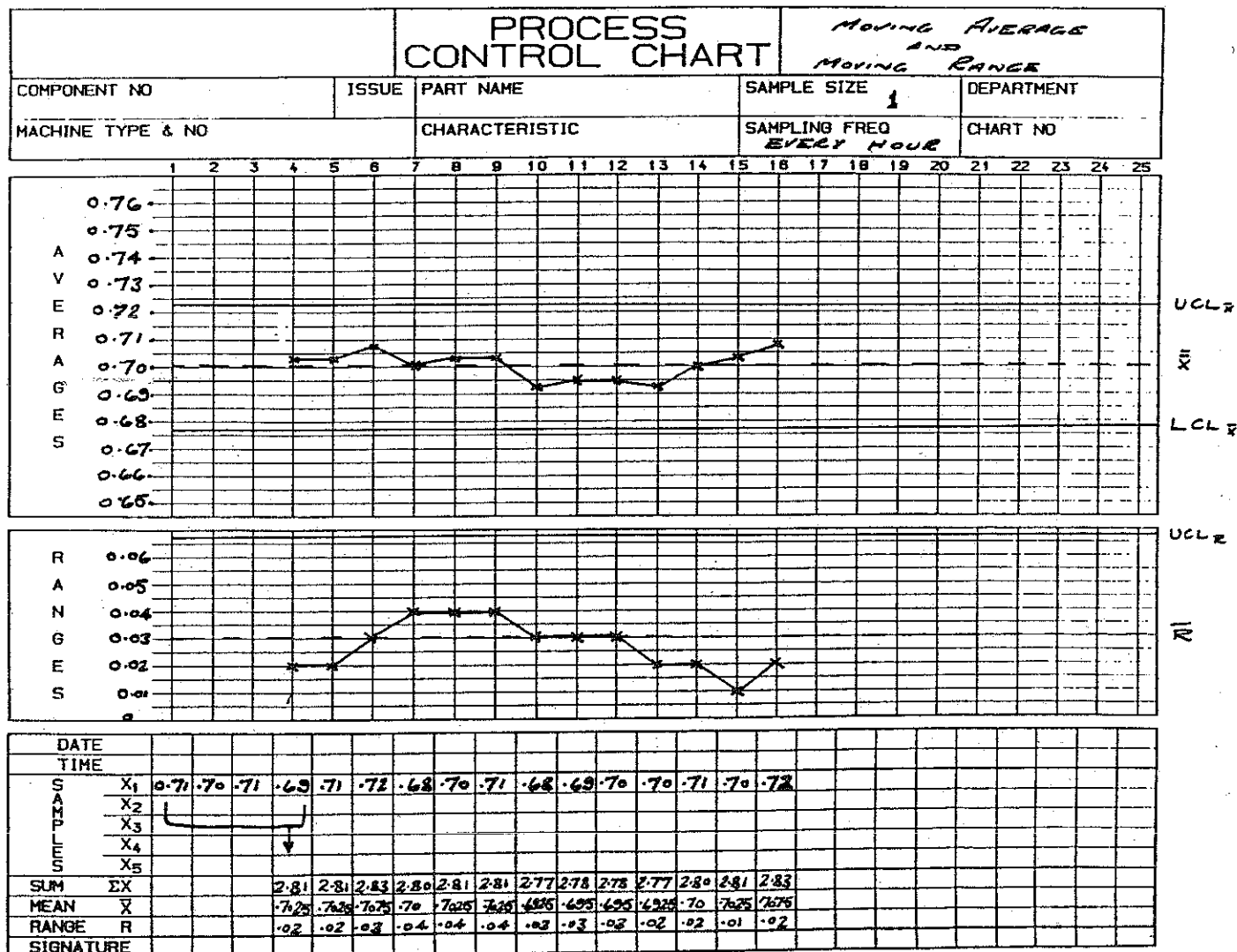
Taking a moving sample size of 4 and using the same data as in the previous example. After 100 readings $\bar{X} = .70$, $\bar{R} = 0.03$

CONTROL LIMITS

Range Chart $UCL_R = D_4 \cdot \bar{R} = 2.282 \times 0.03 = 0.068$

Average Chart $UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \cdot \bar{R} = 0.70 + (0.729 \times 0.03) = 0.72187$

$LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \cdot \bar{R} = 0.70 - (0.729 \times 0.03) = 0.67813$



SCHOOL OF DESIGN AND ADVANCED TECHNOLOGY

DATA SHEET

Tables of Constants and Formulae

$\bar{X}$ and R Charts				
Subgroup Size n	Chart for Averages ($\bar{X}$)	Chart for Ranges (R)		
	Factors for Control Limits	Divisors for Estimate of Standard Deviation	Factors for Control Limits	
	A_2	d_2	D_3	D_4
2	1.880	1.128	-	3.267
3	1.023	1.693	-	2.574
4	0.729	2.059	-	2.282
5	0.577	2.326	-	2.114
6	0.483	2.534	-	2.004
7	0.419	2.704	0.076	1.924
8	0.373	2.847	0.136	1.864
9	0.337	2.970	0.184	1.816
10	0.308	3.078	0.223	1.777

$$UCL_{\bar{X}}, LCL_{\bar{X}} = \bar{\bar{X}} \pm A_2 \bar{R}$$

$$UCL_R = D_4 \bar{R}$$

$$LCL_R = D_3 \bar{R}$$

$$\sigma = \bar{R}/d_2$$

$$\text{Index } C_p = \frac{\text{Total specification tolerance}}{6\sigma}$$

$$\text{Index } C_{pk} = \text{smaller of}$$

$$\frac{\text{Upper specification limit} - \bar{\bar{X}}}{3\sigma} \quad \text{or} \quad \frac{\bar{\bar{X}} - \text{Lower specification limit}}{3\sigma}$$

[illegible]

