

KES

Application Standard of Control Chart

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1. Scope of Application

This shall be practiced for the major characteristics related to the production and quality.

2. Purpose

This is to maintain and improve the processes in the stable management state by studying the process changes, finding the special causes and improving that.

3. Type of Control Charts

Control charts are roughly divided into two types.

3.1 Classification by usage

(1) Control chart for interpretation

This charts are used to analyze the processes and formulated to investigate the reason for distribution by studying the situation for what state the process is in and for where is the problem and for what differences. The mark of control limit shall be drawn with dotted lines.

(2) Control chart for management

This charts are used to manage the processes and to find the reason for special causes during the work by checking the result and removing. The mark of control limit shall be drawn with chain lines.

3.2 Classification by characteristic

Type	Data Property	Characteristic	Name of Control Chart	Note
Variables Control Chart	Length, weight, strength, ingredients, time, yield rate, etc.	Average value and range	$\bar{x}$ - R chart	Special control chart may be used if needed. - Control chart of largest and smallest value (L-S) - Control chart by modified data
		Individual data and range	x - Rs chart	
Attributes Control Chart	Proportion Defective	When n is not fixed	the P chart	
	Number Defective	When n is fixed	the Pn chart	
	Number Nonconformities	When the size of range of nonconformities occurrence is fixed	the C chart	
	Number Nonconformities per Unit	When the size of range of nonconformities occurrence is not fixed	the U chart	

4. Guide on Formulation for Control Chart

4.1 Formulation guide on variables control chart

4.1.1 Formulation guide on $\bar{x}$ -R chart (Form No. 1)

(1) Control chart for interpretation

- Control limit (UCL, LCL) : dotted line (---), center line (CL) : solid line (-)

Procedure		Steps to follow												
1	Writing down basic items	Write down basic items such as the control no. in top of the control chart, formulation period, name of department, name of team, etc.												
2	Writing down the result of preliminary data measurement	- Write it down classifying the measurement date(time) and data by groups. - Complete the data selection in short time as soon as possible.												
3	Calculation of average range for each group and plotting	$\bar{x} = \sum xi / n$ • $R = x_{max} - x_{min}$ n : Size of sample, $\sum xi = x_1 + x_2 + \dots + x_n$ ($n=2\sim5$ is suitable) - Plot obtained average values ($\bar{x}$) and ranges (R)												
4	Calculating control line	- Find the control line with data obtained during the specified period <table border="1"> <thead> <tr> <th>Type</th> <th>UCL</th> <th>CL</th> <th>LCL</th> </tr> </thead> <tbody> <tr> <td>the $\bar{x}$ chart</td> <td>$\bar{\bar{x}} + A_2\bar{R}$</td> <td>$\bar{\bar{x}}$</td> <td>$\bar{\bar{x}} - A_2\bar{R}$</td> </tr> <tr> <td>the R chart</td> <td>$D_4\bar{R}$</td> <td>$\bar{R}$</td> <td>$D_3\bar{R}$</td> </tr> </tbody> </table> $\sum \bar{x}$: sum of average values • K : number of groups $\bar{\bar{x}} = \sum \bar{x} / K$ • $\bar{R} = \sum R / K$ A_2, D_4, D_3 : Read from the value table. (For $n \leq 6$, D_3 value does not exist.)	Type	UCL	CL	LCL	the $\bar{x}$ chart	$\bar{\bar{x}} + A_2\bar{R}$	$\bar{\bar{x}}$	$\bar{\bar{x}} - A_2\bar{R}$	the R chart	$D_4\bar{R}$	$\bar{R}$	$D_3\bar{R}$
Type	UCL	CL	LCL											
the $\bar{x}$ chart	$\bar{\bar{x}} + A_2\bar{R}$	$\bar{\bar{x}}$	$\bar{\bar{x}} - A_2\bar{R}$											
the R chart	$D_4\bar{R}$	$\bar{R}$	$D_3\bar{R}$											
5	Investigation of special causes	- Investigate if there is no abnormality in the array of plotted points. - Estimate the rightness of treatment against special causes and the recurrence possibility and standardize the revision changes. - If there are one or more deviated points, repeat the process to calculate and investigate the control line except when one took steps to prevent the recurrence of special causes during the production process.												
6	Estimating the corresponding process	After eliminating any special causes in the process, calculate the process capability index (C_p, C_{pk}).												
7	Settling the control chart	If there aren't any special causes in the control chart and the control limit is within the specification, it can be confirmed to have stable process (stable state) so that one can formulate the control chart for management.												

(2) Control chart for management

- Control limit (UCL, LCL) : chain line (---), center line (CL) : solid line (—)

Procedure		Steps to follow												
1	Writing down basic items	Write down basic items such as the control no. in top of the control chart, formulation period, name of department, name of team, etc.												
2	Determining the control line	Method 1) Manage by extending the control line determined in the control chart for interpretation. Method 2) Assuming the corresponding process as stable, apply the initial control line. <table border="1"> <thead> <tr> <th>Type</th> <th>UCL</th> <th>CL</th> <th>LCL</th> </tr> </thead> <tbody> <tr> <td>the $\bar{x}$ chart</td> <td>$M + \frac{3}{8} (S_U - S_L)$</td> <td>$M = \frac{(S_U + S_L)}{2}$</td> <td>$M - \frac{3}{8} (S_U - S_L)$</td> </tr> <tr> <td>the R chart</td> <td>$D_4 R$</td> <td>R</td> <td>$D_3 R$</td> </tr> </tbody> </table> S_U : The upper specification limit S_L : The lower specification limit R : Calculate when the number of groups (K) makes up 10. ($R = \sum R / K$) D_4, D_3 : Read from the value table. (For $n \leq 6$, D_3 value does not exist.)	Type	UCL	CL	LCL	the $\bar{x}$ chart	$M + \frac{3}{8} (S_U - S_L)$	$M = \frac{(S_U + S_L)}{2}$	$M - \frac{3}{8} (S_U - S_L)$	the R chart	$D_4 R$	R	$D_3 R$
Type	UCL	CL	LCL											
the $\bar{x}$ chart	$M + \frac{3}{8} (S_U - S_L)$	$M = \frac{(S_U + S_L)}{2}$	$M - \frac{3}{8} (S_U - S_L)$											
the R chart	$D_4 R$	R	$D_3 R$											
3	Writing down the result of data measurement	Write it down classifying the measurement date(time) and data by groups.												
4	Calculating average range for each group and plotting	$\bar{x} = \sum x_i / n$ $R = x_{\max} - x_{\min}$ n : Size of sample, $\sum x_i = x_1 + x_2 + \dots + x_n$ ($n=2 \sim 5$ is suitable) - Plot obtained average values ($\bar{x}$) and ranges (R)												
5	Investigation of special causes	- Check special causes in the plotted points. - Estimate the rightness of treatment against special causes and the recurrence possibility and standardize the revision changes. - When one of the following cases occur, reexamine the control line and repeat the step 3 to 5 until the formulation is completed. - When policy has been changed - When the working instructions has been significantly changed in the process - When the process has been apparently changed - such as facility replacement - When reexamining the control line, one may assume the data to reexamine as preliminary data and formulate "the control chart for interpretation"												
6	Estimating the corresponding process	After eliminating any special causes in the process, calculate the process capability index (C_p, C_{pk}).												
7	Examination of management method	If the result of process estimation shows C_p (One side specification), C_{pk} (Both sides specification) ≥ 1.33 for more than 3 months, examine the possibility to simplify the management method.												
8	Settling the control line	- When one of the following cases occur, reexamine the control line, and in other cases, extend the control line determined through 2~5 to manage. - When policy has been changed - When the work standard has been significantly changed in the process - When the process has been apparently changed - such as facility replacement, change in process capability - When the specified time has passed since the process control started - quarterly, half-yearly, yearly - When reexamining the control line, one may assume the data to reexamine as preliminary data and formulate "the control chart for interpretation"												

4.1.2 Formulation guide on $\bar{x}$ - R_s chart (Form No. 2)

(1) Control chart for interpretation

- Control limit (UCL, LCL) : dotted line (---), scenter line (CL) : solid line(—)

Procedure		Steps to follow												
1	Writing down basic items	Write down basic items such as the control no. in top of the control chart, formulation period, name of department, name of team, etc.												
2	Writing down the result of preliminary data measurement	- Write it down classifying the measurement date (time) and data by groups. - Complete the data selection in short time as soon as possible.												
3	Calculation of average range for each group and plotting	- Continue to plot the variables (x) and ranges (R_s). $R_s = x_i - x_{i+1}$												
4	Calculating control line	- Find the control line with data obtained during the specified period <table border="1"> <thead> <tr> <th>Type</th> <th>UCL</th> <th>CL</th> <th>LCL</th> </tr> </thead> <tbody> <tr> <td>the $\bar{x}$ chart</td> <td>$\bar{\bar{x}} + 2.66 R$</td> <td>$\bar{\bar{x}}$</td> <td>$\bar{\bar{x}} - 2.66 R$</td> </tr> <tr> <td>the R_s chart</td> <td>$3.27 R_s$</td> <td>R_s</td> <td>-</td> </tr> </tbody> </table> Σx : sum of variables • R_s : Sum of ranges K : number of groups • $\bar{x} = \Sigma x / K$ • $R_s = \Sigma R_s / (k-1)$	Type	UCL	CL	LCL	the $\bar{x}$ chart	$\bar{\bar{x}} + 2.66 R$	$\bar{\bar{x}}$	$\bar{\bar{x}} - 2.66 R$	the R_s chart	$3.27 R_s$	R_s	-
Type	UCL	CL	LCL											
the $\bar{x}$ chart	$\bar{\bar{x}} + 2.66 R$	$\bar{\bar{x}}$	$\bar{\bar{x}} - 2.66 R$											
the R_s chart	$3.27 R_s$	R_s	-											
5	Investigation of special causes	- Investigate if there is no abnormality in the array of plotted points. - Estimate the rightness of treatment against special causes and the recurrence possibility and standardize the revision changes. - If there are one or more deviated points, repeat the process to calculate and investigate the control line except when one took steps to prevent the recurrence of special causes during the production process.												
6	Estimating the corresponding process	After eliminating any special causes in the process, calculate the process capability index (C_p, C_{pk}).												
7	Settling the control chart	If there aren't any special causes in the control chart and the control limit is within the specification, it can be confirmed to have stable process (stable state) so that one can formulate the control chart for management.												

(2) Control chart for management

- Control limit (UCL, LCL) : chain line (---), center line (CL) : solid line (—)

Procedure		Steps to follow												
1	Writing down basic items	Write down basic items such as the control no. in top of the control chart, formulation period, name of department, name of team, etc.												
2	Determining the control line	Method 1) Manage by extending the control line determined in the control chart for interpretation. Method 2) Assuming the corresponding process as stable, apply the initial control line. <table border="1"> <thead> <tr> <th>Type</th> <th>UCL</th> <th>CL</th> <th>LCL</th> </tr> </thead> <tbody> <tr> <td>the $\bar{x}$ chart</td> <td>$M + \frac{3}{8} (S_U - S_L)$</td> <td>$M = \frac{(S_U + S_L)}{2}$</td> <td>$M - \frac{3}{8} (S_U - S_L)$</td> </tr> <tr> <td>the R_s chart</td> <td>$3.27 R_s$</td> <td>R_s</td> <td>-</td> </tr> </tbody> </table> S_U : The upper specification limit S_L : The lower specification limit R : Calculate when the number of groups(K) makes up 11.	Type	UCL	CL	LCL	the $\bar{x}$ chart	$M + \frac{3}{8} (S_U - S_L)$	$M = \frac{(S_U + S_L)}{2}$	$M - \frac{3}{8} (S_U - S_L)$	the R_s chart	$3.27 R_s$	R_s	-
Type	UCL	CL	LCL											
the $\bar{x}$ chart	$M + \frac{3}{8} (S_U - S_L)$	$M = \frac{(S_U + S_L)}{2}$	$M - \frac{3}{8} (S_U - S_L)$											
the R_s chart	$3.27 R_s$	R_s	-											
3	Writing down the result of data measurement	Write it down classifying the measurement date(time) and data by groups.												
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5	Investigation of special causes	- Check special causes in the plotted points. - Estimate the rightness of treatment against special causes and the recurrence possibility and standardize the revision changes. - When one of the following cases occur, reexamine the control line and repeat the step 3 to 5 until the formulation is completed. - When policy has been changed - When the working instructions have been significantly changed in the process - When the process has been apparently changed - such as facility replacement - When reexamining the control line, one may assume the data to reexamine as preliminary data and formulate "the control chart for interpretation"												
6	Estimating the corresponding process	After eliminating any special causes in the process, calculate the process capability index (C_p, C_{pk}).												
7	Examination of management method	If the result of process estimation shows C_p (One side specification), C_{pk} (Both sides specification) ≥ 1.33 for more than 3 months, examine the possibility to simplify the management method.												
8	Settling the control line	- When one of the following cases occur, reexamine the control line, and in other cases, extend the control line determined through 2~5 to manage. - When policy has been changed - When the work standard has been significantly changed in the process - When the process has been apparently changed - such as facility replacement, change in process capability - When the specified time has passed since the process control started - quarterly, half-yearly, yearly - When reexamining the control line, one may assume the data to reexamine as preliminary data and formulate "the control chart for interpretation"												

4.1.3 Value table for variables control chart

Size of sample n	the $\bar{x}$ chart	the L-S chart	
	E_2	A_9	e_3
2	2.66	2.695	0.826
3	1.77	1.826	0.748
4	1.46	1.522	0.701
5	1.29	1.363	0.669
6	1.18	1.263	0.645
7	1.11	1.194	0.626
8	1.05	1.143	0.611
9	1.01	1.104	0.598
10	0.98	1.072	0.586

Size of sample n	the $\bar{x}$ chart		the L-S chart			
	$\sqrt{n}$	A_2	D_3	D_4	d_2	d_3
2	1.4142	1.88	—	3.27	1.128	0.853
3	1.7321	1.02	—	2.57	1.693	0.888
4	2.0000	0.73	—	2.28	2.059	0.880
5	2.2361	0.58	—	2.11	2.326	0.864
6	2.4495	0.48	—	2.00	2.534	0.848
7	2.6458	0.42	0.08	1.92	2.704	0.833
8	2.8284	0.37	0.14	1.86	2.847	0.820
9	3.0000	0.34	0.18	1.82	2.970	0.808
10	3.1623	0.31	0.22	1.78	3.078	0.797

4.2 Formulation guide on attributes control chart (Form No. 3)

4.2.1 Control chart for interpretation

– Control limit (UCL, LCL) : dotted line(---), center line (CL) : solid line (—)

Procedure		Steps to follow																				
1	Writing down basic items	Write down basic items such as the control no. in top of the control chart, formulation period, name of department, name of team, etc.																				
2	Writing down the result of preliminary data measurement	- Write it down classifying the measurement date(time) and data by groups. - Complete the data selection in short time as soon as possible.																				
3	Calculating and plotting P_n , P , C and U values	Find P_n, P, C, and U values and then plot them. n : size of sample <table border="1"> <tr> <td>P_n (Number Defective)</td> <td>P (Proportion Defective) = P_n/n</td> </tr> <tr> <td>C (Number nonconformities)</td> <td>U (Number nonconformities per unit) = C/n</td> </tr> </table>	P_n (Number Defective)	P (Proportion Defective) = P_n/n	C (Number nonconformities)	U (Number nonconformities per unit) = C/n																
P_n (Number Defective)	P (Proportion Defective) = P_n/n																					
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4	Calculating the control line	- Find the control line with data obtained during the specified period <table border="1"> <thead> <tr> <th>Type</th> <th>CL</th> <th>UCL</th> <th>LCL</th> </tr> </thead> <tbody> <tr> <td>the P_n chart</td> <td>$\bar{P}_n$</td> <td>$\bar{P}_n + 3\sqrt{\bar{P}_n(1-\bar{P})}$</td> <td>$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$</td> </tr> <tr> <td>the P chart</td> <td>$\bar{P}$</td> <td>$\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$</td> <td>$\bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$</td> </tr> <tr> <td>the C chart</td> <td>$\bar{C}$</td> <td>$\bar{C} + 3\sqrt{\bar{C}}$</td> <td>$\bar{C} - 3\sqrt{\bar{C}}$</td> </tr> <tr> <td>the U chart</td> <td>$\bar{U}$</td> <td>$\bar{U} + 3\sqrt{\frac{\bar{U}}{n}}$</td> <td>$\bar{U} - 3\sqrt{\frac{\bar{U}}{n}}$</td> </tr> </tbody> </table> $\bar{P}_n = \Sigma P_n / K$ $\bar{C} = \Sigma C / K$ $\bar{P} = \Sigma P_n / \Sigma n$ $\bar{U} = \Sigma C / \Sigma n$ Σn : Sum of samples K : number of groups - When LCL value is negative, exclude it. - As n value changes when the P, U chart is applied, control limit should be recalculated accordingly, but when n changes within $\pm 50\%$ of the average size of sample, one may manage as if it is the same.	Type	CL	UCL	LCL	the P_n chart	$\bar{P}_n$	$\bar{P}_n + 3\sqrt{\bar{P}_n(1-\bar{P})}$	$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$	the P chart	$\bar{P}$	$\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$	$\bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$	the C chart	$\bar{C}$	$\bar{C} + 3\sqrt{\bar{C}}$	$\bar{C} - 3\sqrt{\bar{C}}$	the U chart	$\bar{U}$	$\bar{U} + 3\sqrt{\frac{\bar{U}}{n}}$	$\bar{U} - 3\sqrt{\frac{\bar{U}}{n}}$
Type	CL	UCL	LCL																			
the P_n chart	$\bar{P}_n$	$\bar{P}_n + 3\sqrt{\bar{P}_n(1-\bar{P})}$	$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$																			
the P chart	$\bar{P}$	$\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$	$\bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$																			
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5	Investigation of special causes	- Investigate if there is no abnormality in the array of plotted points. - Estimate the rightness of treatment against special causes and the recurrence possibility and standardize the revision changes. - If there are one or more deviated points, repeat the process to calculate and investigate the control line except when one took steps to prevent the recurrence of special causes during the production process. - Regarding the case where point deviates from LCL line as an abnormality, take proper action.																				
6	Estimating the corresponding process	Calculate P_n, P, C, and U with the data obtained during the specified period, estimate the corresponding process.																				
7	Settling the control line	If special causes does not occur in the control chart and it can be confirmed to have stable process (stable state), formulate "the control chart for management". otherwise continue to formulate "the control chart for interpretation"																				

4.2.2 Control chart for management

- Control limit (UCL, LCL) : chain line (---), center line (CL) : solid line (—)

Procedure		Steps to follow																				
1	Writing down basic items	Write down basic items such as the control no. in top of the control chart, formulation period, name of department, name of team, etc.																				
2	Calculating the control line	Method 1) Use the control line as it is determined by formulating the control chart for interpretation. Method 2) Setting up P_n, P, C, and U in the basis of past results, draw the initial control line. <table border="1"> <thead> <tr> <th>Type</th> <th>CL</th> <th>UCL</th> <th>LCL</th> </tr> </thead> <tbody> <tr> <td>the P_n chart</td> <td>$\bar{P}_n$</td> <td>$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$</td> <td>$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$</td> </tr> <tr> <td>the P chart</td> <td>$\bar{P}$</td> <td>$\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$</td> <td>$\bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$</td> </tr> <tr> <td>the C chart</td> <td>$\bar{C}$</td> <td>$\bar{C} + 3\sqrt{\bar{C}}$</td> <td>$\bar{C} - 3\sqrt{\bar{C}}$</td> </tr> <tr> <td>the U chart</td> <td>$\bar{U}$</td> <td>$\bar{U} + 3\sqrt{\frac{\bar{U}}{n}}$</td> <td>$\bar{U} - 3\sqrt{\frac{\bar{U}}{n}}$</td> </tr> </tbody> </table> $\bar{P}_n = \Sigma P_n / K$ $\bar{C} = \Sigma C / K$ $\bar{P} = \Sigma P_n / \Sigma n$ $\bar{U} = \Sigma C / \Sigma n$ • When LCL value is negative, exclude it. n : Sum of samples • As n value changes when the P, U chart is applied, control limit should be recalculated accordingly, but when n changes within $\pm 50\%$ of the average size of sample, one may manage as if it is the same.	Type	CL	UCL	LCL	the P_n chart	$\bar{P}_n$	$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$	$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$	the P chart	$\bar{P}$	$\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$	$\bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$	the C chart	$\bar{C}$	$\bar{C} + 3\sqrt{\bar{C}}$	$\bar{C} - 3\sqrt{\bar{C}}$	the U chart	$\bar{U}$	$\bar{U} + 3\sqrt{\frac{\bar{U}}{n}}$	$\bar{U} - 3\sqrt{\frac{\bar{U}}{n}}$
Type	CL	UCL	LCL																			
the P_n chart	$\bar{P}_n$	$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$	$\bar{P}_n - 3\sqrt{\bar{P}_n(1-\bar{P})}$																			
the P chart	$\bar{P}$	$\bar{P} + 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$	$\bar{P} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$																			
the C chart	$\bar{C}$	$\bar{C} + 3\sqrt{\bar{C}}$	$\bar{C} - 3\sqrt{\bar{C}}$																			
the U chart	$\bar{U}$	$\bar{U} + 3\sqrt{\frac{\bar{U}}{n}}$	$\bar{U} - 3\sqrt{\frac{\bar{U}}{n}}$																			
3	Calculating and plotting P_n , P , C and U values	Find P_n, P, C, and U values and then plot them. n : size of sample <table border="1"> <tbody> <tr> <td>P_n (Number Defective)</td> <td>P (Proportion Defective) = P_n/n</td> </tr> <tr> <td>C (Number nonconformities)</td> <td>U (Number nonconformities per unit) = C/n</td> </tr> </tbody> </table>	P_n (Number Defective)	P (Proportion Defective) = P_n/n	C (Number nonconformities)	U (Number nonconformities per unit) = C/n																
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C (Number nonconformities)	U (Number nonconformities per unit) = C/n																					

Procedure	Steps to follow
4 Investigation of special causes	• Check special causes in the plotted points. • Estimate the rightness of treatment against special causes and the recurrence possibility and standardize the revision changes. • When one of the following cases occur, reexamine the control line and repeat the step 3 to 4 until the formulation is completed. 1) When policy has been changed 2) When the working instructions have been significantly changed in the process 3) When the process has been apparently changed - such as facility replacement • When reexamining the control line, one may assume the data to reexamine as preliminary data and formulate "the control chart for interpretation"
5 Estimating the corresponding process	• Calculate P_n, P, C, and U with the data obtained during the specified period, estimate the corresponding process.
6 Examination of management method	• If P_n, P, C, and U values are improved and shows significantly reduced magnitudes for more than 3 months, examine the possibility to simplify the management method.
7 Settling the control line	• When one of the following cases occur, reexamine the control line, otherwise extend the control line determined through 2~4 to manage. 1) When policy has been changed 2) When the work standard has been significantly changed in the process 3) When the process has been apparently changed - such as facility replacement, change in process capability 4) When the specified time has passed since the process control started - quarterly, half-yearly, yearly • When reexamining the control line, one may assume the data to reexamine as preliminary data and formulate "the control chart for interpretation"