KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI II : 2025/2026

DJF51082 : QUALITY CONTROL

TARIKH : 08 MEI 2026
MASA : 8.30 PAGI - 10.30 PAGI (2 JAM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.

Struktur (4 soalan)

Dokumen sokongan yang disertakan : Buku Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan berstruktur. Jawab **SEMUA** soalan.*

QUESTION 1

SOALAN 1

CLO1

(a) Define the statistical terms given below:

Takrifkan istilah-istilah statistik yang diberikan dibawah:

i. Population

Populasi

ii. Random sampling

Persampelan rawak

iii. Zero defect

Kecacatan sifar

iv. Internal customer

Pelanggan dalaman

v. External customer

Pelanggan luaran

[5 marks]

[*5 markah*]

CLO1

(b) Shimono Engineering Sdn. Bhd. is a specialist in producing bicycles and engineering parts. This company is well-known and recognized by its customers for the good quality of its products and quality assurance. To ensure the company can compete with the international market, it needs to fulfil the ISO9000 requirements.
Shimono Engineering Sdn. Bhd. adalah pakar dalam menghasilkan basikal dan produk kejuruteraan. Syarikat ini terkenal dan diiktiraf oleh pelanggannya menerusi kualiti produk yang baik dan jaminan kualiti. Bagi memastikan syarikat ini boleh bersaing dengan pasaran antarabangsa, mereka perlu memenuhi keperluan ISO9000.

i. Discuss **FIVE (5)** advantages of implementing ISO9000.
*Bincangkan **LIMA (5)** kelebihan melaksanakan ISO9000.*

[5 marks]
[*5 markah*]

ii. Discuss **FIVE (5)** disadvantages of implementing ISO9000.
*Bincangkan **LIMA (5)** kekurangan melaksanakan ISO9000.*

[5 marks]
[*5 markah*]

CLO1

(c) Sweet soy sauce is packed in a bottle with an average volume of 350 ml. The actual volume of sweet soy sauce filled into bottles by machine is normally distributed, with a standard deviation of 3 ml.
Kicap manis dibotolkan di dalam botol dengan purata isipadu 350 ml. Isipadu sebenar kicap manis yang diisi ke dalam botol menggunakan mesin adalah bertaburan secara normal dengan nilai sisihan piawai 3 ml.

i. Compute the probability if the bottle contains greater than 352 ml.
Hitung kebarangkalian jika botol itu mengandungi lebih daripada 352 ml.

[5 marks]
[*5 markah*]

ii. Compute the probability if the bottle contains less than 348 ml.
Hitung kebarangkalian jika botol itu mengandungi kurang daripada 348 ml.

[5 marks]
[5 *markah*]

QUESTION 2
SOALAN 2

CLO1 (a) Describe **TWO (2)** objectives of using an attribute control chart.
*Huraikan **DUA (2)** objektif penggunaan carta kawalan atribut.*

[5 marks]
[5 *markah*]

CLO1 (b) The X-bar and R chart is a type of control chart widely used in statistical quality control to monitor process stability. The X-bar chart tracks changes in the process average, while the R chart monitors variation within samples. By using these two charts, manufacturers can detect unusual shifts or inconsistencies, ensuring the process remains under control and the products meet quality standards.
Carta X-bar dan R ialah sejenis carta kawalan yang digunakan secara meluas dalam kawalan kualiti statistik untuk memantau kestabilan proses. Carta X-bar mengesan perubahan pada purata proses, manakala carta R memantau variasi dalam sampel. Dengan menggunakan kedua-dua carta ini, pengeluar dapat mengesan perubahan luar biasa atau ketidakselarasan, memastikan proses kekal terkawal dan produk memenuhi piawaian kualiti.

i. Elaborate the meaning of the central line (CL) in an $\overline{X}$ chart.
Huraikan maksud garisan tengah (CL) dalam carta $\overline{X}$.

[3 marks]
[3 *markah*]

ii. Explain the meaning of upper control limit (UCL) and lower control limit (LCL) in a control chart.
Terangkan maksud had kawalan atas (UCL) dan had kawalan bawah (LCL) dalam carta kawalan.

[4 marks]
[*4 markah*]

iii. Interpret the meaning if all data points are within the control limits.
Tafsirkan maksud jika semua titik data berada dalam had kawalan.

[3 marks]
[*3 markah*]

CLO1 (c) Voltage test data for the component used in a microcomputer for the ABC company are presented in Table 2 (c). The sample size is 4. Calculate the control limit for the testing and the central line for X-double bar and R-Bar.
Data ujian voltan untuk komponen yang digunakan dalam mikrokomputer untuk syarikat ABC dipersembahkan dalam Jadual 2(c). Saiz sampel ialah 4. Kira had kawalan untuk ujian dan garis tengah untuk X-ganda bar dan R-Bar.

Table 2 (c) / *Jadual 2 (c)*

Sub-Group *Sub-kumpulan*	$\bar{X}$	R	Sub-Group *Sub-kumpulan*	$\bar{X}$	R
1	482	32	14	476	22
2	506	24	15	485	23
3	463	32	16	499	23
4	469	26	17	460	25
5	474	24	18	469	24
6	484	24	19	474	23
7	476	28	20	484	25
8	513	23	21	476	29
9	502	24	22	485	25
10	463	26	23	490	22
11	469	25	24	461	27
12	474	24	25	469	22
13	484	24			

[10 marks]

[*10 markah*]

QUESTION 3

SOALAN 3

CLO1 (a) In quality control, an attribute refers to the characteristic of quality, whether it meets its specification or not, which is to supervise the process of producing a product or service. Express **FIVE (5)** types of defect characteristics that must use the attribute control chart.

*Dalam kawalan kualiti, atribut merujuk kepada ciri kualiti, sama ada ia memenuhi spesifikasinya atau tidak, yang bertujuan untuk menyelia proses pengeluaran produk atau perkhidmatan. Nyatakan **LIMA (5)** jenis ciri kecacatan yang mesti menggunakan carta kawalan atribut.*

[5 marks]

[*5 markah*]

CLO1 (b) Pen manufacturers want to improve the quality of their product. The manufacturer has decided to select a sample size n = 225 for further analysis. Table 3(b) shows the results of the past 20 groups. Based on the data provided:

Pengilang pen ingin meningkatkan kualiti produk mereka. Pengilang telah memutuskan untuk memilih sampel saiz n = 225 untuk analisis lanjut. Jadual 3(b) menunjukkan keputusan bagi 20 kumpulan yang lalu. Berdasarkan data yang diberikan:

i. Calculate the central line, upper, and lower control limits for the P control chart.
Kirakan titik tengah, had kawalan atas dan had kawalan bawah untuk carta kawalan P.

[4 marks]

[*4 markah*]

ii. Plot the P control chart.

Plotkan carta kawalan P.

[6 marks]

[*6 markah*]

Table 3(b)/ *Jadual 3 (b)*

Groups *Kumpulan*	Sample size,n *Saiz sampel, n*	Number np *Nombor np*	Sample Proportion, p *Perkadaran Sampel, p*
1	225	9	0.040
2	225	13	0.058
3	225	15	0.067
4	225	7	0.031
5	225	11	0.049
6	225	8	0.036
7	225	6	0.027
8	225	12	0.053
9	225	6	0.027
10	225	9	0.040
11	225	9	0.040
12	225	6	0.027
13	225	5	0.022
14	225	10	0.044
15	225	8	0.036
16	225	16	0.071
17	225	7	0.031
18	225	6	0.027
19	225	5	0.022
20	225	5	0.022

CLO1 (c) Furniture company Megah Jaya Sdn. Bhd. has produced 5000 units of chairs in December 2020. 80 units of samples have been taken randomly with acceptance number 2 for the acceptance sampling plan. Based on the Operating Characteristic Curve (OC Curve) with the value of fraction defective from 0.01 to 0.07, sketch the OC Curve.

Syarikat perabot Megah Jaya Sdn. Bhd. telah menghasilkan 5000 unit kerusi pada Disember 2020. 80 unit sampel telah diambil secara rawak dengan nombor penerimaan 2 untuk pelan pensampelan penerimaan. Berdasarkan Lengkung Ciri Operasi (OC Curve) dengan nilai pecahan cacat dari 0.01 hingga 0.07, lakarkan Lengkung OC.

[10 marks]
[*10 markah*]

QUESTION 4
SOALAN 4

CLO1 (a) Explain the cost of quality below. With one appropriate example for each cost.
Terangkan kos kualiti di bawah. Dengan berikan contoh yang sesuai untuk setiap kos.

i. Appraisal cost
Kos taksiran

[2 marks]
[*2 markah*]

ii. Internal failure cost
Kos kegagalan dalaman

[2 marks]
[*2 markah*]

iii. External failure cost

Kos kegagalan luaran

[2 marks]

[*2 markah*]

CLO2 (b) Locate the element below to the correct place by using the Cause & Effect Diagram.

Tempatkan elemen di bawah ke tempat yang betul dengan menggunakan Rajah Sebab & Akibat.

Late for class :

Lambat ke kelas :

- Raining

  Hujan
- Play games

  Main permainan
- Alarm malfunction

  Kerosakan jam penggera
- Traffic jammed

  Kesesakan lalulintas
- Insufficient Fuel

  Bahan api tidak mencukupi
- Walking

  Berjalan ke kelas
- Breakfast uncooked

  Sarapan pagi tidak dimasak
- Tired

  Penat

[9 marks]

[*9 markah*]

CLO3

(c) Table 4 (c) shows that a group of cosmetologists was asked to provide the main reason of hair loss in men. Draw a Pareto Chart with their answers from the column. *Jadual 4 (c) menunjukkan sekumpulan pakar kosmetik diminta memberi sebab utama yang menyebabkan keguguran rambut pada lelaki. Lukiskan Carta Pareto berdasarkan jawapan di dalam jadual.*

Table 4(c)/ *Jadual 4 (c)*

Reason / *Sebab*	Voters / U*ndian*
Smoking / *Merokok*	7
Vitamin Deficiency / *Kekurangan vitamin*	4
Infections / *Jangkitan*	3
Genetics / *Genetik*	56
Cosmetic Damage /*Kerosakan Kosmetik*	15
Medication / *Ubat*	2
Chemotherapy / *Kemoterapi*	1
Stress /*Tekanan*	12

[10 marks]

[*10 markah*]

SOALAN TAMAT

DJF51082 QUALITY CONTROL

FORMULA & TABLE

DIPLOMA IN MECHANICAL ENGINEERING

Formulas

A. Statistics

i. Average

- Ungrouped data

$$\overline{X} = \frac{\Sigma X}{n}$$

- Grouped data

$$\overline{X} = \frac{\Sigma fx}{\Sigma f}$$

ii. Standard Deviation

- ungrouped population

$$\sigma = \sqrt{\frac{\sum (X_i - \bar{X})^2}{N}}$$

- Grouped population

$$\sigma = \sqrt{\frac{\sum f(X_i - \bar{X})^2}{N}}$$

- (theory) sample data

$$s = \sqrt{\frac{\sum (X_i - \bar{X})^2}{(n-1)}}$$

- Ungrouped sample

$$s = \sqrt{\frac{n\sum X_i^2 - (\sum X_i)^2}{n(n-1)}}$$

- Grouped sample

$$s = \sqrt{\frac{n(\sum f_i X_i^2) - (\sum f_i X_i)^2}{n(n-1)}}$$

B. Variable Control Charts

i. Average and Range Charts

- $\overline{X}$ chart:
  1. Center line, $\overline{\overline{X}} = \frac{\sum_{i=1}^{m} \overline{X}}{m}$
  2. Upper Control Limit, $UCL_{\overline{X}} = \overline{\overline{X}} + A_2\overline{R}$
  3. Lower Control Limit, $LCL_{\overline{X}} = \overline{\overline{X}} - A_2\overline{R}$
- R chart
  1. Center line, $\overline{R} = \frac{\sum_{i=1}^{m} R_i}{m}$
  2. Upper Control Limit, $UCL_R = D_4\overline{R}$
  3. Lower Control Limit, $LCL_R = D_3\overline{R}$
- Revising the Charts:
  1. New Center line, $\overline{X} = \overline{\overline{X}}_{new} = \frac{\sum_{i=1}^{m} \overline{X} - \overline{X}_d}{m - m_d}$
  2. New Upper Control Limit, $UCL_{\overline{X}} = \overline{X}_0 + A\sigma_0$
  3. New Lower Control Limit, $LCL_{\overline{X}} = \overline{X}_0 - A\sigma_0$
  4. Sigma, $\sigma_0 = R_0 / d_2$
  5. New Center line, $R_0 = \overline{R}_{new} = \frac{\sum_{i=1}^{m} R_i - R_d}{m - m_d}$
  6. New Upper Control Limit, $UCL_R = D_2\sigma_0$
  7. New Lower Control Limit, $LCL_R = D_1\sigma_0$

ii. Average and Standard Deviation Charts

- $\overline{X}$ chart:
  1. Center line, $\overline{\overline{X}} = \frac{\sum_{i=1}^{m} \overline{X}}{m}$
  2. Upper Control Limit, $UCL_{\overline{X}} = \overline{\overline{X}} + A_3\overline{s}$
  3. Lower Control Limit, $LCL_{\overline{X}} = \overline{\overline{X}} - A_3\overline{s}$
- s chart
  1. Center line, $\overline{s} = \frac{\sum_{i=1}^{m} s_i}{m}$
  2. Upper Control Limit, $UCL_s = B_4\overline{s}$
  3. Lower Control Limit, $LCL_s = B_3\overline{s}$
- Revising the Charts:
  1. New Center line, $\overline{X} = \overline{\overline{X}}_{new} = \frac{\sum_{i=1}^{m} \overline{X} - \overline{X}_d}{m - m_d}$
  2. New Upper Control Limit, $UCL_{\overline{X}} = \overline{X}_0 + A\sigma_0$
  3. New Lower Control Limit, $LCL_{\overline{X}} = \overline{X}_0 - A\sigma_0$
  4. Sigma, $\sigma_0 = s_0 / c_4$
  5. New Center line, $s_0 = \overline{s}_{new} = \frac{\sum_{i=1}^{m} s_i - s_d}{m - m_d}$
  6. New Upper Control Limit, $UCL_s = B_6\sigma_0$
  7. New Lower Control Limit, $LCL_s = B_5\sigma_0$

C. Capability Index

i. $C_p = \frac{USL - LSL}{6\sigma}$

ii. $C_{PK} = \frac{USL - \overline{X}}{3\sigma}, \frac{\overline{X} - LSL}{3\sigma}$

D. Attribute Control Charts

i. Fraction Nonconforming (p) Chart

1. Fraction, $p = \frac{np}{n}$
2. Center line, $\bar{p} = \frac{\sum_{i=1}^{n} np}{\sum_{i=1}^{n} n}$
3. Upper Control Limit, $UCL_{\bar{p}} = \bar{p} + 3\frac{\sqrt{\bar{p}(1-\bar{p})}}{\sqrt{n}}$
4. Lower Control Limit, $LCL_{\bar{p}} = \bar{p} - 3\frac{\sqrt{\bar{p}(1-\bar{p})}}{\sqrt{n}}$

- Revising the Charts:
  1. New Center line, $\bar{p}_{new} = \frac{\sum_{i=1}^{n} np - np_d}{\sum_{i=1}^{n} n - n_d}$
  2. New Upper Control Limit, $UCL_{\bar{p}_{new}} = \bar{p}_{new} + 3\frac{\sqrt{\bar{p}_{new}(1-\bar{p}_{new})}}{\sqrt{n}}$
  3. New Lower Control Limit, $LCL_{\bar{p}_{new}} = \bar{p}_{new} - 3\frac{\sqrt{\bar{p}_{new}(1-\bar{p}_{new})}}{\sqrt{n}}$

ii. Percent Nonconforming (100p) Chart

1. Center line, $100\bar{p} = 100\left[\frac{\sum_{i=1}^{n} np}{\sum_{i=1}^{n} n}\right]$
2. Upper Control Limit, $UCL_{100\bar{p}} = 100\left[\bar{p} + 3\frac{\sqrt{\bar{p}(1-\bar{p})}}{\sqrt{n}}\right]$
3. Lower Control Limit, $LCL_{100\bar{p}} = 100\left[\bar{p} - 3\frac{\sqrt{\bar{p}(1-\bar{p})}}{\sqrt{n}}\right]$

iii. Number of Nonconforming (np) Chart

1. Center line, $\overline{np} = \frac{\sum_{i=1}^{n} np}{m}$
2. Upper Control Limit, $UCL_{\overline{np}} = \overline{np} + 3\sqrt{\overline{np}(1-\bar{p})}$
3. Lower Control Limit, $LCL_{\overline{np}} = \overline{np} + 3\sqrt{\overline{np}(1-\bar{p})}$

iv. Count of Nonconformities (c) Chart

1. Center line, $\bar{c} = \frac{\sum_{i=1}^{n} c}{m}$
2. Upper Control Limit, $UCL_{\bar{c}} = \bar{c} + 3\sqrt{\bar{c}}$
3. Lower Control Limit, $LCL_{\bar{c}} = \bar{c} - 3\sqrt{\bar{c}}$

- Revising the Charts:
  1. New Center line, $\bar{c}_{new} = \frac{\sum_{i=1}^{n} c - c_d}{m - m_d}$
  2. New Upper Control Limit, $UCL_{\bar{c}_{new}} = \bar{c}_{new} + 3\sqrt{\bar{c}_{new}}$
  3. New Lower Control Limit, $LCL_{\bar{c}_{new}} = \bar{c}_{new} - 3\sqrt{\bar{c}_{new}}$

v. Nonconformities per Unit (u) Chart

1. Nonconformities per unit, $u = \frac{c}{n}$
2. Center line, $\bar{u} = \frac{\sum_{i=1}^{n} c}{\sum_{i=1}^{n} n}$
3. Upper Control Limit, $UCL_{u} = \bar{u} + 3\frac{\sqrt{\bar{u}}}{\sqrt{n}}$
4. Lower Control Limit, $LCL_{u} = \bar{u} - 3\frac{\sqrt{\bar{u}}}{\sqrt{n}}$

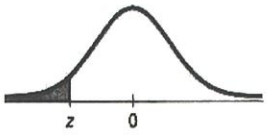
Note:

- **NONE of the formula in page 1 and 2 content "Cube Root" ($3\sqrt{\ }$), only "3 x $\sqrt{\ }$ ".**
- **Symbol 'm' in this booklet refers to the number of group (g).**

TABLES

A. Normal Distribution Table

Table Z
Areas under the standard Normal curve

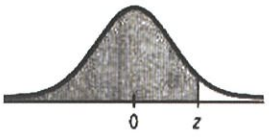


$$Z = \frac{X_i - \mu}{\sigma}$$

Second decimal place in z										
0.09	*0.08*	*0.07*	*0.06*	*0.05*	*0.04*	*0.03*	*0.02*	*0.01*	*0.00*	*z*
									0.0000†	*−3.9*
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	*−3.8*
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	*−3.7*
0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002	*−3.6*
0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	*−3.5*
0.0002	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	*−3.4*
0.0003	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0005	0.0005	0.0005	*−3.3*
0.0005	0.0005	0.0005	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	*−3.2*
0.0007	0.0007	0.0008	0.0008	0.0008	0.0008	0.0009	0.0009	0.0009	0.0010	*−3.1*
0.0010	0.0010	0.0011	0.0011	0.0011	0.0012	0.0012	0.0013	0.0013	0.0013	*−3.0*
0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019	*−2.9*
0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026	*−2.8*
0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035	*−2.7*
0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047	*−2.6*
0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062	*−2.5*
0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082	*−2.4*
0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107	*−2.3*
0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139	*−2.2*
0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179	*−2.1*
0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228	*−2.0*
0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287	*−1.9*
0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359	*−1.8*
0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446	*−1.7*
0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548	*−1.6*
0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668	*−1.5*
0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808	*−1.4*
0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968	*−1.3*
0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151	*−1.2*
0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357	*−1.1*
0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587	*−1.0*
0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841	*−0.9*
0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119	*−0.8*
0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420	*−0.7*
0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743	*−0.6*
0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085	*−0.5*
0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446	*−0.4*
0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821	*−0.3*
0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207	*−0.2*
0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602	*−0.1*
0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000	*−0.0*

†For $z \leq -3.90$, the areas are 0.0000 to four decimal places.

Table Z (cont.)
Areas under the standard Normal curve



	Second decimal place in z									
z	*0.00*	*0.01*	*0.02*	*0.03*	*0.04*	*0.05*	*0.06*	*0.07*	*0.08*	*0.09*
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	1.0000†									

†For $z \geq 3.90$, the areas are 1.0000 to four decimal places.

B. Factors For Computing Center Line And Three-Sigma Control Limits

Observations in Sample, n	$\bar{X}$-Charts			s-Charts						R-Charts						
	Factors for Control Limits			Factors for Center line		Factors for Control Limits				Factors for Center line		Factors for Control Limits				
	A	A_2	A_3	c_4	$1/c_4$	B_3	B_4	B_5	B_6	d_2	$1/d_2$	d_3	D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.0423	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	1.0140	0.497	1.503	0.490	1.483	3.689	0.2711	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	1.0133	0.510	1.490	0.504	1.470	3.735	0.2677	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	1.0126	0.523	1.477	0.516	1.459	3.778	0.2647	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	1.0119	0.534	1.466	0.528	1.448	3.819	0.2618	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	1.0114	0.545	1.455	0.539	1.438	3.858	0.2592	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	1.0109	0.555	1.445	0.549	1.429	3.895	0.2567	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	1.0105	0.565	1.435	0.559	1.420	3.931	0.2544	0.708	1.806	6.056	0.459	1.541

C. Cumulative Poission Distribution Table

						np_0					
c	**0.01**	**0.05**	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
0	0.990	0.951	0.905	0.819	0.741	0.670	0.607	0.549	0.497	0.449	0.407
1	1.000	0.999	0.995	0.982	0.963	0.938	0.910	0.878	0.844	0.809	0.772
2		1.000	1.000	0.999	0.996	0.992	0.986	0.977	0.966	0.953	0.937
3				1.000	1.000	0.999	0.998	0.997	0.994	0.991	0.987
4						1.000	1.000	1.000	0.999	0.999	0.998
5									1.000	1.000	1.000
c	**1.0**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**2.0**
0	0.368	0.333	0.301	0.273	0.247	0.223	0.202	0.183	0.165	0.150	0.135
1	0.736	0.699	0.663	0.627	0.592	0.558	0.525	0.493	0.463	0.434	0.406
2	0.920	0.900	0.879	0.857	0.833	0.809	0.783	0.757	0.731	0.704	0.677
3	0.981	0.974	0.966	0.957	0.946	0.934	0.921	0.907	0.891	0.875	0.857
4	0.996	0.995	0.992	0.989	0.986	0.981	0.976	0.970	0.964	0.956	0.947
5	0.999	0.999	0.998	0.998	0.997	0.996	0.994	0.992	0.990	0.987	0.983
6	1.000	1.000	1.000	1.000	0.999	0.999	0.999	0.998	0.997	0.997	0.995
7					1.000	1.000	1.000	1.000	0.999	0.999	0.999
8									1.000	1.000	1.000
c	**2.2**	**2.4**	**2.6**	**2.8**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**
0	0.111	0.091	0.074	0.061	0.050	0.030	0.018	0.011	0.007	0.004	0.002
1	0.355	0.308	0.267	0.231	0.199	0.136	0.092	0.061	0.040	0.027	0.017
2	0.623	0.570	0.518	0.469	0.423	0.321	0.238	0.174	0.125	0.088	0.062
3	0.819	0.779	0.736	0.692	0.647	0.537	0.433	0.342	0.265	0.202	0.151
4	0.928	0.904	0.877	0.848	0.815	0.725	0.629	0.532	0.440	0.358	0.285
5	0.975	0.964	0.951	0.935	0.916	0.858	0.785	0.703	0.616	0.529	0.446
6	0.993	0.988	0.983	0.976	0.966	0.935	0.889	0.831	0.762	0.686	0.606
7	0.998	0.997	0.995	0.992	0.988	0.973	0.949	0.913	0.867	0.809	0.744
8	1.000	0.999	0.999	0.998	0.996	0.990	0.979	0.960	0.932	0.894	0.847
9		1.000	1.000	0.999	0.999	0.997	0.992	0.983	0.968	0.946	0.916
10				1.000	1.000	0.999	0.997	0.993	0.986	0.975	0.957
11						1.000	0.999	0.998	0.995	0.989	0.980
12							1.000	0.999	0.998	0.996	0.991
13								1.000	0.999	0.998	0.996
14									1.000	0.999	0.999
15										1.000	0.999
16											1.000

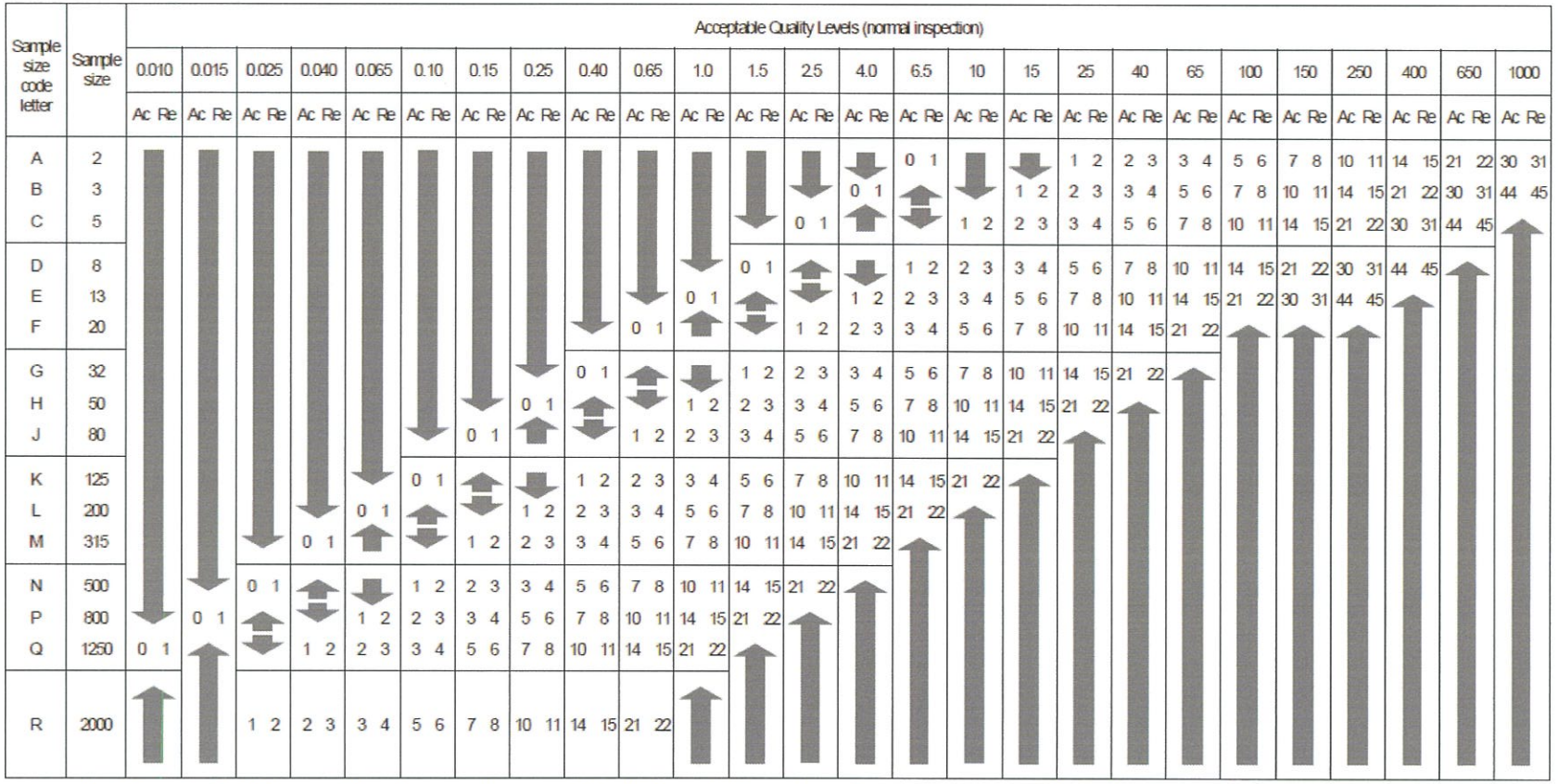
Cumulative Poission Distribution Table (cont.)

	np_0										
c	**6.5**	**7.0**	**7.5**	**8.0**	**9.0**	**10.0**	**12.0**	**14.0**	**16.0**	**18.0**	**20.0**
0	0.002	0.001	0.001	0.000							
1	0.011	0.007	0.005	0.003	0.001						
2	0.043	0.030	0.020	0.014	0.006	0.003	0.001				
3	0.112	0.082	0.059	0.042	0.021	0.010	0.002				
4	0.224	0.173	0.132	0.100	0.055	0.029	0.008	0.002			
5	0.369	0.301	0.241	0.191	0.116	0.067	0.020	0.006	0.001		
6	0.527	0.450	0.378	0.313	0.207	0.130	0.046	0.014	0.004	0.001	
7	0.673	0.599	0.525	0.453	0.324	0.220	0.090	0.032	0.010	0.003	0.001
8	0.792	0.729	0.662	0.593	0.456	0.333	0.155	0.062	0.022	0.007	0.002
9	0.877	0.830	0.776	0.717	0.587	0.458	0.242	0.109	0.043	0.015	0.005
10	0.933	0.901	0.862	0.816	0.706	0.583	0.347	0.176	0.077	0.030	0.011
11	0.966	0.947	0.921	0.888	0.803	0.697	0.462	0.260	0.127	0.055	0.021
12	0.984	0.973	0.957	0.936	0.876	0.792	0.576	0.358	0.193	0.092	0.039
13	0.993	0.987	0.978	0.966	0.926	0.864	0.682	0.464	0.275	0.143	0.066
14	0.997	0.994	0.990	0.983	0.959	0.917	0.772	0.570	0.368	0.208	0.105
15	0.999	0.998	0.995	0.992	0.978	0.951	0.844	0.669	0.467	0.287	0.157
16	1.000	0.999	0.998	0.996	0.989	0.973	0.899	0.756	0.566	0.375	0.221
17		1.000	0.999	0.998	0.995	0.986	0.937	0.827	0.659	0.469	0.297
18			1.000	0.999	0.998	0.993	0.963	0.883	0.742	0.562	0.381
19				1.000	0.999	0.997	0.979	0.923	0.812	0.651	0.470
20					1.000	0.998	0.988	0.952	0.868	0.731	0.559
21						0.999	0.994	0.971	0.911	0.799	0.644
22						1.000	0.997	0.983	0.942	0.855	0.721
23							0.999	0.991	0.963	0.899	0.787
24							0.999	0.995	0.978	0.932	0.843
25							1.000	0.997	0.987	0.955	0.888
26								0.999	0.993	0.972	0.922
27								0.999	0.996	0.983	0.948
28								1.000	0.998	0.990	0.966
29									0.999	0.994	0.978
30									0.999	0.997	0.987
31									1.000	0.998	0.992
32										0.999	0.995
33										1.000	0.997
34											0.999
35											0.999
36											1.000

D (i) Sample-Size Code Letters

Lot or batch size			Special Inspection Levels				General Inspection Levels		
			S-1	S-2	S-3	S-4	I	II	III
2	to	8	A	A	A	A	A	A	B
9	to	15	A	A	A	A	A	B	C
16	to	25	A	A	B	B	B	C	D
26	to	50	A	B	B	C	C	D	E
51	to	90	B	B	C	C	C	E	F
91	to	150	B	B	C	D	D	F	G
151	to	280	B	C	D	E	E	G	H
281	to	500	B	C	D	E	F	H	J
501	to	1,200	C	C	E	F	G	J	K
1,201	to	3,200	C	D	E	G	H	K	L
3,201	to	10,000	C	D	F	G	J	L	M
10,001	to	35,000	C	D	F	H	K	M	N
35,001	to	150,000	D	E	G	J	L	N	P
150,001	to	500,000	D	E	G	J	M	P	Q
500,001	and	over	D	E	H	K	N	Q	R

D (ii) Single Sampling Plans for Normal Inspection (Master Table)



Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)																																					
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	⇓		⇓		⇓		⇓		⇓		⇓		⇓		⇓		⇓		⇓		⇓		⇓		⇓		⇓		0	1	⇓		1	2	2	3	3	4	5	6
B	3																											0	1	⇕		1	2	2	3	3	4	5	6	7	8
C	5																									0	1	⇑		1	2	2	3	3	4	5	6	7	8	10	11
D	8																							0	1	⇕		⇓		1	2	2	3	3	4	5	6	7	8	10	11
E	13																					0	1	⇕		⇕		1	2	2	3	3	4	5	6	7	8	10	11	14	15
F	20																			0	1	⇑		⇕		⇕		2	3	3	4	5	6	7	8	10	11	14	15	21	22
G	32																	0	1	⇕		⇓		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22		
H	50															0	1	⇕		⇕		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22				
J	80													0	1	⇑		⇕		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22						
K	125											0	1	⇕		⇓		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22								
L	200									0	1	⇕		⇕		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22										
M	315							0	1	⇑		⇕		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22												
N	500					0	1	⇕		⇓		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22														
P	800			0	1	⇕		⇕		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22																
Q	1250	0	1	⇑		⇕		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22																		
R	2000					1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22																				

⇓ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.

⇑ = Use first sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

D (iii) Single Sampling Plans for Tightened Inspection (Master Table)

Sample size code letter	Sample size	Acceptable Quality Levels (tightened inspection)																																	
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2																											⇓																					
B	3																											0	1																				
C	5																											⇑				⇓				1	2												
D	8																									0	1							1	2	2	3	3	4	5	6	8	9	12	13	18	19	27	28	41	42
E	13																									⇓		0	1					2	3	3	4	5	6	8	9	12	13	18	19	27	28	41	42		
F	20																									⇑		⇓						3	4	5	6	8	9	12	13	18	19								
G	32																											⇑						5	6	8	9	12	13	18	19								
H	50																																	8	9	12	13	18	19								
J	80																																	12	13	18	19										
K	125																																	18	19												
L	200																																														
M	315																																														
N	500																																														
P	800																																														
Q	1250																																														
R	2000																																														
S	3150																																														

⇓ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.

⇑ = Use first sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

D (iv) Single Sampling Plans for Reduced Inspection (Master

Sample size code letter	Sample size	Acceptable Quality Levels (reduced inspection)†																																					
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2																											0	1					1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31
B	2																															0	2	1	3	2	4	3	5	5	6	7	8	10	11	14	15	21	22	30	31
C	2																									0	1			0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24		
D	3																							0	1			0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24				
E	5																					0	1			0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13	14	17	21	24						
F	8																			0	1					0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13										
G	13																	0	1			0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13														
H	20															0	1					1	3	1	4	2	5	3	6	5	8	7	10	10	13																
J	32													0	1					0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13																
K	50											0	1					0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13																		
L	80									0	1					0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13																				
M	125							0	1			0	2			1	3	1	4	2	5	3	6	5	8	7	10	10	13																						
N	200					0	1			0	2	1	3	1	4	2	5	2	5	3	6	5	8	7	10	10	13																						
P	315			0	1			0	2	1	3	1	4	2	5	3	6	3	6	5	8	7	10	10	13																						
Q	500	0	1			0	2	1	3	1	4	2	5	3	6	5	8	5	8	7	10	10	13																						
R	800					0	2	1	3	1	4	2	5	3	6	5	8	7	10	10	13																										

= Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.

= Use first sampling plan above arrow.

† = If the acceptance number has been exceeded, but the rejection number has not been reached; accept the lot, but reinstate normal inspection.

Ac = Acceptance number.

Re = Rejection number.