UNIVERSITI SAINS MALAYSIA

Peperiksaan Kursus Semasa Cuti Panjang
Sidang 1994/95

Jun 1995

MSG 362 Statistik Gunaan I

Masa : [3 jam]

Jawab **SEMUA** lima soalan. Soalan-soalan MESTI dijawab di dalam Bahasa Malaysia. Sifir New Cambridge Elementary Statistical Tables disediakan. Satu set lampiran dikepilkan. Alat penghitung *"non-programmable"* boleh digunakan. Ia disediakan oleh pelajar diri sendiri.

1. (a) Senaraikan tujuh alat utama kawalan kualiti. Huraikan penggunaannya setiap alat ini di dalam bidang kawalan kualiti.

(60%)

(b) Sebuah kilang mempunyai 5 barisan pemprosesan yang menghasilkan sejenis produk, produk-x. Pada suatu pemeriksaan, sampel yang tak bersandar diambil dari setiap barisan pemprosesan dan maklumat di ringkas seperti yang berikut:

Barisan	saiz sampel	minnya
1	6	4.16
2	6	4.15
3	8	4.26
4	10	4.24
5	10	4.32

dan diketahui $\sum\sum\left(X_{ij} - 4.00\right)^2 = 42.85$. X_{ij} ialah cerapan ke-j di dalam sampel ke-i.
Bolehkah dinyatakan min-minnya adalah sama? Gunakan $\alpha = 0.05$.

(40%)

...2/-

2. (a) Sampel sebanyak 200 cerapan diambil daripada suatu populasi dan didapati fungsi taburan longgokan $\tilde{F}(x)$ adalah seperti yang berikut:

$$\tilde{F}(x) = \begin{cases} 0.00, & x < 2 \quad ; \\ 0.01, & 2 \le x < 3 \; ; \\ 0.05, & 3 \le x < 4 \; ; \\ 0.13, & 4 \le x < 5 \; ; \\ 0.33, & 5 \le x < 6 \; ; \\ 0.61, & 6 \le x < 7 \; ; \\ 0.83, & 7 \le x < 8 \; ; \\ 0.90, & 8 \le x < 9 \; ; \\ 0.95, & 9 \le x < 10 \; ; \\ 0.98, & 10 \le x < 11 \; ; \\ 1.00, & 11 \le x \quad ; \end{cases}$$

Gunakan ujian Kolmogorov-Simirnov untuk menguji hipotesis bahawa populasinya adalah normal dengan $\mu = 6.50$ dan $\sigma = 1.10$.
Gunakan $\alpha = 0.05$.

(30%)

(b) Keputusan pemeriksaan subsampel-subsampel (setiap saiz 300) awal hasil chip elektronik suatu barisan pemprosesan sebuah kilang adalah seperti yang berikut:

subsampel	Bilangan yang cacat	subsampel	Bilangan yang cacat
1	5	14	9
2	4	15	2
3	6	16	7
4	7	17	26
5	8	18	2
6	15	19	3
7	5	20	19
8	8	21	6
9	6	22	7
10	7	23	10
11	6	24	6
12	2	25	1
13	7	26	5

...3/-

(i) Binakan carta kawalan kadaran kecacatan untuk kegunaan nanti. Anggapkan sebabnya terumpukkan kalau mana-mana data terletak di luar had kawalan percubaan dan tidak digunakan di dalam penghitungan.

(ii) Jika kadaran kecacatan proses penghasilan telah berubah ke atas 25% nilai piawainya, apakah kebarangkalian carta kecacatan ini dapat mengesan perubahan ini?

(40%)

(c) Tentukan persamaan garislurus penerimaan dan persamaan garislurus penolakan untuk rancangan pensampelan berjujukan butir demi butir yang berikut:

$$\alpha = 0.05\,; \quad p_0 = 0.01,$$
$$\beta = 0.10\,; \quad p_1 = 0.05.$$

Tunjukkan kawasan penerimaannya, penolakannya, dan kawasan berterusannya di atas satu satah, dan di dalam satu jadual sehingga saiz sampel $n = 20$.

(30%)

3. (a) Pihak pengurusan ingin menggunakan carta $\overline{X}$-R untuk menjaga proses penghasilannya. Dari data awal 26 subkumpulan setiap saiz $n = 5$, didapati bahawa:

subsampel	$\overline{X}$ min	R julat	subsampel	min $\overline{X}$	julat R
1	4.42	0.37	14	4.40	0.39
2	6.38	0.34	15	4.41	0.35
3	6.39	0.35	16	4.44	0.34
4	4.42	0.32	17	4.34	0.37
5	4.48	0.31	18	4.36	0.36
6	4.37	0.35	19	4.42	0.35
7	4.43	0.31	20	4.72	0.83
8	4.40	0.34	21	4.50	0.32
9	4.22	0.37	22	4.31	0.34
10	4.65	0.39	23	4.39	0.30
11	4.37	0.30	24	4.40	0.38
12	4.35	0.32	25	4.41	0.28
13	4.30	0.90	26	4.89	0.35

...4/

(i) Binakan carta $\overline{X}$-R untuk kegunaan kelak. Jika mana-mana data di luar had-had kawalan percubaan, anggapkan sebabnya terumpukkan.

(ii) Jika min proses telah berubah ke 4.60, apakah kebarangkalian bahawa carta $\overline{X}$ ini dapat mengesan perubahan pada sampel yang pertama selepas perubahan berlaku. Anggapkan sisihan piawainya tidak berubah.

(iii) Dapatkan carta-$\overline{X}$ dengan saiz subsampel itu supaya dapat mengesan perubahan min proses ke 4.60 dengan keyakinan 0.95 pada subsampel yang pertama selepas perubahan ini berlaku.

(60%)

(b) Untuk saiz lot N = 4000, AQL = 1.5%, gunakan MIL-STD-105E pada paras inspeksi II. Tentukan rancangan pensampelan penerimaan berganda dua untuk inspeksi normal, inspeksi ketak dan inspeksi longgar. Terangkan nombor-nombor digunakan.

(20%)

(c) Terangkan setiap sebutan yang berikut:

(1) α, risiko pengeluar;
(2) β, risiko pengguna;
(3) AQL, paras kualiti boleh diterima;
(4) LQL, paras kualiti penghad;
(5) AOQ, kualiti keluar secara purata;
(6) AOQL, had kualiti keluar secara purata;

(20%)

4. (a) Dari menggunakan carta-carta bilangan kecacatan per unit secara berasingan, Syarikat Radio Bhd. ingin menggunakan carta Demerit per unit untuk menjaga barisan pemprosesannya. Baris pemprosesannya telah stabil, dan yang berikut ialah maklumat data awal 24 subkumpulan setiap saiz 200:

...5/-

	Jenis Kecacatan		
Subsampel	Genting	Major	Minor
1	0	1	10
2	1	2	12
3	2	2	15
4	0	2	17
5	0	4	10
6	1	2	12
7	0	4	14
8	2	6	10
9	4	8	15
10	0	4	17
11	0	6	30
12	1	6	27
13	2	7	24
14	1	0	24
15	0	2	18
16	1	4	16
17	1	4	17
18	0	7	15
19	1	8	16
20	1	10	18
21	1	6	11
22	1	4	21
23	1	3	25
24	1	2	9

(i) Dapatkan carta Demerit per unit jika pemberat 3 jenis kecacatan ialah 9:3:1.

(ii) Di dalam satu subsampel yang saiznya 200, didapati

Jenis kecacatan :	Genting	Major	Minor
Bilangan kecacatan:	2	10	27

Apakah demerit per unit bagi subsampel ini? Adakah proses di dalam kawalan?

(50%)

(b) (i) Takrifkan C_p, indeks keupayaan bagi suatu proses penghasilan merujuk kepada speksifikasi-speksifikasi suatu permintaan.

(ii) Terangkan perhubungan had-had kawalan dan had-had speksifikasi merujuk kepada indeks keupayaannya.

(30%)

...6/-

(c) Tulis nota pendek tentang

(i) kebolehpercayaan suatu ciptaan
(ii) kadar kegagalan dan kadar bahaya

(20%)

5. (a) Yang berikut ialah 2 rancangan pensampelan penerimaan tunggal:

(A) $N = 4000, \quad n = 80, \quad c = 2;$
(B) $N = 4000, \quad n = 100, \quad c = 3;$

Jika ingin digunakan rancangan pensampelan penerimaan yang AOQL nya (had keluar secara purata) lebih kecil, (A) atau (B) patut digunakan? Beri alasan.

(40%)

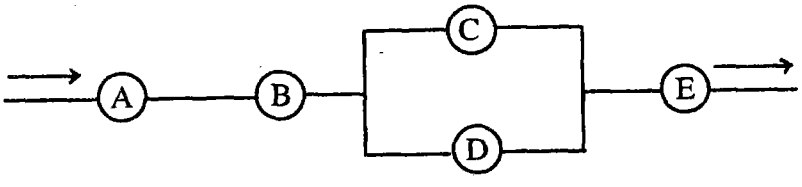
(b) Jika f.k.k. suatu pembolehubah masa hayat suatu komponen elektrik ialah f(x), dan kadar bahayanya ialah h(x),

$$h(x) = \alpha\beta^{x-1}, \qquad x > 1$$
$$\alpha, \beta \text{ positif}$$

cari f.k.k. nya f(x).

(30%)

(c) Suatu sistem campuran adalah seperti yang ditunjukkan:



Jika komponen A, B, C, D adalah saling tak bersandar dan mempunyai taburan masa hayat seperti x yang f.k.k. nya

$$f(x) = \frac{1}{500} e^{-\frac{1}{500}x}; \quad x > 0$$

cari kebolehpercayaan sistem ini pada min bagi x.

(40%)

- oooOOooo -

Table 6-4 ***np'*** **Values for Corresponding *c* Values and Typical Producer's and Consumer's Risks**

c	$P_a = 0.95$ ($\alpha = 0.05$)	$P_a = 0.10$ ($\beta = 0.10$)	*Ratio of* $p'_{0.10}/p'_{0.95}$
0	0.051	2.303	44.890
1	0.355	3.890	10.946
2	0.818	5.322	6.509
3	1.366	6.681	4.890
4	1.970	7.994	4.057
5	2.613	9.275	3.549
6	3.286	10.532	3.206
7	3.981	11.771	2.957
8	4.695	12.995	2.768
9	5.426	14.206	2.618
10	6.169	15.407	2.497
11	6.924	16.598	2.397
12	7.690	17.782	2.312
13	8.464	18.958	2.240
14	9.246	20.128	2.177
15	10.035	21.292	2.122

Source: Extracted by permission from J. M. Cameron, "Tables for Constructing and for Computing the Operating Characteristics of Single-Sampling Plans," *Industrial Quality Control*, 9, No. 1 (July 1952), p. 39.

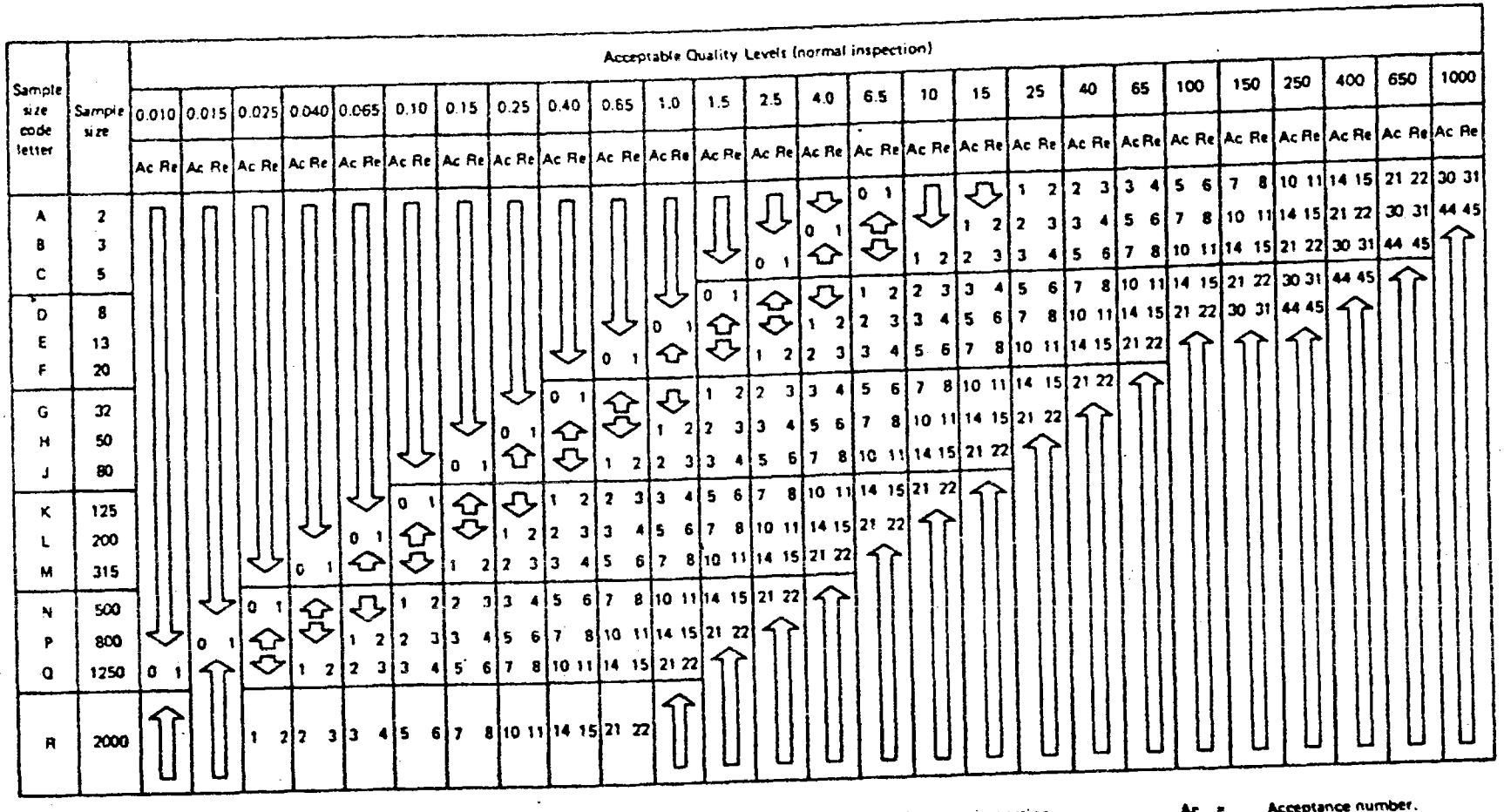
Table 6-5 Sample-Size Code Letters (Table I of MIL-STD 105D)

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 1200	C	C	E	F	G	J	K
1201 to 3200	C	D	E	G	H	K	L
3201 to 10000	C	D	F	G	J	L	M
10001 to 35000	C	D	F	H	K	M	N
35001 to 150000	D	E	G	J	L	N	P
150001 to 500000	D	E	G	J	M	P	Q
500001 and over	D	E	H	K	N	Q	R

Note.

Small sample inspection levels of MIL-STD-105C	*Convert to these special inspection levels*
L-1 and L-2	S-1
L-3 and L-4	S-2
L-5 and L-6	S-3
L-7 and L-8	S-4

Table 6-6 Single Sampling Plans for Normal Inspection (Table II-A of MIL-STD 105D)[a]



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	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	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	44 45
B	3														0 1	⇩		1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	
C	5													0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45		
D	8												0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45			
E	13											0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45				
F	20										0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45					
G	32									0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45						
H	50								0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45							
J	80							0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45								
K	125						0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45									
L	200					0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45										
M	315				0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45											
N	500			0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45												
P	800		0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45													
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	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧

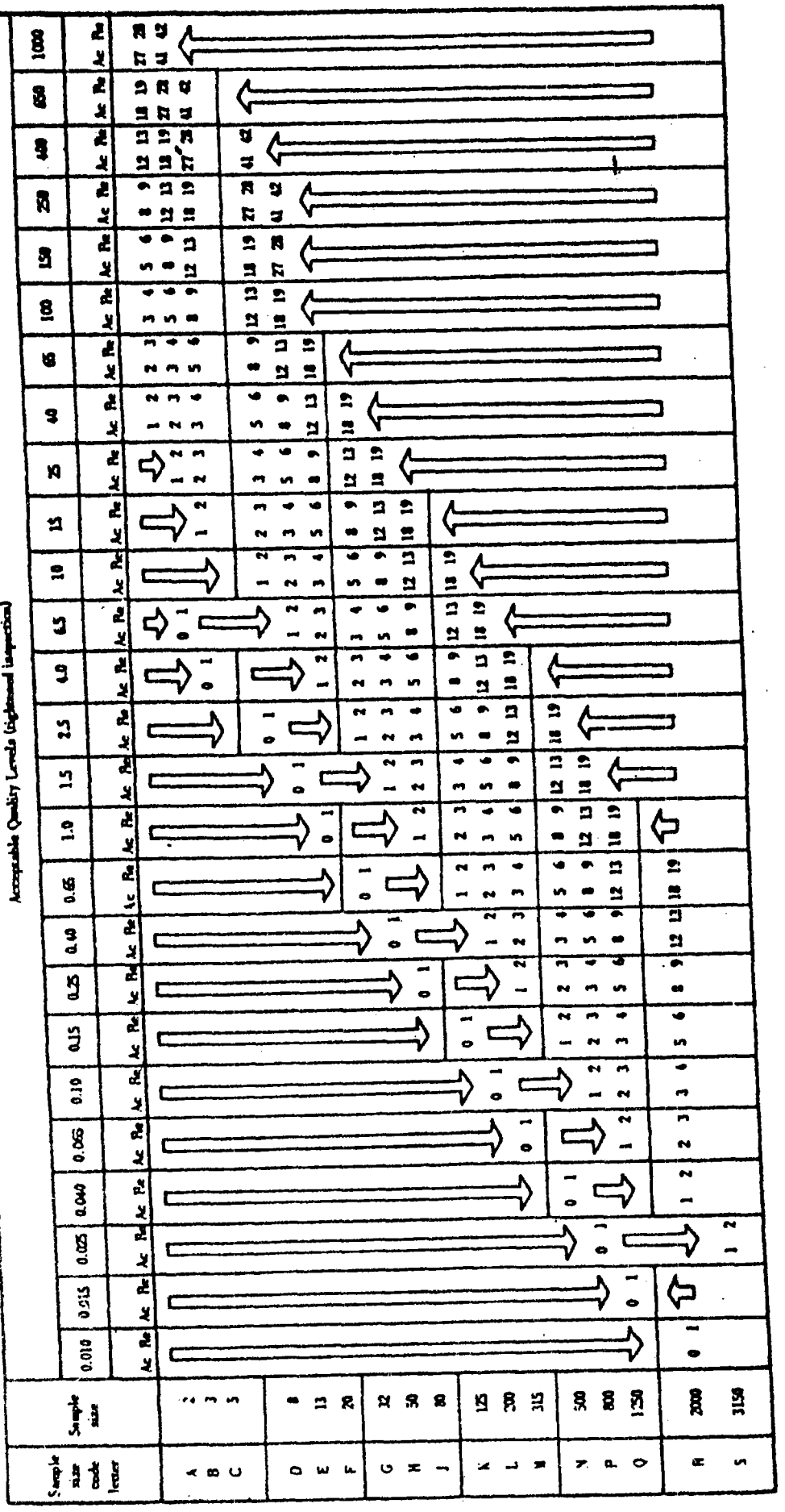
⇩ = Use first sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100 percent inspection.

⇧ = Use first sampling plan above arrow.

Ac = Acceptance number.

Re = Rejection number.

Table 6-7 Single Sampling Plans for Tightened Inspection (Table II-B of MIL-STD 105D)[a]



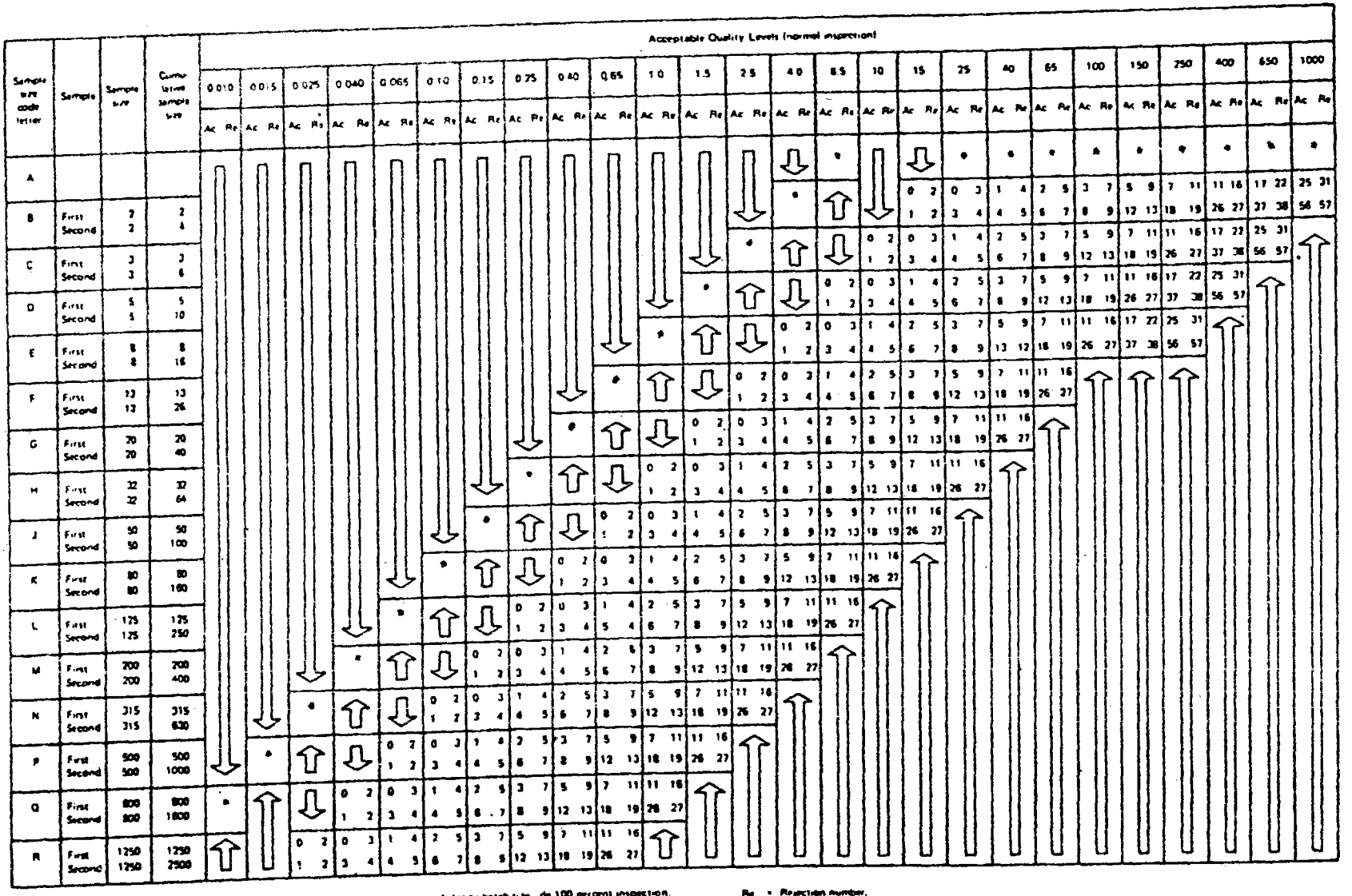
⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.

Table 6-8 Single Sampling Plans for Reduced Inspection (Table II-C of MIL-STD 105D)[a]

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	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 1	↑	↓	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	↑	↓	0 2	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	3 6	5 8	7 10	10 13	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
P	315	↓	0 1	↑	↓	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Q	500	0 1	↑	↓	0 2	1 3	1 4	2 5	3 6	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.
Ac = Acceptance number.
Re = Rejection number.
† = If the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot, but reinstate normal inspection (see 10.1.4).

Table 8-9 Double Sampling Plans for Normal Inspection (Table III-A of MIL-STD 105D)[a]



Sample size code letter	Sample	Sample size	Cumulative 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	
				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																												⇩		*			
B	First	2	2																									*		⇧		⇩	
	Second	2	4																														
C	First	3	3																									*		⇧		⇩	
	Second	3	6																														
D	First	5	5																									*		⇧		⇩	
	Second	5	10																														
E	First	8	8																									*		⇧		⇩	
	Second	8	16																														
F	First	13	13																									*		⇧		⇩	
	Second	13	26																														
G	First	20	20																									*		⇧		⇩	
	Second	20	40																														
H	First	32	32																									*		⇧		⇩	
	Second	32	64																														
J	First	50	50																									*		⇧		⇩	
	Second	50	100																														
K	First	80	80																									*		⇧		⇩	
	Second	80	160																														
L	First	125	125																									*		⇧		⇩	
	Second	125	250																														
M	First	200	200																									*		⇧		⇩	
	Second	200	400																														
N	First	315	315																									*		⇧		⇩	
	Second	315	630																														
P	First	500	500																									*		⇧		⇩	
	Second	500	1000																														
Q	First	800	800																									*		⇧		⇩	
	Second	800	1800																														
R	First	1250	1250																									*		⇧		⇩	
	Second	1250	2500																														

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (normal inspection)																													
				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
A				⇩		*		*		*		▲		*		*		*		*		*	
B	First	2	2	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	2	4	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
C	First	3	3	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	3	6	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
D	First	5	5	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	5	10	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
E	First	8	8	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	8	16	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
F	First	13	13	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	13	26	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
G	First	20	20	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	20	40	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
H	First	32	32	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	32	64	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
J	First	50	50	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	50	100	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
K	First	80	80	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	80	160	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
L	First	125	125	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	125	250	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
M	First	200	200	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	200	400	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
N	First	315	315	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	315	630	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
P	First	500	500	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	500	1000	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
Q	First	800	800	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	800	1800	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
R	First	1250	1250	0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	1250	2500	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57

⇩ = 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.

* = Use corresponding single sample plan (or alternatively, use double sampling plan below, where available).

Table 8-1 Double Sampling Plans for Tightened Inspection (Table III-B of MIL-STD 105D)[a]

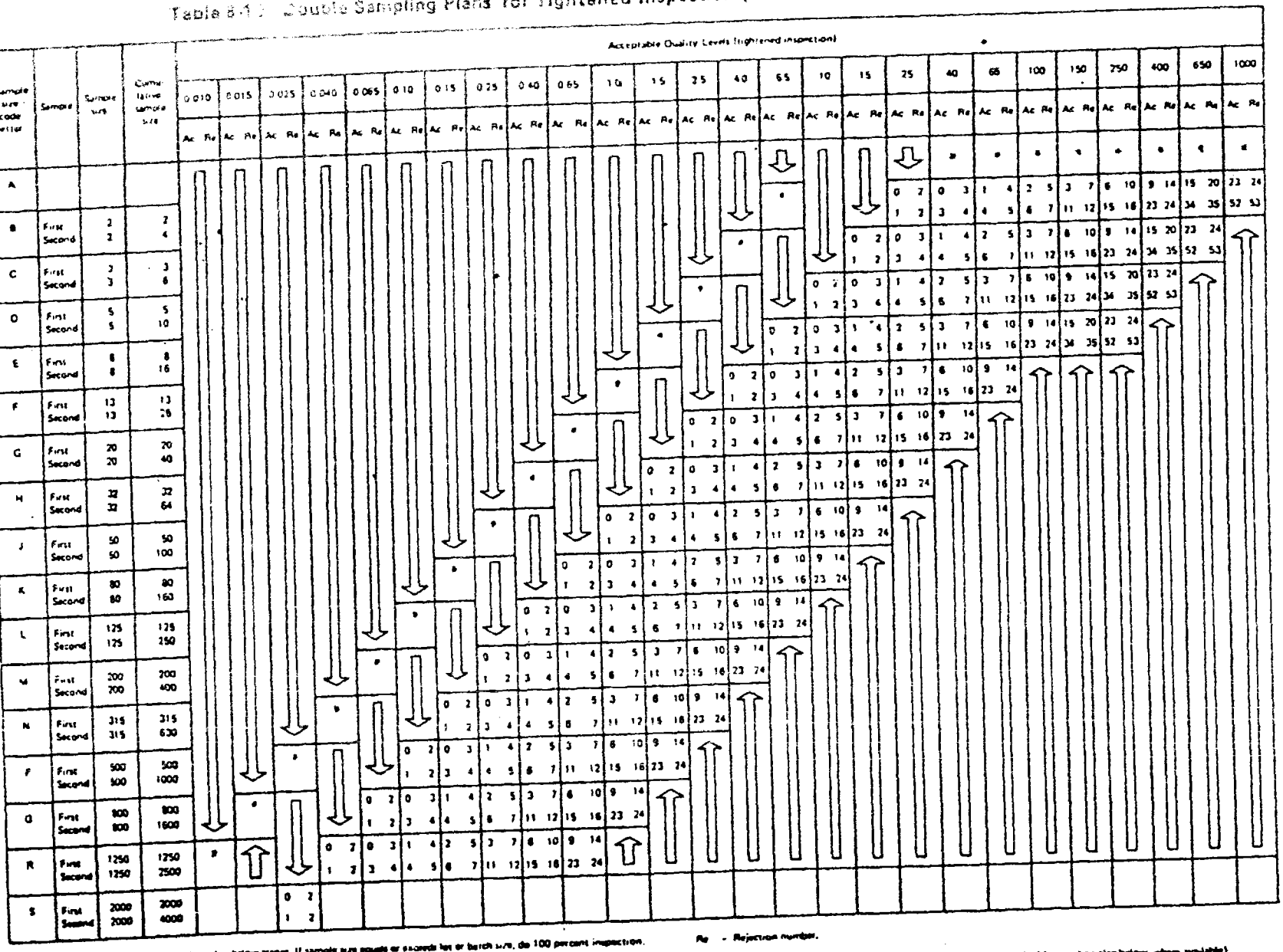
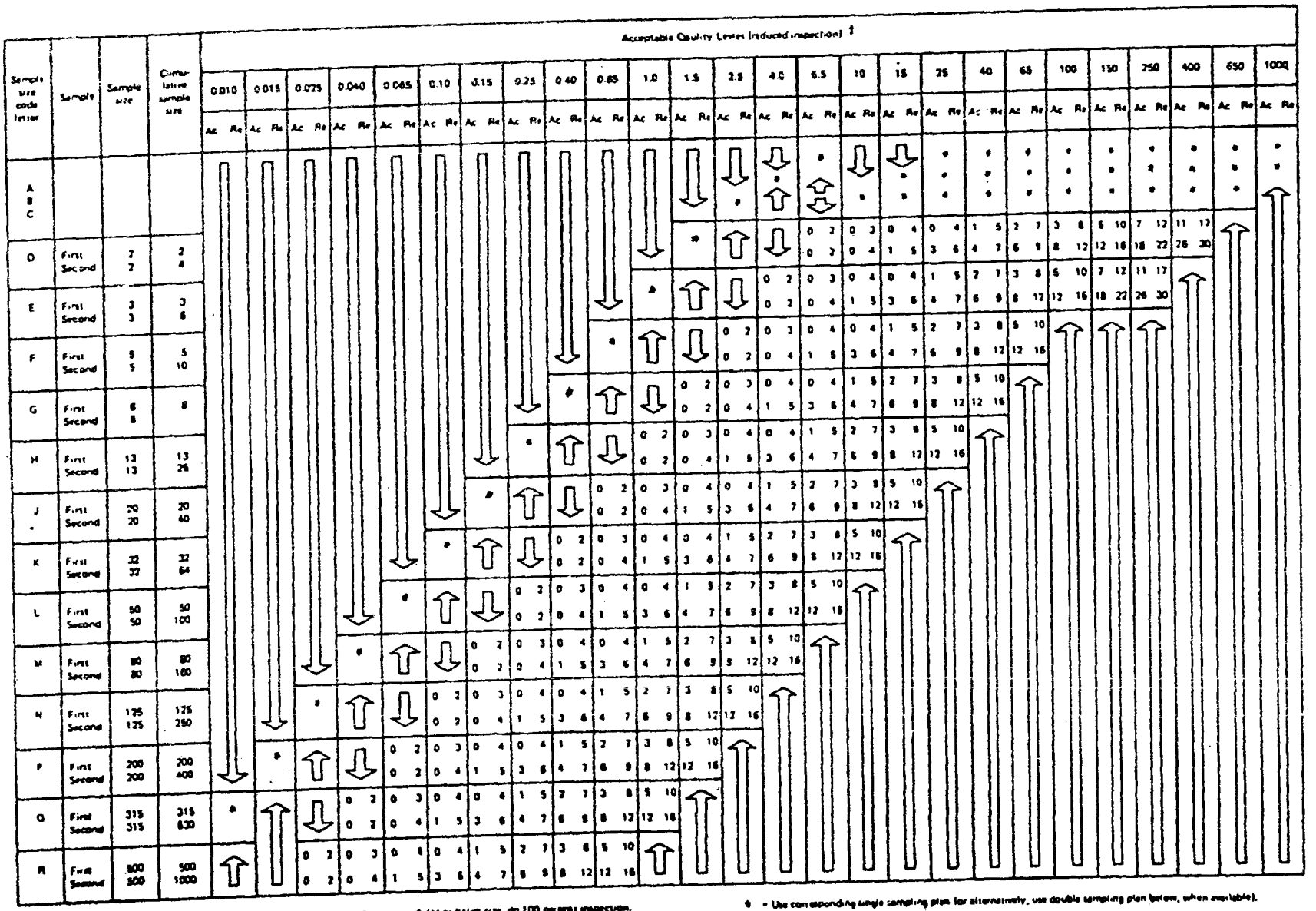


Table 6-11 Double Sampling Plans for Reduced Inspection (Table III-C of MIL-STD 105D)[a]



⇩ = 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.

* = Use corresponding single sampling plan (or alternatively, use double sampling plan below, where available).

† = If, after the second sample, the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot, but reinstate normal inspection (see 10.14).

TABLE B Factors for Computing Central Lines and 3σ Control Limits for $\bar{X}$, s, and R, Charts

Observations in Sample, n	Chart for Averages: Factors for Control Limits			Chart for Standard Deviations: Factors for Central Line		Chart for Standard Deviations: Factors for Control Limits				Chart for Ranges: Factors for Central Line		Chart for Ranges: 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_1	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	0.135	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

TABLE 3-6 Factors for Computing 3σ Control Limits for Median and Range Charts from the Median Range

Subgroup Size	A_5	D_5	D_6	d_3
2	2.224	0	3.865	0.954
3	1.265	0	2.745	1.588
4	0.829	0	2.375	1.978
5	0.712	0	2.179	2.257
6	0.562	0	2.055	2.472
7	0.520	0.078	1.967	2.645
8	0.441	0.139	1.901	2.791
9	0.419	0.187	1.850	2.916
10	0.369	0.227	1.809	3.024

Source: Extracted by permission from P. C. Clifford, "Control Charts Without Calculations," *Industrial Quality Control*, 15, No. 6 (May 1959), 44.

7 Kolmogorov-Smirnov Test

Table 7. Solutions c of Equation (1) in Sec. 15.3
n = Size of sample

n	$\alpha = 20\%$	$\alpha = 10\%$	$\alpha = 5\%$	$\alpha = 2\%$	$\alpha = 1\%$
	0.	0.	0.	0.	0.
1	900	950	975	990	995
2	684	776	842	900	929
3	565	636	708	785	829
4	493	565	624	689	734
5	447	509	563	627	669
6	410	468	519	577	617
7	381	436	483	538	576
8	359	410	454	507	542
9	339	387	430	480	513
10	323	369	409	457	486
11	308	352	391	437	468
12	296	338	375	419	449
13	285	325	361	404	432
14	275	314	349	390	418
15	266	304	338	377	404
16	258	295	327	366	392
17	250	286	318	355	381
18	244	279	309	346	371
19	237	271	301	337	361
20	232	265	294	329	352
21	226	259	287	321	344
22	221	253	281	314	337
23	216	247	275	307	330
24	212	242	269	301	323
25	208	238	264	295	317
26	204	233	259	290	311
27	200	229	254	284	305
28	197	225	250	279	300
29	193	221	246	275	295
30	190	218	242	270	290
35	177	202	224	251	269
40	165	189	210	235	252
45	156	179	198	222	238
50	148	170	188	211	226
55	142	162	180	201	216
60	136	155	172	193	207
65	131	149	166	185	199
70	126	144	160	179	192
75	122	139	154	173	185
80	118	135	150	167	179
85	114	131	145	162	174
90	111	127	141	158	169
95	108	124	137	154	165
100	106	121	134	150	161
Approximation for large n	$1.07/\sqrt{n}$	$1.22/\sqrt{n}$	$1.36/\sqrt{n}$	$1.52/\sqrt{n}$	$1.63/\sqrt{n}$