

Possible Useful Formulae/Values

$$\text{Boltzmann constant} = 1.3806503 \times 10^{-23} \text{ J/K}$$

$$10 \text{ Log (B/fb)} = E_b/N_0 \text{ (dB)} - C/N \text{ (dB)}$$

$$B/fb_{\text{ dB}} = E_b/N_0_{\text{ dB}} - C/N_{\text{ dB}}$$

$$n = \text{Log (DR + 1)} / \text{Log 2}$$

$$DR_{\text{ dB}} = 20 \text{ log (V max / V min)}$$

$$SQR_{\text{ dB}} = 10.8 + 20 \text{ log (v/q)}$$

$$S/N = 6n + 1.8 \text{ dB}$$

$$DR_{\text{ dB}} = 20 \text{ log (} 2^n - 1 \text{)}$$

$$DR = 2^n - 1$$

Useful TRIG ID's & sample scenarios

$$\sin^2 \omega_c t = \frac{1}{2} (1 - \cos 2\omega_c t)$$

$$-\sin^2 \omega_c t = -\frac{1}{2} (1 - \cos 2\omega_c t)$$

$$\cos^2 \omega_c t = \frac{1}{2} (1 + \cos 2\omega_c t)$$

$$-\cos^2 \omega_c t = -\frac{1}{2} (1 + \cos 2\omega_c t)$$

FOR
8PSK
+90° ϕ
-90°

$$* \sin A \sin B = \frac{1}{2} \cos(A-B) - \frac{1}{2} \cos(A+B)$$

$$\text{same} * \cos A \cos B = \frac{1}{2} \cos(A-B) + \frac{1}{2} \cos(A+B)$$

$$* \sin A \cos B = \frac{1}{2} \sin(A+B) + \frac{1}{2} \sin(A-B)$$

$$\text{same} \cos A \cos B = \frac{1}{2} \cos(A-B) + \frac{1}{2} \cos(A+B)$$

$$* \cos A \sin B = \frac{1}{2} [\sin(a+b) - \sin(a-b)]$$

TABLE 11-3 Line-Encoding Summary

Encoding Format	Minimum BW	Average DC	Clock Recovery	Error Detection
UPNRZ	$f_b/2^*$	$+V/2$	Poor	No
BNRZ	$f_b/2^*$	$0 V^*$	Poor	No
UPRZ	f_b	$+V/4$	Good	No
BPRZ	f_b	$0 V^*$	Best [*]	No
BPRZ-AMI	$f_b/2^*$	$0 V^*$	Good	Yes [*]

* Denotes best performance or quality.

FIGURE 10-18 12-bit-to-8-bit digital companding: (a) 8-bit μ 255 compressed code format; (b) μ 255 encoding table; (c) μ 255 decoding table

Sign bit 1 = + 0 = -	3-Bit segment identifier 000 to 111	4-Bit quantization interval A B C D 0000 to 1111
----------------------------	--	--

(a)

Encoded PCM			Transmission media		Decoded PCM		
			Transmit	Receive			
Segment	12-Bit linear code	8-Bit compressed code			8-Bit compressed code	12-Bit recovered code	Segment
0	s0000000ABCD	s000ABCD			s000ABCD	s0000000ABCD	0
1	s0000001ABCD	s001ABCD			s001ABCD	s0000001ABCD	1
2	s000001ABCDX	s010ABCD			s010ABCD	s000001ABCD1	2
3	s0000ABCDXX	s011ABCD			s011ABCD	s0000ABCD10	3
4	s0001ABCDXXX	s100ABCD			s100ABCD	s0001ABCD100	4
5	s001ABCDXXXX	s101ABCD			s101ABCD	s001ABCD1000	5
6	s01ABCDXXXXX	s110ABCD			s110ABCD	s01ABCD10000	6
7	s1ABCDXXXXXX	s111ABCD			s111ABCD	s1ABCD100000	7

(b)

(c)

TABLE 11-5 European Transmission Rates and Capacities

Line	Transmission Bit Rate (Mbps)	Channel Capacity
E1	2.048	30
E2	8.448	120
E3	34.368	480
E4	139.264	1920

FIGURE 9-48 Error rates of PSK modulation systems

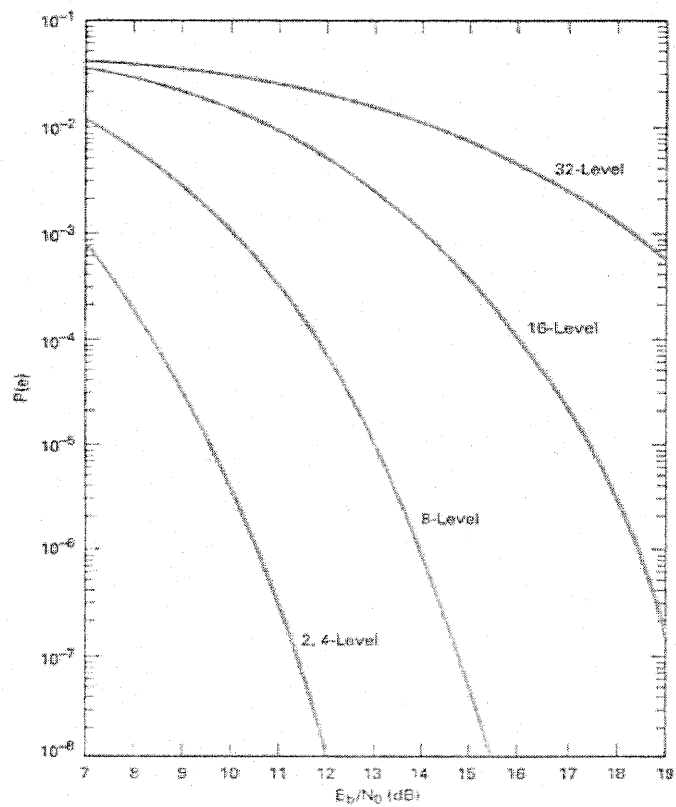


FIGURE 9-49 Error rates of QAM modulation systems

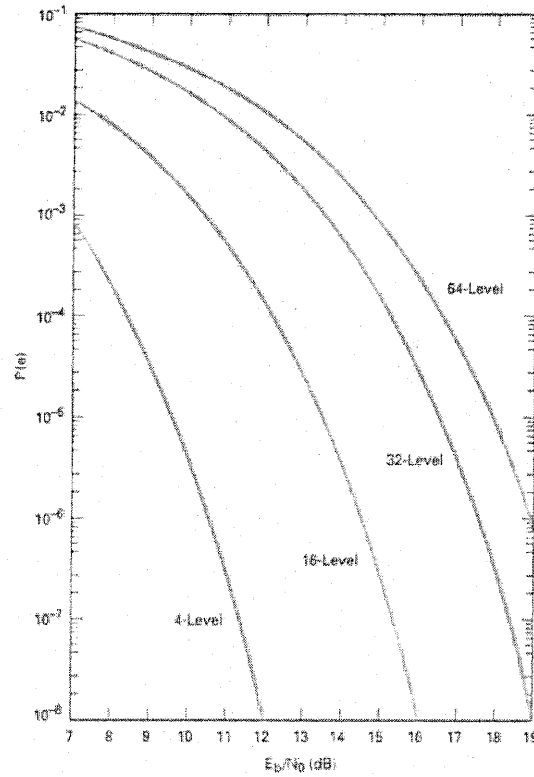
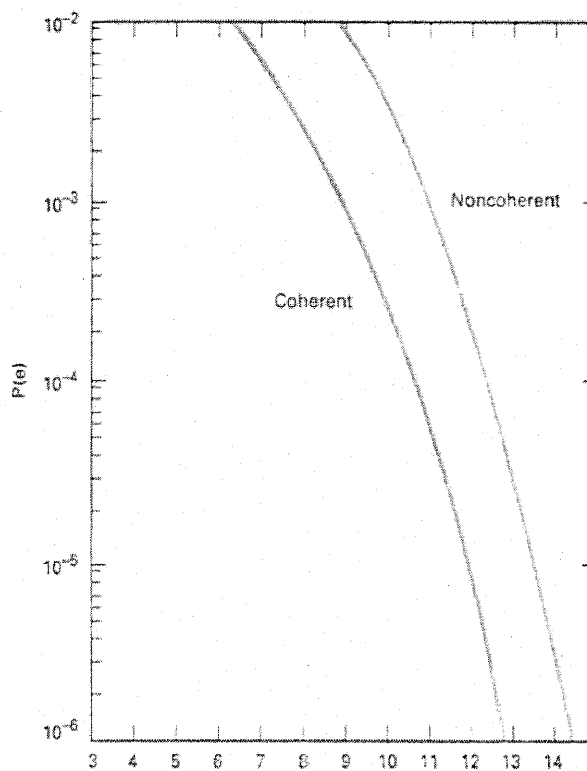


FIGURE 9-50 Error rates for FSK modulation systems



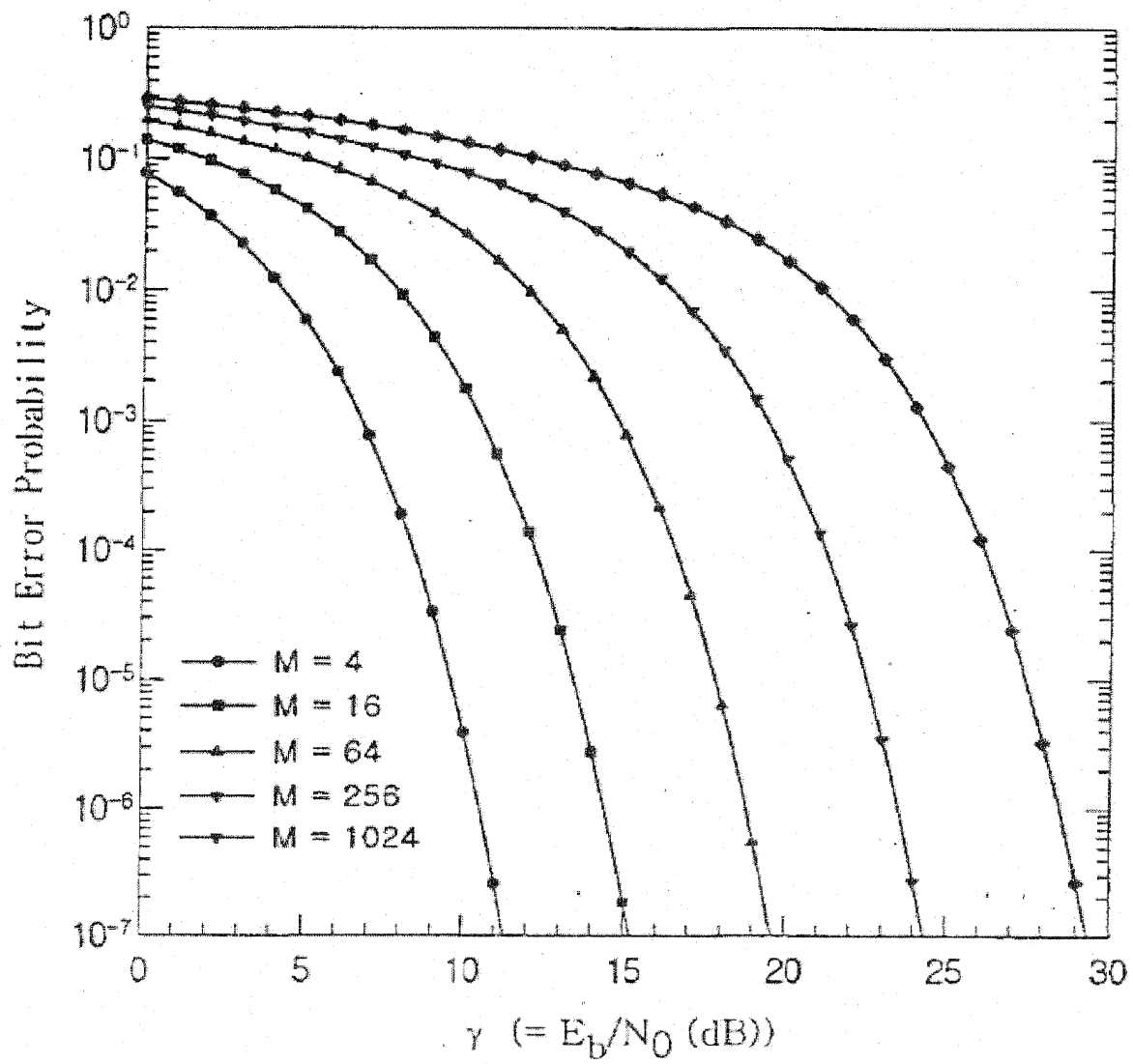


Table 7-3 Bessel Functions of the First Kind, $J_n(m)$

Bessel Functions of the First Kind, $J_n(m)$																
Modulation Index	Carrier															
	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	
m	Side-Frequency Pairs															
0.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	—	—	—	—	—	—	—	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.02	—	—	—	—	—	—	—	—	—	—	—	—
2.0	0.22	0.58	0.35	0.06	0.01	—	—	—	—	—	—	—	—	—	—	—
2.4	0	0.52	0.43	0.13	0.03	—	—	—	—	—	—	—	—	—	—	—
2.5	-0.05	0.50	0.43	0.20	0.06	0.02	—	—	—	—	—	—	—	—	—	—
3.0	-0.26	0.34	0.45	0.22	0.07	0.02	—	—	—	—	—	—	—	—	—	—
4.0	-0.40	-0.07	0.49	0.31	0.13	0.04	0.01	—	—	—	—	—	—	—	—	—
5.0	-0.18	-0.33	0.05	0.43	0.28	0.13	0.05	0.02	—	—	—	—	—	—	—	—
5.45	0	-0.34	0.12	0.36	0.39	0.26	0.13	0.05	0.02	—	—	—	—	—	—	—
6.0	0.15	-0.28	-0.12	0.26	0.40	0.32	0.19	0.09	0.03	0.01	—	—	—	—	—	—
7.0	0.30	0.00	-0.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—	—	—	—	—	—
8.0	0.17	0.23	-0.30	-0.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	—	—	—	—	—
8.65	0	0.27	-0.11	-0.29	-0.10	0.19	0.34	0.32	0.22	0.13	0.06	0.02	—	—	—	—
9.0	-0.09	0.25	0.06	-0.24	-0.23	0.03	0.26	0.34	0.28	0.18	0.10	0.05	0.03	—	—	—
10.0	-0.25	0.05	0.25	-0.18	-0.27	-0.06	0.20	0.33	0.31	0.21	0.12	0.06	0.02	0.05	0.03	0.01
				0.06	-0.22	-0.23	-0.01	0.22	0.32	0.29	0.21	0.12	0.06	0.03	0.01	0.01

TABLE 11-2 North American Digital Hierarchy Summary

Line Type	Digital Signal	Bit Rate	Channel Capacities	Services Offered
T1	DS-1	1.544 Mbps	24	Voice-band telephone or data
Fractional T1	DS-1	64 kbps to 1.536 Mbps	24	Voice-band telephone or data
T1C	DS-1C	3.152 Mbps	48	Voice-band telephone or data
T2	DS-2	6.312 Mbps	96	Voice-band telephone, data, or picture phone
T3	DS-3	44.736 Mbps	672	Voice-band telephone, data, picture phone, and broadcast-quality television
Fractional T3	DS-3	64 kbps to 23.152 Mbps	672	Voice-band telephone, data, picture phone, and broadcast-quality television
T4M	DS-4	274.176 Mbps	4032	Same as T3 except more capacity
T5	DS-5	560.160 Mbps	8064	Same as T3 except more capacity

Poisson Capacity Tables
Hundred Call Seconds at
Various Grade Levels

Figure 11.6
Sample Poisson Capacity Table

Trunks	Grade of Service At Indicated CCS Load			
	P.01	P.02	P.05	P.10
2	5.4	7.9	12.9	19.1
4	29.6	36.7	49.1	63.0
6	64.4	76.0	94.1	113.0
8	105.0	119.0	143.0	168.0
10	148.0	166.0	195.0	224.0
15	269.0	293.0	333.0	370.0
20	399.0	429.0	477.0	523.0
25	535.0	571.0	626.0	670.0
30	675.0	715.0	773.0	836.0
40	964.0	1012.0	1038.0	1157.0
50	1261.0	1317.0	1403.0	1482.0

To use this table find the usage in CCS in the appropriate grade of service column and read the number that appears on the same line in the trunks column on the extreme left.

Erlang B Capacity Tables
Erlangs of Use at
Various Grade of Service Levels

Figure 11.7
Sample Erlang B Capacity Table

Trunks	Grade of Service At Indicated Erlang Load			
	P.01	P.02	P.05	P.10
2	.153	.224	.382	.6
4	.870	1.093	1.525	2.0
6	1.909	2.276	2.961	3.8
8	3.128	3.627	4.543	5.6
10	4.462	5.084	6.216	7.5
15	8.106	9.010	10.63	12.5
20	12.03	13.18	15.25	17.60
25	16.13	17.51	19.99	22.80
30	20.34	21.93	24.80	28.10
40	29.01	31.00	34.60	38.80
50	37.90	40.25	44.53	49.60

To use this table find the usage in Erlangs in the appropriate grade of service column and read the number that appears on the same line in the trunks column on the extreme left.

TRUNK CAPACITY - ERLANGS (ERLANG B)

TRUNKS	GOS	.001	.002	.005	.01	.02
5		.76	.9	1.13	1.36	1.66
6		1.15	1.33	1.62	1.91	2.28
7		1.58	1.80	2.16	2.50	2.94
8		2.05	2.31	2.73	3.13	3.63
9		2.56	2.85	3.33	3.78	4.34
10		3.09	3.43	3.96	4.46	5.08
11		3.65	4.02	4.61	5.16	5.84
12		4.23	4.64	5.28	5.88	6.62
13		4.88	5.27	5.96	6.61	7.41
14		5.92	6.66	7.35	7.35	8.20
15		6.08	6.58	7.38	8.11	9.01
16		6.72	7.26	8.10	8.87	9.83
17		7.38	7.95	8.83	9.65	10.66
18		8.05	8.64	9.58	10.44	11.49
19		8.72	9.35	10.33	11.23	12.33
20		9.41	10.07	11.09	12.03	13.18
25		12.97	13.76	15.00	16.12	17.5
50		32.51	33.88	35.98	37.9	40.25
100		75.24	77.47	80.91	84.06	
15		119.94	122.86	127.4	131.58	

Poisson

Trunks	P.001		P.01		P.02		P.05		P.10	
	CCS	Erlangs	CCS	Erlangs	CCS	Erlangs	CCS	Erlangs	CCS	Erlangs
1	0.11	0.00	0.40	0.01	0.68	0.02	1.98	0.06	3.82	0.11
2	1.58	0.04	5.40	0.15	7.70	0.21	12.89	0.36	19.12	0.53
3	6.91	0.19	15.70	0.44	20.41	0.57	29.41	0.82	39.60	1.10
4	15.41	0.43	29.59	0.82	36.68	1.02	49.28	1.37	63.00	1.75
5	26.60	0.74	46.12	1.28	55.80	1.55	70.88	1.97	87.98	2.44
6	39.96	1.11	64.44	1.79	75.96	2.11	93.96	2.61	113.04	3.14
7	54.72	1.52	83.88	2.33	96.84	2.69	118.08	3.28	140.04	3.89
8	70.92	1.97	104.76	2.91	119.16	3.31	142.92	3.97	168.12	4.67
9	88.20	2.45	126.00	3.50	141.84	3.94	168.84	4.69	195.12	5.42
10	106.92	2.97	149.04	4.14	165.96	4.61	195.12	5.42	223.92	6.22
11	126.00	3.50	172.08	4.78	191.16	5.31	222.12	6.17	253.08	7.03
12	145.08	4.03	195.12	5.42	216.00	6.00	249.12	6.92	281.88	7.83
13	165.96	4.61	219.96	6.11	240.84	6.69	276.84	7.69	311.04	8.64
14	186.84	5.19	244.08	6.78	267.12	7.42	304.92	8.47	340.92	9.47
15	208.08	5.78	268.92	7.47	293.04	8.14	333.00	9.25	370.08	10.28
16	231.12	6.42	294.48	8.18	320.04	8.89	362.16	10.06	401.04	11.14
17	253.08	7.03	320.04	8.89	347.04	9.64	389.88	10.83	430.92	11.97
18	276.12	7.67	345.96	9.61	374.04	10.39	419.04	11.64	461.88	12.83
19	299.16	8.31	372.96	10.36	401.04	11.14	447.84	12.44	492.12	13.67
20	322.92	8.97	398.88	11.08	429.12	11.92	477.00	13.25	523.08	14.53
21	345.96	9.61	425.88	11.83	457.92	12.72	506.88	14.08	554.04	15.39
22	370.08	10.28	452.88	12.58	486.00	13.50	536.04	14.89	585.00	16.25
23	394.92	10.97	479.88	13.33	514.08	14.28	565.92	15.72	615.96	17.11
24	419.04	11.64	506.88	14.08	542.16	15.06	596.16	16.56	646.92	17.97
25	443.88	12.33	534.96	14.86	570.96	15.86	626.04	17.39	677.88	18.83
26	469.08	13.03	561.96	15.61	599.04	16.64	655.92	18.22	709.92	19.72
27	495.00	13.75	590.04	16.39	627.12	17.42	686.16	19.06	740.88	20.58
28	519.84	14.44	618.12	17.17	655.92	18.22	717.12	19.92	772.92	21.47
29	545.04	15.14	646.92	17.97	685.08	19.03	747.00	20.75	804.96	22.36
30	570.96	15.86	675.00	18.75	714.96	19.86	777.96	21.61	835.92	23.22
31	596.88	16.58	703.08	19.53	744.12	20.67	808.92	22.47	867.96	24.11
32	623.88	17.33	731.88	20.33	772.92	21.47	839.88	23.33	900.00	25.00
33	650.16	18.06	759.96	21.11	803.16	22.31	870.84	24.19	932.04	25.89
34	676.08	18.78	789.12	21.92	831.96	23.11	902.16	25.06	964.08	26.78
35	703.08	19.53	817.92	22.72	861.84	23.94	933.12	25.92	996.12	27.67
36	729.00	20.25	847.08	23.53	892.08	24.78	964.08	26.78	1,028.16	28.56
37	756.00	21.00	875.88	24.33	921.96	25.61	995.04	27.64	1,059.84	29.44
38	783.00	21.75	905.04	25.14	951.84	26.44	1,026.00	28.50	1,091.88	30.33
39	810.00	22.50	934.92	25.97	982.08	27.28	1,056.96	29.36	1,126.44	31.29
40	837.00	23.25	964.08	26.78	1,011.96	28.11	1,087.92	30.22	1,157.04	32.14
41	865.08	24.03	992.88	27.58	1,041.84	28.94	1,119.96	31.11	1,190.16	33.06
42	892.08	24.78	1,023.12	28.42	1,072.08	29.78	1,150.92	31.97	1,221.84	33.94
43	919.08	25.53	1,051.92	29.22	1,103.04	30.64	1,182.96	32.86	1,254.96	34.86
44	947.16	26.31	1,082.16	30.06	1,132.92	31.47	1,213.92	33.72	1,287.00	35.75
45	974.88	27.08	1,112.04	30.89	1,163.88	32.33	1,245.96	34.61	1,320.12	36.67
46	1,002.96	27.86	1,141.92	31.72	1,194.12	33.17	1,276.92	35.47	1,352.16	37.56
47	1,029.96	28.61	1,171.08	32.53	1,225.08	34.03	1,308.96	36.36	1,384.92	38.47
48	1,058.04	29.39	1,200.96	33.36	1,254.96	34.86	1,340.28	37.23	1,416.96	39.36
49	1,410.12	39.17	1,230.84	34.19	1,285.92	35.72	1,371.96	38.11	1,450.08	40.28
50	1,114.92	30.97	1,261.08	35.03	1,316.88	36.58	1,402.92	38.97	1,482.12	41.17

Erlang B

Trunks	P.001		P.01		P.02		P.05		P.10	
	CCS	Erlangs	CCS	Erlangs	CCS	Erlangs	CCS	Erlangs	CCS	Erlangs
1	0.00	0.00	0.40	0.01	0.70	0.02	1.80	0.05	4.00	0.11
2	1.80	0.05	5.40	0.15	7.90	0.22	13.70	0.38	21.60	0.60
3	6.80	0.19	16.60	0.46	21.60	0.60	32.40	0.90	45.70	1.27
4	15.80	0.44	31.30	0.87	39.20	1.09	54.70	1.52	73.80	2.05
5	27.40	0.76	49.00	1.36	59.80	1.66	79.90	2.22	104.00	2.88
6	41.40	1.15	68.80	1.91	82.10	2.28	107.00	2.96	135.00	3.76
7	56.90	1.58	90.00	2.50	106.00	2.94	135.00	3.74	168.00	4.67
8	73.80	2.05	113.00	3.13	131.00	3.63	163.00	4.54	202.00	5.60
9	92.20	2.56	136.00	3.78	156.00	4.34	193.00	5.37	236.00	6.55
10	111.00	3.09	161.00	4.46	183.00	5.08	224.00	6.22	270.00	7.51
11	131.00	3.65	186.00	5.16	210.00	5.84	255.00	7.08	306.00	8.49
12	152.00	4.23	212.00	5.88	238.00	6.62	286.00	7.95	341.00	9.47
13	174.00	4.83	238.00	6.61	267.00	7.41	318.00	8.83	377.00	10.47
14	196.00	5.45	265.00	7.35	295.00	8.20	350.00	9.73	413.00	11.47
15	219.00	6.08	292.00	8.11	324.00	9.01	383.00	10.63	449.00	12.48
16	242.00	6.72	319.00	8.87	354.00	9.83	415.00	11.54	486.00	13.50
17	266.00	7.38	347.00	9.65	384.00	10.66	449.00	12.46	523.00	14.52
18	290.00	8.05	376.00	10.44	414.00	11.49	482.00	13.38	560.00	15.55
19	314.00	8.72	404.00	11.23	444.00	12.33	515.00	14.31	597.00	16.58
20	339.00	9.41	433.00	12.03	474.00	13.18	549.00	15.25	634.00	17.61
21	364.00	10.11	462.00	12.84	505.00	14.04	583.00	16.19	671.00	18.65
22	389.00	10.81	491.00	13.65	536.00	14.90	617.00	17.13	709.00	19.69
23	415.00	11.52	521.00	14.47	567.00	15.76	651.00	18.08	748.00	20.74
24	441.00	12.24	550.00	15.29	599.00	16.63	685.00	19.03	784.00	21.78
25	467.00	12.97	580.00	16.12	630.00	17.50	720.00	19.99	822.00	22.83
26	493.00	13.70	611.00	16.96	662.00	18.38	754.00	20.94	860.00	23.83
27	520.00	14.44	641.00	17.80	693.00	19.26	788.00	21.90	898.00	24.94
28	546.00	15.18	671.00	18.64	725.00	20.15	823.00	22.87	936.00	26.00
29	573.00	15.93	702.00	19.49	757.00	21.04	858.00	23.83	974.00	27.05
30	600.00	16.68	732.00	20.34	789.00	21.93	893.00	24.80	1,012.00	28.11
31	628.00	17.44	763.00	21.19	822.00	22.83	928.00	25.77	1,050.00	29.17
32	655.00	18.20	794.00	22.05	854.00	23.73	963.00	26.75	1,088.00	30.23
33	683.00	18.97	825.00	22.91	887.00	24.63	998.00	27.72	1,127.00	31.30
34	711.00	19.74	856.00	23.77	919.00	25.53	1,033.00	28.70	1,164.00	32.36
35	739.00	20.52	887.00	24.64	951.00	26.43	1,068.00	29.68	1,203.00	33.43
36	767.00	21.30	918.00	25.51	984.00	27.34	1,104.00	30.66	1,232.00	34.50
37	795.00	22.08	950.00	26.38	1,017.00	28.25	1,139.00	31.64	1,281.00	35.57
38	823.00	22.86	981.00	27.25	1,050.00	29.17	1,175.00	32.63	1,319.00	36.64
39	851.00	23.65	1,013.00	28.13	1,083.00	30.08	1,210.00	33.61	1,358.00	37.71
40	880.00	24.44	1,044.00	29.01	1,116.00	31.00	1,246.00	34.60	1,396.00	38.79
41	909.00	25.24	1,076.00	29.89	1,149.00	31.92	1,281.00	35.59	1,435.00	39.86
42	937.00	26.04	1,108.00	30.77	1,182.00	32.84	1,317.00	36.58	1,474.00	40.94
43	966.00	26.84	1,140.00	31.66	1,215.00	33.76	1,353.00	37.57	1,512.00	42.01
44	995.00	27.64	1,171.00	32.54	1,248.00	34.68	1,388.00	38.56	1,551.00	43.09
45	1,024.00	28.45	1,203.00	33.43	1,282.00	35.61	1,424.00	39.55	1,590.00	44.16
46	1,053.00	29.26	1,236.00	34.32	1,315.00	36.53	1,459.00	40.54	1,629.00	45.24
47	1,083.00	30.07	1,268.00	35.21	1,349.00	37.46	1,495.00	41.54	1,668.00	46.32
48	1,111.00	30.88	1,300.00	36.11	1,382.00	38.39	1,531.00	42.54	1,706.00	47.40
49	1,141.00	31.69	1,332.00	37.00	1,415.00	39.32	1,567.00	43.54	1,745.00	48.48
50	1,170.00	32.51	1,364.00	37.90	1,449.00	40.25	1,603.00	44.53	1,784.00	49.56

N	P(o)	A	D1	D2	P(i) for t=							
					.1	.2	.3	.4	.5	.75	1	
1	.002	.001	.002	1.00	.002	.002	.001	.001	.001	.001	.001	
	.005	.004	.005	1.00	.005	.004	.004	.003	.003	.002	.002	
	.01	.009	.010	1.01	.009	.008	.007	.007	.006	.005	.004	
	.02	.019	.020	1.02	.018	.016	.015	.014	.012	.010	.007	
	.05	.049	.053	1.05	.045	.041	.038	.034	.031	.025	.019	
	.1	.099	.111	1.11	.091	.084	.076	.070	.064	.051	.041	
	.2	.199	.250	1.25	.185	.170	.157	.145	.134	.110	.090	
	.5	.499	.998	2.00	.476	.452	.430	.409	.389	.343	.303	
	2	.0005	.031		.508							
.001		.045	.001	.512	.001	.001	.001					
.002		.064	.001	.517	.002	.001	.001	.001	.001			
.005		.102	.003	.527	.004	.003	.003	.002	.002	.001	.001	
.01		.146	.005	.539	.008	.007	.006	.005	.004	.002	.002	
.02		.210	.011	.559	.017	.014	.012	.010	.008	.005	.003	
.05		.342	.030	.603	.042	.036	.030	.026	.022	.014	.010	
.1		.499	.067	.666	.086	.074	.064	.055	.047	.032	.022	
.2		.740	.159	.794	.176	.155	.137	.121	.107	.078	.057	
.5	1.280	.695	1.39	.465	.433	.403	.375	.349	.291	.243		
3	.0005	.148		.351								
	.001	.189		.356	.001	.001						
	.002	.241	.001	.362	.002	.001	.001	.001	.001			
	.005	.333	.002	.375	.004	.003	.002	.002	.001	.001		
	.01	.428	.004	.389	.008	.006	.005	.004	.003	.001	.001	
	.02	.554	.008	.409	.016	.012	.010	.008	.006	.003	.002	
	.05	.787	.023	.452	.040	.032	.026	.021	.017	.010	.005	
	.1	1.039	.051	.510	.082	.068	.056	.046	.038	.023	.015	
	.2	1.392	.124	.622	.170	.145	.123	.105	.090	.060	.040	
.5	2.115	.565	1.13	.458	.419	.383	.351	.321	.257	.206		
4	.0005	.353		.274								
	.001	.425		.280	.001							
	.002	.514	.001	.287	.001	.001	.001					
	.005	.663	.001	.300	.004	.003	.002	.001	.001			
	.01	.809	.003	.313	.007	.005	.004	.003	.002	.001		
	.02	.983	.007	.333	.015	.011	.008	.006	.004	.002	.001	
	.05	1.318	.019	.373	.038	.029	.022	.017	.013	.007	.003	
	.1	1.652	.043	.426	.079	.063	.049	.039	.031	.017	.010	
	.2	2.102	.105	.527	.165	.137	.113	.094	.077	.048	.030	
.5	2.977	.489	.978	.451	.407	.368	.332	.300	.232	.180		

					P(i) for t=							
N	P(o)	A	D1	D2	.1	.2	.3	.4	.5	.75	1	
5	.0005	.628		.229								
	.001	.734		.234	.001							
	.002	.859		.241	.001	.001	.001					
	.005	1.064	.001	.254	.003	.002	.002	.001	.001			
	.01	1.258	.003	.267	.007	.005	.003	.002	.002	.001		
	.02	1.497	.006	.285	.014	.010	.007	.005	.003	.001	.001	
	.05	1.905	.016	.323	.037	.027	.020	.014	.011	.005	.002	
	.1	2.313	.037	.372	.076	.058	.045	.034	.026	.013	.007	
	.2	2.847	.093	.464	.161	.130	.105	.085	.069	.040	.023	
	.5	3.856	.437	.874	.446	.398	.355	.316	.282	.212	.159	
6	.0005	.961		.198								
	.001	1.099		.204	.001							
	.002	1.260		.211	.001	.001						
	.005	1.518	.001	.223	.003	.002	.001	.001	.001			
	.01	1.758	.002	.236	.007	.004	.003	.002	.001			
	.02	2.047	.005	.253	.013	.009	.006	.004	.003	.001		
	.05	2.531	.014	.288	.035	.025	.018	.012	.009	.004	.002	
	.1	3.006	.033	.334	.074	.055	.041	.030	.022	.011	.005	
	.2	3.617	.084	.420	.158	.124	.098	.077	.061	.033	.018	
	.5	4.746	.399	.798	.441	.389	.343	.303	.267	.195	.143	
7	.0005	1.340		.177								
	.001	1.509		.182	.001							
	.002	1.705		.189	.001	.001						
	.005	2.014	.001	.201	.003	.002	.001	.001				
	.01	2.296	.002	.213	.006	.004	.002	.002	.001			
	.02	2.632	.005	.229	.013	.008	.005	.003	.002	.001		
	.05	3.188	.013	.262	.034	.023	.016	.011	.007	.003	.001	
	.1	3.724	.031	.305	.072	.052	.037	.027	.019	.009	.004	
	.2	4.406	.077	.386	.154	.119	.092	.071	.055	.029	.015	
	.5	5.646	.369	.739	.437	.381	.333	.291	.254	.181	.129	
8	.0005	1.757		.160								
	.001	1.957		.165	.001							
	.002	2.186		.172	.001	.001						
	.005	2.543	.001	.183	.003	.002	.001	.001				
	.01	2.865	.002	.195	.006	.004	.002	.001	.001			
	.02	3.246	.004	.210	.012	.008	.005	.003	.002	.001		
	.05	3.668	.012	.242	.033	.022	.014	.010	.006	.002	.001	
	.1	4.463	.028	.283	.070	.049	.035	.024	.017	.007	.003	
	.2	5.210	.072	.358	.151	.114	.087	.066	.050	.025	.012	
	.5	6.553	.346	.691	.433	.374	.324	.280	.243	.169	.118	

A	N	P(0)	D1	D2	P(t) for t=						
					.1	.2	.3	.4	.5	.75	1
6.1	7	.6482	.720	1.11	.592	.541	.495	.452	.413	.330	.264
	8	.3808	.200	.526	.315	.260	.215	.178	.147	.092	.057
	9	.2114	.073	.345	.158	.118	.089	.066	.050	.024	.012
	10	.1106	.028	.256	.075	.051	.034	.023	.016	.006	.002
	11	.0545	.011	.204	.033	.020	.013	.008	.005	.001	
	12	.0252	.004	.169	.014	.008	.004	.002	.001		
	13	.0110	.002	.145	.006	.003	.001	.001			
	14	.0045	.001	.127	.002	.001					
	15	.0017		.112	.001						
	16										
6.2	7	.6863	.855	1.25	.631	.583	.538	.496	.459	.375	.307
	8	.4055	.225	.556	.339	.283	.236	.197	.165	.105	.067
	9	.2276	.081	.357	.172	.130	.098	.074	.056	.028	.014
	10	.1205	.032	.263	.082	.056	.039	.026	.018	.007	.003
	11	.0601	.013	.208	.037	.023	.014	.009	.005	.002	
	12	.0282	.005	.172	.016	.009	.005	.003	.002		
	13	.0124	.002	.147	.006	.003	.002	.001			
	14	.0052	.001	.128	.002	.001					
	15	.0020		.114	.001						
	16										
6.3	7	.7200	1.03	1.43	.671	.626	.584	.544	.507	.426	.358
	8	.4311	.254	.588	.364	.307	.259	.218	.184	.120	.079
	9	.2445	.091	.370	.187	.142	.109	.083	.063	.032	.016
	10	.1310	.035	.270	.090	.062	.043	.030	.021	.008	.003
	11	.0661	.014	.213	.041	.026	.016	.010	.006	.002	.001
	12	.0314	.006	.175	.018	.010	.006	.003	.002		
	13	.0141	.002	.149	.007	.004	.002	.001			
	14	.0059	.001	.130	.003	.001	.001				
	15	.0024		.115	.001						
	16										
6.4	7	.7572	1.26	1.67	.713	.672	.632	.596	.561	.483	.416
	8	.4576	.286	.625	.390	.332	.283	.241	.206	.138	.092
	9	.2622	.101	.385	.202	.156	.120	.093	.071	.037	.019
	10	.1420	.039	.278	.099	.069	.048	.034	.023	.010	.004
	11	.0726	.016	.217	.046	.029	.018	.012	.007	.002	.001
	12	.0349	.006	.179	.020	.011	.007	.004	.002	.001	
	13	.0159	.002	.152	.008	.004	.002	.001	.001		
	14	.0068	.001	.132	.003	.001	.001				
	15	.0027		.116	.001						
	16										

A	N	P(0)	D1	D2	P(t) for t=						
					.1	.2	.3	.4	.5	.75	1
6.5	7	.7954	1.59	2.00	.757	.720	.685	.651	.619	.547	.482
	8	.4850	.323	.667	.417	.359	.309	.266	.229	.157	.108
	9	.2807	.112	.400	.219	.170	.133	.103	.080	.043	.023
	10	.1537	.044	.286	.108	.076	.054	.038	.027	.011	.005
	11	.0795	.018	.222	.051	.032	.021	.013	.008	.003	.001
	12	.0388	.007	.182	.022	.013	.007	.004	.002	.001	
	13	.0178	.003	.154	.009	.005	.003	.001	.001		
	14	.0077	.001	.133	.004	.002	.001				
	15	.0032		.118	.001						
	16										
6.6	7	.8346	2.09	2.50	.802	.770	.740	.711	.683	.618	.559
	8	.5133	.367	.714	.446	.388	.337	.293	.255	.180	.127
	9	.3000	.125	.417	.236	.186	.146	.115	.090	.050	.027
	10	.1660	.049	.294	.118	.084	.060	.043	.030	.013	.006
	11	.0868	.020	.227	.056	.036	.023	.015	.010	.003	.001
	12	.0429	.008	.185	.025	.015	.008	.005	.003	.001	
	13	.0200	.003	.156	.011	.006	.003	.002	.001		
	14	.0088	.001	.135	.004	.002	.001				
	15	.0036		.119	.002	.001					
	16	.0014		.106	.001						
6.7	7	.8746	2.92	3.33	.849	.824	.799	.776	.753	.698	.648
	8	.5425	.417	.769	.476	.418	.367	.323	.283	.205	.148
	9	.3200	.139	.435	.254	.202	.161	.128	.101	.057	.032
	10	.1790	.054	.303	.129	.093	.067	.048	.034	.015	.007
	11	.0947	.022	.233	.062	.040	.026	.017	.011	.004	.001
	12	.0473	.009	.189	.028	.016	.010	.006	.003	.001	
	13	.0223	.004	.159	.012	.006	.003	.002	.001		
	14	.0099	.001	.137	.005	.002	.001	.001			
	15	.0042	.001	.120	.002	.001					
	16	.0017		.108	.001						
6.8	7	.9155	4.58	5.00	.897	.880	.862	.845	.828	.788	.750
	8	.5726	.477	.833	.508	.450	.399	.354	.314	.233	.172
	9	.3409	.155	.455	.274	.220	.176	.141	.113	.065	.038
	10	.1926	.060	.312	.140	.102	.074	.054	.039	.017	.008
	11	.1030	.025	.238	.068	.044	.029	.019	.013	.004	.002
	12	.0521	.010	.192	.031	.018	.011	.007	.004	.001	
	13	.0249	.004	.161	.013	.007	.004	.002	.001		
	14	.0112	.002	.139	.005	.003	.001	.001			
	15	.0048	.001	.122	.002	.001					
	16	.0019		.109	.001						

A	N	P(o)	D1	D2	P(t) for t=						
					.1	.2	.3	.4	.5	.75	1
15.0	16	.7301	.730	1.00	.661	.598	.541	.489	.443	.345	.269
	17	.5203	.260	.500	.426	.349	.286	.234	.191	.116	.070
	18	.3613	.120	.333	.268	.198	.147	.109	.081	.038	.018
	19	.2442	.061	.250	.064	.110	.074	.049	.033	.012	.004
	20	.1604	.032	.200	.097	.059	.036	.022	.013	.004	.001
	21	.1023	.017	.167	.056	.031	.017	.009	.005	.001	
	22	.0633	.009	.143	.031	.016	.008	.004	.002		
	23	.0380	.005	.125	.017	.008	.003	.002	.001		
	24	.0221	.002	.111	.009	.004	.001	.001			
	25	.0124	.001	.100	.005	.002	.001				
	26	.0068	.001	.091	.002	.001					
	27	.0036		.083	.001						
	28	.0018		.077	.001						
15.5	16	.8590	1.72	2.00	.817	.777	.739	.703	.669	.590	.521
	17	.6230	.415	.667	.536	.462	.397	.342	.294	.202	.139
	18	.4410	.176	.400	.343	.268	.208	.162	.126	.068	.036
	19	.3043	.087	.286	.214	.151	.106	.075	.053	.022	.009
	20	.2043	.045	.222	.130	.083	.053	.034	.022	.007	.002
	21	.1334	.024	.182	.077	.044	.026	.015	.009	.002	.001
	22	.0846	.013	.154	.044	.023	.012	.006	.003	.001	
	23	.0521	.007	.133	.025	.012	.005	.003	.001		
	24	.0311	.004	.118	.013	.006	.002	.001			
	25	.0180	.002	.105	.007	.003	.001				
	26	.0101	.001	.095	.004	.001					
	27	.0055		.087	.002	.001					
	28	.0029		.080	.001						
16.0	17	.7372	.737	1.00	.667	.604	.546	.494	.447	.348	.271
	18	.5312	.266	.500	.435	.356	.292	.239	.195	.119	.072
	19	.3736	.125	.333	.277	.205	.152	.113	.083	.039	.019
	20	.2561	.064	.250	.172	.115	.077	.052	.035	.013	.005
	21	.1709	.034	.200	.104	.063	.038	.023	.014	.004	.001
	22	.1109	.018	.167	.061	.033	.018	.010	.006	.001	
	23	.0699	.010	.143	.035	.017	.009	.004	.002		
	24	.0428	.005	.125	.019	.009	.004	.002	.001		
	25	.0255	.003	.111	.010	.004	.002	.001			
	26	.0147	.001	.100	.005	.002	.001				
	27	.0082	.001	.091	.003	.001					
	28	.0045		.083	.001						
	29	.0024		.077	.001						

A	N	P(o)	D1	D2	P(t) for t=						
					.1	.2	.3	.4	.5	.75	1
16.5	17	.8628	1.73	2.00	.821	.781	.743	.706	.672	.593	.523
	18	.6320	.421	.667	.544	.468	.403	.347	.299	.205	.141
	19	.4525	.181	.400	.352	.274	.214	.166	.130	.069	.037
	20	.3162	.090	.286	.223	.157	.111	.078	.055	.023	.010
	21	.2154	.048	.222	.137	.088	.056	.036	.023	.007	.002
	22	.1428	.026	.182	.083	.048	.027	.016	.009	.002	.001
	23	.0922	.014	.154	.048	.025	.013	.007	.004	.001	
	24	.0578	.008	.133	.027	.013	.006	.003	.001		
	25	.0352	.004	.118	.015	.006	.003	.001	.001		
	26	.0209	.002	.105	.008	.003	.001				
	27	.0120	.001	.095	.004	.001	.001				
	28	.0067	.001	.087	.002	.001					
	29	.0036		.080	.001						
17.0	18	.7437	.744	1.00	.673	.609	.551	.499	.451	.351	.274
	19	.5413	.271	.500	.443	.363	.297	.243	.199	.121	.073
	20	.3851	.128	.333	.285	.211	.157	.116	.086	.041	.019
	21	.2673	.067	.250	.179	.120	.081	.054	.036	.013	.005
	22	.1810	.036	.200	.110	.067	.040	.024	.015	.004	.001
	23	.1193	.020	.167	.065	.036	.020	.011	.006	.001	
	24	.0766	.011	.143	.038	.019	.009	.005	.002		
	25	.0478	.006	.125	.021	.010	.004	.002	.001		
	26	.0290	.003	.111	.012	.005	.002	.001			
	27	.0171	.002	.100	.006	.002	.001				
	28	.0098	.001	.091	.003	.001					
	29	.0055		.083	.002						
	30	.0030		.077	.001						
17.5	18	.8664	1.73	2.00	.824	.784	.746	.709	.675	.595	.525
	19	.6404	.427	.667	.551	.474	.408	.351	.302	.208	.143
	20	.4632	.185	.400	.361	.281	.219	.170	.138	.071	.038
	21	.3274	.094	.286	.231	.163	.115	.081	.057	.024	.010
	22	.2259	.050	.222	.144	.092	.059	.037	.024	.008	.003
	23	.1520	.028	.182	.088	.051	.029	.017	.010	.002	.001
	24	.0996	.015	.154	.052	.027	.014	.007	.004	.001	
	25	.0636	.008	.133	.030	.014	.007	.003	.001		
	26	.0395	.005	.118	.017	.007	.003	.001	.001		
	27	.0238	.003	.105	.009	.004	.001	.001			
	28	.0140	.001	.095	.005	.002	.001				
	29	.0080	.001	.087	.003	.001					
	30	.0044		.080	.001						
	31	.0024		.074	.001						

ources Continued)

V =	13	14
01		
02		
03		
05		
08	.00001	
13	.00002	
21	.00003	
32	.00005	.00001
48	.00008	.00001
71	.00013	.00002
103	.00020	.00003
147	.00029	.00005
205	.00043	.00007
282	.00062	.00011
383	.00088	.00016
513	.00122	.00023
678	.00169	.00034
886	.00230	.00048
1144	.00309	.00067
1461	.00411	.00093
1847	.00541	.00128
2312	.00704	.00173
2867	.00906	.00231
3523	.01156	.00307

Table 5-3. Binomial Loss Probability ($S = 30$ Sources)

Traffic per Source (a in Erl)	Loss Probability (P) for $N =$					
	9	10	11	12	13	14
0.11	.00301	.00072	.00015	.00003		
0.12	.00542	.00141	.00032	.00006	.00001	
0.13	.00916	.00260	.00065	.00014	.00003	
0.14	.01465	.00451	.00121	.00029	.00006	.00001
0.15	.02234	.00742	.00215	.00055	.00012	.00002
0.16	.03270	.01165	.00363	.00099	.00024	.00005
0.17	.04616	.01757	.00586	.00171	.00044	.00010
0.18	.06309	.02556	.00908	.00284	.00078	.00019
0.19	.08377	.03600	.01359	.00451	.00132	.00034
0.20	.10838	.04926	.01970	.00694	.00215	.00059
0.21	.13697	.06566	.02775	.01034	.00340	.00098
0.22	.16946	.08544	.03805	.01496	.00519	.00159
0.23	.20561	.10878	.05094	.02109	.00772	.00249
0.24	.24510	.13575	.06669	.02901	.01117	.00380
0.25	.28746	.16631	.08554	.03903	.01578	.00565
0.26	.33214	.20030	.10765	.05143	.02180	.00818
0.27	.37852	.23747	.13312	.06647	.02984	.01160
0.28	.42595	.27745	.16195	.08437	.03911	.01610
0.29	.47376	.31980	.19403	.10530	.05094	.02191
0.30	.52130	.36400	.22918	.12938	.06522	.02927
0.31	.56794	.40949	.26711	.15663	.08217	.03843
0.32	.61312	.45566	.30746	.18699	.10196	.04963
0.33	.65636	.50191	.34977	.22034	.12472	.06313
0.34	.69724	.54767	.39357	.25645	.15050	.07912
0.35	.73545	.59239	.43832	.29502	.17928	.09779
0.36	.77076	.63556	.48346	.33568	.21099	.11928
0.37	.80302	.67675	.52844	.37799	.24546	.14366
0.38	.83218	.71562	.57274	.42149	.28243	.17098
0.39	.85825	.75187	.61586	.46565	.32160	.20116
0.40	.88131	.78532	.65733	.50996	.36258	.23410
0.41	.90149	.81584	.69679	.55390	.40496	.26961
0.42	.91897	.84339	.73391	.59699	.44826	.30742
0.43	.93396	.86799	.76845	.63875	.49198	.34719
0.44	.94667	.88972	.80023	.67878	.53563	.38856
0.45	.95733	.90871	.82915	.71672	.57873	.43109
0.46	.96619	.92514	.85520	.75229	.62079	.47430
0.47	.97347	.93919	.87839	.78526	.66139	.51773
0.48	.97939	.95109	.89883	.81551	.70014	.56088
0.49	.98415	.96104	.91663	.84293	.73672	.60327
0.50	.98794	.96929	.93198	.86753	.77087	.64446

(table continues)

Table 5-6. Binomial Loss Probability ($S = 60$ Sources)

Traffic per Source (a in Erl)	Loss Probability (P) for $N =$					
	16	18	20	22	24	26
0.11	.00048	.00004				
0.12	.00125	.00013	.00001			
0.13	.00287	.00035	.00003			
0.14	.00601	.00086	.00009	.00001		
0.15	.01154	.00193	.00024	.00002		
0.16	.02060	.00396	.00057	.00006	.00001	
0.17	.03443	.00757	.00125	.00016	.00002	
0.18	.05431	.01354	.00225	.00036	.00004	
0.19	.08137	.02283	.00485	.00079	.00010	.00001
0.20	.11639	.03651	.00872	.00159	.00022	.00002
0.21	.15967	.05567	.01485	.00304	.00048	.00006
0.22	.21096	.08126	.02409	.00549	.00096	.00013
0.23	.26940	.11401	.03736	.00945	.00185	.00028
0.24	.33356	.15426	.05561	.01555	.00337	.00057
0.25	.40165	.20189	.07970	.02453	.00587	.00109
0.26	.47157	.25631	.11032	.03721	.00979	.00201
0.27	.54122	.31644	.14784	.05445	.01571	.00354
0.28	.60858	.38079	.19227	.07705	.02428	.00599
0.29	.67195	.44761	.24320	.10564	.03627	.00978
0.30	.72996	.51502	.29982	.14066	.05244	.01541
0.31	.78173	.58117	.36092	.18221	.07353	.02349
0.32	.82678	.64437	.42499	.23004	.10020	.03469
0.33	.86505	.70321	.49038	.28355	.13288	.04974
0.34	.89679	.75664	.55536	.34175	.17179	.06936
0.35	.92253	.80398	.61830	.40335	.21681	.09416
0.36	.94292	.84494	.67775	.46688	.26749	.12464
0.37	.95873	.87957	.73255	.53075	.32305	.16108
0.38	.97072	.90817	.78188	.59337	.38240	.20348
0.39	.97962	.93128	.82525	.65330	.44422	.25155
0.40	.98608	.94953	.86250	.62500	.50703	.30467
0.41	.99068	.96364	.89379	.76039	.56932	.36191
0.42	.99388	.97430	.91948	.80595	.62964	.42212
0.43	.99606	.98219	.94010	.84565	.68669	.48392
0.44	.99751	.98790	.95629	.87947	.73941	.54588
0.45	.99846	.99194	.96873	.90753	.78702	.60655
0.46	.99907	.99474	.97806	.93055	.82903	.66458
0.47	.99945	.99664	.98492	.94880	.86526	.71883
0.48	.99968	.99789	.98985	.96300	.89581	.76838
0.49	.99982	.99871	.99331	.97380	.92099	.81262
0.50	.99990	.99923	.99568	.98183	.94126	.85120

(table continues)

Table 5-6

Traffic per Source (a in Erl)
0.11
0.12
0.13
0.14
0.15
0.16
0.17
0.18
0.19
0.20
0.21
0.22
0.23
0.24
0.25
0.26
0.27
0.28
0.29
0.30
0.31
0.32
0.33
0.34
0.35
0.36
0.37
0.38
0.39
0.40
0.41
0.42
0.43
0.44
0.45
0.46
0.47
0.48
0.49
0.50

$$P_k = (1-p) p^k$$

$$\bar{N} = p / (1-p)$$

$$\bar{N}_q = \lambda w$$

$$w = (p/\mu) / (1-p)$$

$$T = (1/\mu) / (1-p)$$

$$T = \bar{x} + w$$

$$\rho = \lambda/\mu$$

$$\bar{x} = 1/\mu$$

$$\rho = \frac{\lambda \bar{x}}{m}$$

$$P_k = \frac{(\lambda/\mu)^k / k!}{\sum_{i=0}^m (\lambda/\mu)^i / i!}$$

$$P_0 = \left[\sum_{k=0}^{m-1} \frac{(m-p)^k}{k!} + \frac{(m-p)^m}{m!(1-p)} \right]^{-1}$$

$$P_k = P_0 \left[\frac{(m\rho)^k}{k!} \right]; \quad k \leq m$$

$$P_k = P_0 \left[\frac{\rho^k m^m}{m!} \right]; \quad k \geq m$$