THE CALCULATION OF AGGREGATE LOSS DISTRIBUTIONS FROM CLAIM SEVERITY AND CLAIM COUNT DISTRIBUTIONS

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EDITOR'S NOTE

The following pages reproduce the exhibits associated with the paper "The Calculation of Aggregate Loss Distributions from Claim Severity and Claim Count Distributions" by Philip E. Heckman and Glenn G. Meyers (*PCAS* LXX, 1983). These exhibits were omitted from the original printing of the paper.

CLAIM SEVERITY DISTRIBUTION
NAME: PRODUCTS BI

LOSS AMOUNT	CUMULATIVE PROBABILITY
0.0	0.0
1000.00	0.38935
5000.00	0.77870
6000.00	0.78435
7000.00	0.78981
8000.00	0.79498
9000.00	0.79993
10000.00	0.80466
12500.00	0.81564
15000.00	0.82553
17500.00	0.83449
20000.00	0.84264
25000.00	0.85690
35000.00	0.87927
50000.00	0.90280
75000.00	0.92739
100000.00	0.94256
125000.00	0.95278
150000.00	0.96009
175000.00	0.96556
200000.00	0.96979
225000.00	0.97316
250000.00	0.97590

SUMMARY STATISTICS:

SEVERITY MEAN =   18197.94
SEVERITY STD DEV = 48406.40

CLAIM SEVERITY DISTRIBUTION
NAME: WORKERS COMP

LOSS AMOUNT	CUMULATIVE PROBABILITY
0.0	0.0
25.00	0.20230
50.00	0.48880
100.00	0.71960
150.00	0.78150
200.00	0.81090
250.00	0.82890
300.00	0.84270
400.00	0.86090
500.00	0.87410
750.00	0.89600
1000.00	0.90980
1500.00	0.92720
2000.00	0.93921
2500.00	0.94758
3000.00	0.95381
4000.00	0.96257
5000.00	0.96851
6000.00	0.97283
7000.00	0.97613
8000.00	0.97875
9000.00	0.98087
10000.00	0.98262
12500.00	0.98594
15000.00	0.98825
17250.00	0.98984
20000.00	0.99132
25000.00	0.99322
30000.00	0.99451
40000.00	0.99613
50000.00	0.99710
75000.00	0.99835
100000.00	0.99896
150000.00	0.99944
250000.00	0.99978
350000.00	0.99988
500000.00	0.99995
750000.00	0.99998
1000000.00	0.99999
1500000.00	1.00000

SUMMARY STATISTICS:

SEVERITY MEAN =   985.15
SEVERITY STD DEV = 9812.41

EXHIBIT II

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	500000	PRODUCTS BI	0.0000	27.476	5.242

MIXING PARAMETER	0.0000	
AGGREGATE MEAN	500000	
AGGREGATE STD DEV	271071	

AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
50000.00	0.1000	0.0052	450056.03	0.9001
100000.00	0.2000	0.0320	400903.28	0.8018
150000.00	0.3000	0.0755	353535.23	0.7071
200000.00	0.4000	0.1295	308630.16	0.6173
250000.00	0.5000	0.1882	266560.19	0.5331
300000.00	0.6000	0.2510	227496.34	0.4550
350000.00	0.7000	0.3247	191859.59	0.3837
400000.00	0.8000	0.4029	160044.58	0.3201
450000.00	0.9000	0.4798	132125.88	0.2643
500000.00	1.0000	0.5518	107942.62	0.2159
550000.00	1.1000	0.6180	87204.77	0.1744
600000.00	1.2000	0.6802	69680.98	0.1394
650000.00	1.3000	0.7363	55121.80	0.1102
700000.00	1.4000	0.7854	43194.73	0.0864
750000.00	1.5000	0.8270	33533.74	0.0671
800000.00	1.6000	0.8619	25780.81	0.0516
850000.00	1.7000	0.8913	19632.21	0.0393
900000.00	1.8000	0.9154	14819.09	0.0296
950000.00	1.9000	0.9349	11093.50	0.0222
1000000.00	2.0000	0.9503	8237.03	0.0165
1050000.00	2.1000	0.9624	6064.95	0.0121
1100000.00	2.2000	0.9718	4429.20	0.0089
1150000.00	2.3000	0.9791	3209.97	0.0064
1200000.00	2.4000	0.9846	2309.49	0.0046
1250000.00	2.5000	0.9888	1649.77	0.0033
1300000.00	2.6000	0.9919	1169.94	0.0023
1350000.00	2.7000	0.9942	823.78	0.0016
1400000.00	2.8000	0.9958	576.14	0.0012
1450000.00	2.9000	0.9971	400.33	0.0008
1500000.00	3.0000	0.9979	276.38	0.0006
1550000.00	3.1000	0.9986	189.56	0.0004
1600000.00	3.2000	0.9990	129.17	0.0003
1650000.00	3.3000	0.9993	87.45	0.0002
1700000.00	3.4000	0.9995	58.83	0.0001
1750000.00	3.5000	0.9997	39.30	0.0001
1800000.00	3.6000	0.9998	26.06	0.0001
1850000.00	3.7000	0.9999	17.13	0.0000
1900000.00	3.8000	0.9999	11.16	0.0000
1950000.00	3.9000	0.9999	7.19	0.0000
2000000.00	4.0000	1.0000	4.58	0.0000

EXHIBIT III

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	500000	PRODUCTS BI	0 2500	27 476	14 704

MIXING PARAMETER   0 0000
AGGREGATE MEAN   500000
AGGREGATE STD DEV   368754

AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
50000.00	0.1000	0.0563	451375.88	0.9028
100000.00	0.2000	0.1135	405615.08	0.8112
150000.00	0.3000	0.1708	362727.50	0.7255
200000.00	0.4000	0.2265	322670.09	0.6453
250000.00	0.5000	0.2793	285324.63	0.5706
300000.00	0.6000	0.3434	250861.35	0.5017
350000.00	0.7000	0.4075	219644.06	0.4393
400000.00	0.8000	0.4685	191560.03	0.3831
450000.00	0.9000	0.5252	166420.19	0.3328
500000.00	1.0000	0.5770	143995.20	0.2880
550000.00	1.1000	0.6264	124090.32	0.2482
600000.00	1.2000	0.6723	106575.73	0.2132
650000.00	1.3000	0.7139	91249.17	0.1825
700000.00	1.4000	0.7512	77895.65	0.1558
750000.00	1.5000	0.7844	66302.29	0.1326
800000.00	1.6000	0.8139	56271.91	0.1125
850000.00	1.7000	0.8400	47633.75	0.0953
900000.00	1.8000	0.8630	40223.35	0.0804
950000.00	1.9000	0.8831	33887.41	0.0678
1000000.00	2.0000	0.9005	28486.06	0.0570
1050000.00	2.1000	0.9155	23893.90	0.0478
1100000.00	2.2000	0.9285	20001.23	0.0400
1150000.00	2.3000	0.9396	16710.51	0.0334
1200000.00	2.4000	0.9491	13935.70	0.0279
1250000.00	2.5000	0.9573	11601.30	0.0232
1300000.00	2.6000	0.9642	9641.64	0.0193
1350000.00	2.7000	0.9700	8000.07	0.0160
1400000.00	2.8000	0.9750	6627.78	0.0133
1450000.00	2.9000	0.9791	5482.82	0.0110
1500000.00	3.0000	0.9826	4529.24	0.0091
1550000.00	3.1000	0.9856	3736.45	0.0075
1600000.00	3.2000	0.9880	3078.39	0.0062
1650000.00	3.3000	0.9901	2533.07	0.0051
1700000.00	3.4000	0.9918	2081.83	0.0042
1750000.00	3.5000	0.9932	1709.01	0.0034
1800000.00	3.6000	0.9944	1401.39	0.0028
1850000.00	3.7000	0.9954	1147.92	0.0023
1900000.00	3.8000	0.9962	939.31	0.0019
1950000.00	3.9000	0.9969	767.86	0.0015
2000000.00	4.0000	0.9975	627.10	0.0013
2050000.00	4.1000	0.9979	511.68	0.0010
2100000.00	4.2000	0.9983	417.14	0.0008
2150000.00	4.3000	0.9986	339.77	0.0007
2200000.00	4.4000	0.9989	276.54	0.0006
2250000.00	4.5000	0.9991	224.90	0.0004
2300000.00	4.6000	0.9992	182.78	0.0004
2350000.00	4.7000	0.9994	148.45	0.0003
2400000.00	4.8000	0.9995	120.51	0.0002
2450000.00	4.9000	0.9996	97.78	0.0002
2500000.00	5.0000	0.9997	79.33	0.0002

EXHIBIT IV

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	250000	PRODUCTS BI	0.0000	13.738	3.706

MIXING PARAMETER	0.0000
AGGREGATE MEAN	250000
AGGREGATE STD DEV	191676

AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
25000.00	0.1000	0.0508	225403.80	0.9016
50000.00	0.2000	0.1291	202676.86	0.8107
75000.00	0.3000	0.2009	181812.52	0.7273
100000.00	0.4000	0.2676	162679.19	0.6507
125000.00	0.5000	0.3289	145147.95	0.5806
150000.00	0.6000	0.3843	129074.38	0.5163
175000.00	0.7000	0.4341	114315.48	0.4573
200000.00	0.8000	0.4788	100737.62	0.4030
225000.00	0.9000	0.5189	88218.38	0.3529
250000.00	1.0000	0.5548	76648.41	0.3066
275000.00	1.1000	0.6034	66060.59	0.2642
300000.00	1.2000	0.6556	56817.03	0.2273
325000.00	1.3000	0.7008	48785.07	0.1951
350000.00	1.4000	0.7405	41812.29	0.1672
375000.00	1.5000	0.7749	35764.65	0.1431
400000.00	1.6000	0.8047	30518.36	0.1221
425000.00	1.7000	0.8303	25963.29	0.1039
450000.00	1.8000	0.8524	22003.53	0.0880
475000.00	1.9000	0.8714	18556.24	0.0742
500000.00	2.0000	0.8878	15550.43	0.0622
525000.00	2.1000	0.9045	12946.55	0.0518
550000.00	2.2000	0.9201	10761.15	0.0430
575000.00	2.3000	0.9332	8932.75	0.0357
600000.00	2.4000	0.9442	7404.15	0.0296
625000.00	2.5000	0.9534	6127.36	0.0245
650000.00	2.6000	0.9611	5061.04	0.0202
675000.00	2.7000	0.9675	4170.32	0.0167
700000.00	2.8000	0.9728	3425.93	0.0137
725000.00	2.9000	0.9773	2803.56	0.0112
750000.00	3.0000	0.9810	2282.95	0.0091
775000.00	3.1000	0.9844	1849.60	0.0074
800000.00	3.2000	0.9873	1496.51	0.0060
825000.00	3.3000	0.9897	1209.42	0.0048
850000.00	3.4000	0.9916	976.16	0.0039
875000.00	3.5000	0.9932	786.79	0.0031
900000.00	3.6000	0.9945	633.11	0.0025
925000.00	3.7000	0.9955	508.41	0.0020
950000.00	3.8000	0.9964	407.26	0.0016
975000.00	3.9000	0.9970	325.21	0.0013
1000000.00	4.0000	0.9976	258.68	0.0010
1025000.00	4.1000	0.9981	204.95	0.0008
1050000.00	4.2000	0.9985	162.19	0.0006
1075000.00	4.3000	0.9988	128.22	0.0005
1100000.00	4.4000	0.9990	101.24	0.0004
1125000.00	4.5000	0.9992	79.83	0.0003
1150000.00	4.6000	0.9994	62.86	0.0003
1175000.00	4.7000	0.9995	49.41	0.0002
1200000.00	4.8000	0.9996	38.75	0.0002
1225000.00	4.9000	0.9997	30.33	0.0001
1250000.00	5.0000	0.9998	23.67	0.0001

EXHIBIT V

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	1000000	PRODUCTS BI	0.0000	54.951	7.413

MIXING PARAMETER	0.0000
AGGREGATE MEAN	1000000
AGGREGATE STD DEV	383352

AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
100000.00	0.1000	0.0001	900000.86	0.9000
200000.00	0.2000	0.0026	800088.87	0.8001
300000.00	0.3000	0.0134	700794.65	0.7008
400000.00	0.4000	0.0372	603226.59	0.6032
500000.00	0.5000	0.0812	509004.78	0.5090
600000.00	0.6000	0.1457	420179.50	0.4202
700000.00	0.7000	0.2291	338775.36	0.3388
800000.00	0.8000	0.3268	266476.65	0.2665
900000.00	0.9000	0.4315	204363.65	0.2044
1000000.00	1.0000	0.5358	152759.95	0.1528
1100000.00	1.1000	0.6334	111301.59	0.1113
1200000.00	1.2000	0.7197	79067.18	0.0791
1300000.00	1.3000	0.7923	54787.70	0.0548
1400000.00	1.4000	0.8506	37052.22	0.0371
1500000.00	1.5000	0.8956	24471.64	0.0245
1600000.00	1.6000	0.9291	15795.43	0.0158
1700000.00	1.7000	0.9530	9970.78	0.0100
1800000.00	1.8000	0.9697	6159.75	0.0062
1900000.00	1.9000	0.9809	3726.91	0.0037
2000000.00	2.0000	0.9882	2209.92	0.0022
2100000.00	2.1000	0.9929	1285.15	0.0013
2200000.00	2.2000	0.9958	733.40	0.0007
2300000.00	2.3000	0.9976	410.99	0.0004
2400000.00	2.4000	0.9986	226.28	0.0002
2500000.00	2.5000	0.9992	122.48	0.0001
2600000.00	2.6000	0.9996	65.20	0.0001
2700000.00	2.7000	0.9998	34.15	0.0000
2800000.00	2.8000	0.9999	17.61	0.0000
2900000.00	2.9000	0.9999	8.93	0.0000
3000000.00	3.0000	1.0000	4.48	0.0000

EXHIBIT VI

COLLECTIVE RISK MODEL

LINE # 1 CLAIM SEVERITY DISTRIBUTION
NAME AGE<30

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
7500 00	0 33000
37500 00	0 86000
67500 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 20512 50
SEVERITY STD DEV = 17025 34

LINE # 2 CLAIM SEVERITY DISTRIBUTION
NAME AGE 30-34

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
9500 00	0 33000
47500 00	0 86000
85500 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 25982 50
SEVERITY STD DEV = 21565 44

LINE # 3 CLAIM SEVERITY DISTRIBUTION
NAME AGE 35-39

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
10000 00	0 33000
50000 00	0 86000
90000 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 27350 00
SEVERITY STD DEV = 22700 46

LINE # 4 CLAIM SEVERITY DISTRIBUTION
NAME AGE 40-44

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
11000 00	0 33000
55000 00	0 86000
99000 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 30085 00
SEVERITY STD DEV = 24970 50

LINE # 5 CLAIM SEVERITY DISTRIBUTION
NAME AGE 45-49

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
12500 00	0 33000
62500 00	0 86000
112500 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 34187 50
SEVERITY STD DEV = 28375 57

LINE # 6 CLAIM SEVERITY DISTRIBUTION
NAME AGE 50-54

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
12500 00	0 33000
62500 00	0 86000
112500 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 34187 50
SEVERITY STD DEV = 28375 57

LINE # 7 CLAIM SEVERITY DISTRIBUTION
NAME AGE 55-59

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
13500 00	0 33000
67500 00	0 86000
121500 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 36922 50
SEVERITY STD DEV = 30645 62

LINE # 8 CLAIM SEVERITY DISTRIBUTION
NAME AGE 60-64

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
13500 00	0 33000
67500 00	0 86000
121500 00	1 00000

SUMMARY STATISTICS

SEVERITY MEAN = 36922 50
SEVERITY STD DEV = 30645 62

LINE # 9 CLAIM SEVERITY DISTRIBUTION
NAME AGE 65+

LOSS AMOUNT	CUMULATIVE PROBABILITY
0 0	0 0
15000 00	0 33000
39471 00	0 86000

SUMMARY STATISTICS

SEVERITY MEAN = 22435 75
SEVERITY STD DEV = 12613 05

EXHIBIT VI (cont.)

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	47086	AGE <30	-0.0005	2.295	1.514
2	36342	AGE 30-34	-0.0009	1.399	1.182
3	35830	AGE 35-39	-0.0010	1.310	1.144
4	54938	AGE 40-44	-0.0012	1.826	1.350
5	136126	AGE 45-49	-0.0010	3.982	1.991
6	270050	AGE 50-54	-0.0008	7.899	2.801
7	395471	AGE 55-59	-0.0010	10.711	3.255
8	258525	AGE 60-64	-0.0018	7.002	2.629
9	13247	AGE 65+	-0.0400	0.590	0.759

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MIXING PARAMETER      0.0000
AGGREGATE MEAN        1247615
AGGREGATE STD DEV      268182
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AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
124761.50	0.1000	0.0000	1122853.49	0.9000
249523.00	0.2000	0.0000	998092.02	0.8000
374284.50	0.3000	0.0000	873331.76	0.7000
499046.00	0.4000	0.0006	748596.17	0.6000
623807.50	0.5000	0.0047	624091.03	0.5002
748569.00	0.6000	0.0226	500799.81	0.4014
873330.50	0.7000	0.0739	381593.41	0.3059
998092.00	0.8000	0.1776	271922.78	0.2180
1122853.50	0.9000	0.3342	178628.28	0.1432
1247615.00	1.0000	0.5180	106942.98	0.0857
1372376.50	1.1000	0.6913	57912.49	0.0464
1497138.00	1.2000	0.8256	28257.40	0.0226
1621899.50	1.3000	0.9129	12411.61	0.0099
1746661.00	1.4000	0.9615	4913.10	0.0039
1871422.50	1.5000	0.9848	1757.08	0.0014
1996184.00	1.6000	0.9946	569.57	0.0005
2120945.50	1.7000	0.9983	167.97	0.0001
2245707.00	1.8000	0.9995	45.23	0.0000
2370468.50	1.9000	0.9999	11.16	0.0000
2495230.00	2.0000	1.0000	2.52	0.0000

EXHIBIT VII

COLLECTIVE RISK MODEL

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LINE #  2  CLAIM SEVERITY DISTRIBUTION
NAME   AGGPRODUCTS DI

   LOSS AMOUNT         CUMULATIVE PROBABILITY

          0  0                 0  0
      50000  00            0  05630
     100000  00            0  11350
     150000  00            0  17080
     200000  00            0  22650
     250000  00            0  27930
     300000  00            0  34340
     350000  00            0  40750
     400000  00            0  46850
     450000  00            0  52520
     500000  00            0  57700
     550000  00            0  62640
     600000  00            0  67230
     650000  00            0  71390
     700000  00            0  75120
     750000  00            0  78440
     800000  00            0  81390
     850000  00            0  84000
     900000  00            0  86300
     950000  00            0  88310
    1000000  00            0  90050


SUMMARY STATISTICS

   SEVERITY MEAN  =      471677  50
   SEVERITY STD DEV =    302129  53
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LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	500000	WORKERS COMP	0 0500	507 536	115 703
2	471677	AGGPRODUCTS DI	-1 0000	1 000	0 000

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MIXING PARAMETER        0  0000
AGGREGATE MEAN          971677
AGGREGATE STD DEV       391334
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AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
100000 00	0 1029	0 0000	871677 79	0 8971
200000 00	0 2058	0 0014	771716 06	0 7942
300000 00	0 3087	0 0129	672291 84	0 6919
400000 00	0 4117	0 0456	575012 81	0 5918
500000 00	0 5146	0 1026	482229 96	0 4963
600000 00	0 6175	0 1807	396242 53	0 4078
700000 00	0 7204	0 2734	318855 59	0 3281
800000 00	0 8233	0 3727	251134 30	0 2585
900000 00	0 9262	0 4715	193373 56	0 1990
1000000 00	1 0291	0 5644	145233 93	0 1495
1100000 00	1 1321	0 6473	105930 73	0 1090
1200000 00	1 2350	0 7234	74529 47	0 0767
1300000 00	1 3379	0 7958	50519 41	0 0520
1400000 00	1 4408	0 8595	33390 65	0 0344
1500000 00	1 5437	0 9078	21893 95	0 0225
1600000 00	1 6466	0 9407	14435 87	0 0149
1700000 00	1 7496	0 9618	9640 27	0 0099
1800000 00	1 8525	0 9750	6531 19	0 0067
1900000 00	1 9554	0 9833	4480 87	0 0046
2000000 00	2 0583	0 9887	3101 11	0 0032
2100000 00	2 1612	0 9922	2155 16	0 0022
2200000 00	2 2641	0 9945	1497 26	0 0015
2300000 00	2 3670	0 9961	1035 06	0 0011
2400000 00	2 4700	0 9973	709 00	0 0007
2500000 00	2 5729	0 9981	479 13	0 0005
2600000 00	2 6758	0 9987	318 19	0 0003
2700000 00	2 7787	0 9991	207 46	0 0002
2800000 00	2 8816	0 9994	133 15	0 0001
2900000 00	2 9845	0 9996	84 80	0 0001
3000000 00	3 0874	0 9998	54 02	0 0001
3100000 00	3 1904	0 9998	34 55	0 0000
3200000 00	3 2933	0 9999	22 33	0 0000
3300000 00	3 3962	0 9999	14 51	0 0000
3400000 00	3 4991	1 0000	9 52	0 0000
3500000 00	3 6020	1 0000	6 31	0 0000

EXHIBIT VIIIA

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	500000	WORKERS COMP	0.0500	507.536	115.703

MIXING PARAMETER   0.0500
AGGREGATE MEAN   500000
AGGREGATE STD DEV   278304

AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
100000.00	0.2000	0.0020	400028.62	0.8001
150000.00	0.3000	0.0167	350409.99	0.7008
200000.00	0.4000	0.0582	302152.97	0.6043
250000.00	0.5000	0.1296	256731.38	0.5135
300000.00	0.6000	0.2229	215475.78	0.4310
350000.00	0.7000	0.3260	179181.62	0.3584
400000.00	0.8000	0.4284	148061.99	0.2961
450000.00	0.9000	0.5231	121890.37	0.2438
500000.00	1.0000	0.6066	100182.61	0.2004
550000.00	1.1000	0.6779	82345.54	0.1647
600000.00	1.2000	0.7374	67775.00	0.1355
650000.00	1.3000	0.7864	55910.65	0.1118
700000.00	1.4000	0.8262	46260.63	0.0925
750000.00	1.5000	0.8585	38407.99	0.0768
800000.00	1.6000	0.8845	32007.21	0.0640
850000.00	1.7000	0.9055	26776.33	0.0536
900000.00	1.8000	0.9224	22487.47	0.0450
950000.00	1.9000	0.9360	18957.66	0.0379
1000000.00	2.0000	0.9470	16040.54	0.0321
1050000.00	2.1000	0.9559	13619.25	0.0272
1100000.00	2.2000	0.9631	11600.54	0.0232
1150000.00	2.3000	0.9691	9909.96	0.0198
1200000.00	2.4000	0.9739	8487.99	0.0170
1250000.00	2.5000	0.9779	7286.92	0.0146
1300000.00	2.6000	0.9812	6268.44	0.0125
1350000.00	2.7000	0.9840	5401.65	0.0108
1400000.00	2.8000	0.9863	4661.53	0.0093
1450000.00	2.9000	0.9883	4027.72	0.0081
1500000.00	3.0000	0.9899	3483.56	0.0070
1600000.00	3.2000	0.9925	2611.80	0.0052
1700000.00	3.4000	0.9944	1962.32	0.0039
1800000.00	3.6000	0.9958	1476.33	0.0030
1900000.00	3.8000	0.9969	1111.75	0.0022
2000000.00	4.0000	0.9976	837.86	0.0017
2250000.00	4.5000	0.9988	414.75	0.0008
2500000.00	5.0000	0.9994	206.98	0.0004
2750000.00	5.5000	0.9997	104.49	0.0002
3000000.00	6.0000	0.9999	53.46	0.0001
3500000.00	7.0000	1.0000	14.80	0.0000

EXHIBIT VIIIB

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	500000	PRODUCTS BI	0.2500	27.476	14.704

```
MIXING PARAMETER      0.0500
AGGREGATE MEAN        500000
AGGREGATE STD DEV     394054
```

AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
50000.00	0.1000	0.0590	451443.29	0.9029
100000.00	0.2000	0.1190	405889.22	0.8118
150000.00	0.3000	0.1785	363331.93	0.7267
200000.00	0.4000	0.2370	323717.22	0.6474
250000.00	0.5000	0.2979	287072.48	0.5741
300000.00	0.6000	0.3615	253551.37	0.5071
350000.00	0.7000	0.4244	223208.29	0.4464
400000.00	0.8000	0.4844	195943.85	0.3919
450000.00	0.9000	0.5403	171578.19	0.3432
500000.00	1.0000	0.5920	149904.46	0.2998
550000.00	1.1000	0.6394	130708.08	0.2614
600000.00	1.2000	0.6825	113772.55	0.2275
650000.00	1.3000	0.7213	98883.57	0.1978
700000.00	1.4000	0.7561	85833.47	0.1717
750000.00	1.5000	0.7870	74425.07	0.1489
800000.00	1.6000	0.8144	64474.34	0.1289
850000.00	1.7000	0.8386	55811.94	0.1116
900000.00	1.8000	0.8598	48283.68	0.0966
950000.00	1.9000	0.8784	41750.46	0.0835
1000000.00	2.0000	0.8947	36087.71	0.0722
1050000.00	2.1000	0.9089	31184.51	0.0624
1100000.00	2.2000	0.9212	26942.67	0.0539
1150000.00	2.3000	0.9319	23275.58	0.0466
1200000.00	2.4000	0.9412	20107.21	0.0402
1250000.00	2.5000	0.9492	17370.97	0.0347
1300000.00	2.6000	0.9561	15008.74	0.0300
1350000.00	2.7000	0.9622	12969.91	0.0259
1400000.00	2.8000	0.9673	11210.47	0.0224
1450000.00	2.9000	0.9718	9692.27	0.0194
1500000.00	3.0000	0.9757	8382.22	0.0168
1550000.00	3.1000	0.9790	7251.73	0.0145
1600000.00	3.2000	0.9819	6276.06	0.0126
1650000.00	3.3000	0.9844	5433.88	0.0109
1700000.00	3.4000	0.9865	4706.75	0.0094
1750000.00	3.5000	0.9883	4078.79	0.0082
1800000.00	3.6000	0.9899	3536.32	0.0071
1850000.00	3.7000	0.9913	3067.53	0.0061
1900000.00	3.8000	0.9925	2662.27	0.0053
1950000.00	3.9000	0.9935	2311.79	0.0046
2000000.00	4.0000	0.9944	2008.55	0.0040
2050000.00	4.1000	0.9951	1746.06	0.0035
2100000.00	4.2000	0.9958	1518.75	0.0030
2150000.00	4.3000	0.9963	1321.81	0.0026
2200000.00	4.4000	0.9968	1151.08	0.0023
2250000.00	4.5000	0.9972	1003.02	0.0020
2300000.00	4.6000	0.9976	874.53	0.0017
2350000.00	4.7000	0.9979	762.99	0.0015
2400000.00	4.8000	0.9982	666.09	0.0013
2450000.00	4.9000	0.9984	581.88	0.0012
2500000.00	5.0000	0.9986	508.66	0.0010

EXHIBIT VIIIC

COLLECTIVE RISK MODEL

LINE # 1   CLAIM SEVERITY DISTRIBUTION
NAME: AGGWORKERS COMP

LOSS AMOUNT	CUMULATIVE PROBABILITY
0. 00	0
100000. 00	0. 00200
150000. 00	0. 01670
200000. 00	0. 05820
250000. 00	0. 12960
300000. 00	0. 22290
350000. 00	0. 32600
400000. 00	0. 42840
450000. 00	0. 52310
500000. 00	0. 60660
550000. 00	0. 67790
600000. 00	0. 73740
650000. 00	0. 78640
700000. 00	0. 82620
750000. 00	0. 85850
800000. 00	0. 88450
850000. 00	0. 90550
900000. 00	0. 92240
950000. 00	0. 93600
1000000. 00	0. 94700
1050000. 00	0. 95590
1100000. 00	0. 96310
1150000. 00	0. 96910
1200000. 00	0. 97390
1250000. 00	0. 97790
1300000. 00	0. 98120
1350000. 00	0. 98400
1400000. 00	0. 98630
1450000. 00	0. 98830
1500000. 00	0. 98990
1600000. 00	0. 99250
1700000. 00	0. 99440
1800000. 00	0. 99580
1900000. 00	0. 99690
2000000. 00	0. 99760
2250000. 00	0. 99880
2500000. 00	0. 99970
2750000. 00	0. 99990
3000000. 00	0. 99990
3500000. 00	1. 00000

SUMMARY STATISTICS

SEVERITY MEAN = 499980. 00
SEVERITY STD DEV = 279204. 82

LINE # 2   CLAIM SEVERITY DISTRIBUTION
NAME: AGGPRODUCTS BI

LOSS AMOUNT	CUMULATIVE PROBABILITY
0. 00	0
50000. 00	0. 05900
100000. 00	0. 11900
150000. 00	0. 17850
200000. 00	0. 23700
250000. 00	0. 29790
300000. 00	0. 36150
350000. 00	0. 42440
400000. 00	0. 48440
450000. 00	0. 54030
500000. 00	0. 59200
550000. 00	0. 63940
600000. 00	0. 68250
650000. 00	0. 72130
700000. 00	0. 75610
750000. 00	0. 78700
800000. 00	0. 81940
850000. 00	0. 83860
900000. 00	0. 85980
950000. 00	0. 87840
1000000. 00	0. 89470

SUMMARY STATISTICS

SEVERITY MEAN = 464057. 50
SEVERITY STD DEV = 305133. 12

EXHIBIT VIIIC (cont.)

COLLECTIVE RISK MODEL

LINE	EXPECTED LOSS	CLAIM SEVERITY DISTRIBUTION	CONTAGION PARAMETER	CLAIM COUNT MEAN	CLAIM COUNT STD DEV
1	499980	AGGWORKERS COMP	-1 0000	1.000	0.000
2	464057	AGGPRODUCTS BI	-1 0000	1.000	0.000

MIXING PARAMETER 0 0500
AGGREGATE MEAN 964037
AGGREGATE STD DEV 475482

AGGREGATE LOSS AMOUNT	ENTRY RATIO	CUMULATIVE PROBABILITY	EXCESS PURE PREMIUM	EXCESS PURE PREMIUM RATIO
100000 00	0 1037	0 0002	864042 82	0 8963
200000 00	0 2075	0 0052	764219 69	0 7927
300000 00	0 3112	0 0282	665690 29	0 6905
400000 00	0 4149	0 0767	570723 02	0 5920
500000 00	0 5187	0 1480	481793 22	0 4998
600000 00	0 6224	0 2348	400838 32	0 4158
700000 00	0 7261	0 3286	328977 39	0 3412
800000 00	0 8298	0 4226	266553 35	0 2765
900000 00	0 9336	0 5124	213347 26	0 2213
1000000 00	1 0373	0 5955	168805 70	0 1751
1100000 00	1 1410	0 6705	132180 58	0 1371
1200000 00	1 2448	0 7362	102593 67	0 1064
1300000 00	1 3485	0 7920	79085 13	0 0820
1400000 00	1 4522	0 8382	60674 39	0 0629
1500000 00	1 5560	0 8754	46424 32	0 0482
1600000 00	1 6597	0 9047	35491 54	0 0368
1700000 00	1 7634	0 9275	27153 98	0 0282
1800000 00	1 8671	0 9450	20817 57	0 0216
1900000 00	1 9709	0 9582	16008 18	0 0166
2000000 00	2 0746	0 9683	12355 99	0 0128
2100000 00	2 1783	0 9758	9577 22	0 0099
2200000 00	2 2821	0 9815	7456 65	0 0077
2300000 00	2 3858	0 9858	5832 22	0 0060
2400000 00	2 4895	0 9891	4582 47	0 0048
2500000 00	2 5933	0 9915	3616 50	0 0038
2600000 00	2 6970	0 9934	2866 29	0 0030
2700000 00	2 8007	0 9948	2280 82	0 0024
2800000 00	2 9045	0 9959	1821 77	0 0019
2900000 00	3 0082	0 9968	1460 19	0 0015
3000000 00	3 1119	0 9975	1174 14	0 0012
3100000 00	3 2156	0 9980	946 93	0 0010
3200000 00	3 3194	0 9984	765 77	0 0008
3300000 00	3 4231	0 9987	620 81	0 0006
3400000 00	3 5268	0 9990	504 43	0 0005
3500000 00	3 6306	0 9992	410 73	0 0004
3600000 00	3 7343	0 9993	335 08	0 0003
3700000 00	3 8380	0 9994	273 85	0 0003
3800000 00	3 9418	0 9996	224 17	0 0002
3900000 00	4 0455	0 9996	183 78	0 0002
4000000 00	4 1492	0 9997	150 88	0 0002
4100000 00	4 2529	0 9998	124 02	0 0001
4200000 00	4 3567	0 9998	102 07	0 0001
4300000 00	4 4604	0 9998	84 10	0 0001
4400000 00	4 5641	0 9999	69 36	0 0001
4500000 00	4 6679	0 9999	57 26	0 0001
4600000 00	4 7716	0 9999	47 33	0 0000
4700000 00	4 8753	0 9999	39 16	0 0000
4800000 00	4 9791	0 9999	32 45	0 0000
4900000 00	5 0828	1 0000	26 93	0 0000
5000000 00	5 1865	1 0000	22 41	0 0000

EXHIBIT IX

```
C*********************************************************************
C                        PROGRAM USED WITH
C            "THE CALCULATION OF AGGREGATE LOSS DISTRIBUTIONS
C            FROM CLAIM SEVERITY AND CLAIM COUNT DISTRIBUTIONS"
C                              BY
C                  PHILIP HECKMAN AND GLENN MEYERS
C
C        THE PROGRAM IS WRITTEN IN IBM FORTRAN WITH G1 COMPILER.
C*********************************************************************
        IMPLICIT REAL*8 (A-H,O-Z)
        REAL*8 CUMPRB(128),AMT(128,32),PK(128,32)
        REAL*8 VARC(32),XLAM(32),SIGP(32),EXLOSS(32)
        REAL*8 A(257),T(256,5),F(256,5),G(256,5),X(512),ER(512)
        INTEGER NPTS(32)
        COMPLEX*16 NAME(32),EXHBT
C*********************************************************************
C       STEPS 1 AND 2
C*********************************************************************
        SIGSQA=0.0
        XMUA=0.0
        READ(3,1)EXHBT
C   EXHBT IS SUPPLIED TO IDENTIFY THE RUN
     1  FORMAT(2A8)
        READ(3,*)VARB
C   VARB=MIXING PARAMETER
        VARB=DMIN1(VARB,1.0-1D-7)
        VARB=DMAX1(VARB,1D-7)
        DO 10 N=1,32
        READ(3,*,END=20)EXLOSS(N),VARC(N)
C   EXLOSS=EXPECTED LOSSES FOR THIS LINE
C   VARC=CONTAGION PARAMETER FOR THIS LINE
        IF(DABS(VARC(N)).LT.1D-7)VARC(N)=1D-7
        READ(3,1)NAME(N)
C   NAME IS SUPPLIED BY THE USER TO IDENTIFY THE C.S.D.
        READ(3,*)NPTS(N)
C   NPTS IS THE NUMBER OF POINTS NEEDED TO SPECIFY THE C.S.D.
        AMT(1,N)=0.0
        CUMPRB(1)=0.0
        NPTS(N)=NPTS(N)+1
        X1=0.0
        X2=0.0
        NPT=NPTS(N)
        DO 3 I=2,NPT
        READ(3,*)AMT(I,N),CUMPRB(I)
C   AMT IS A CLAIM SEVERITY
C   CUMPRB IS THE CUMULATIVE PROBABILITY OF AMT
        PROB=CUMPRB(I)-CUMPRB(I-1)
        PK(I-1,N)=PROB/(AMT(I,N)-AMT(I-1,N))
        X1=X1+PROB*(AMT(I-1,N)+AMT(I,N))/2.
     3  X2=X2+PROB*(AMT(I,N)**2+AMT(I,N)*AMT(I-1,N)+AMT(I-1,N)**2)/3.
        PROB=1.0-CUMPRB(NPT)
```

1

```
      X1=X1+PROB*AMT(NPT,N)
      X2=X2+PROB*AMT(NPT,N)**2
      PK(NPT,N)=PROB
C  NOTE:UNUSUAL USE OF PK(NPT,N)
      SIGS=X2-X1**2
      XLAM(N)=EXLOSS(N)/X1
      SIGP(N)=DSQRT(XLAM(N)+VARC(N)*XLAM(N)**2)
      SIGSQA=XLAM(N)*(SIGS)+(X1*SIGP(N))**2+SIGSQA
      SIGS=DSQRT(SIGS)
      XMUA=X1*XLAM(N)+XMUA
C**********************************************************************
C     PRODUCE DISPLAY OF CLAIM SEVERITY DISTRIBUTION
C**********************************************************************
      WRITE(7,7)EXHBT,N,NAME(N)
   7  FORMAT('1',2A8,T31,'COLLECTIVE RISK MODEL'//
     &' LINE # ',I2,'  CLAIM SEVERITY DISTRIBUTION'/
     &' NAME: ',2A8//
     &'   LOSS AMOUNT    CUMULATIVE PROBABILITY'/)
      DO 8 I=1,NPT
   8  WRITE(7,9)AMT(I,N),CUMPRB(I)
   9  FORMAT(3X,F10.2,T27,F7.5)
  10  WRITE(7,11)X1,SIGS
  11  FORMAT(//' SUMMARY STATISTICS:'//'   SEVERITY MEAN =    ',F10.2/
     &'   SEVERITY STD DEV = ',F10.2/)
      WRITE(7,15)
  15  FORMAT(' ONLY 32 LINES ALLOWED')
C
  20  SIGSQA=VARB*XMUA**2+SIGSQA*(1.0+VARB)
      SIGA=DSQRT(SIGSQA)
      NL=N-1
C**********************************************************************
C     STEPS 3 AND 4
C**********************************************************************
      XMAX=0.0
      NUMX=1
      READ(2,*)ITYPE
C  ITYPE=1 IF AGGREGATE LOSS AMOUNT IS INPUT
C  ITYPE=2 IF ENTRY RATIO IS INPUT
      IF(ITYPE.EQ.2)GOTO 35
      IF(ITYPE.NE.1)STOP
  30  READ(2,*,END=50)X(NUMX)
C  X IS AN AGGREGATE LOSS AMOUNT
      ER(NUMX)=X(NUMX)/XMUA
      XMAX=DMAX1(XMAX,X(NUMX))
      NUMX=NUMX+1
      GOTO 30
  35  READ(2,*,END=50)ER(NUMX)
C  ER IS AN ENTRY RATIO
      X(NUMX)=ER(NUMX)*XMUA
      XMAX=DMAX1(XMAX,X(NUMX))
      NUMX=NUMX+1
      GOTO 35
  50  NUMX=NUMX-1
      H=2.*3.14159265*SIGA/XMAX
```

2

```
C**********************************************************************
C    STEP 5
C**********************************************************************
      A(1)=0.0
      DO 60 I=.,256
      DO 60 .'=1,5
      F(I,J)=1.0
  60  G(I,J)=0.0
C
      DO 100 I=1,5
      A(I+1)=F/2.**(5-I)
 100  CALL GAUSS5(I,A,T,F,G,NPTS,AMT,PK,XLAM,VARC,SIGA,NL)
      DO 110 I=6,256
      A(J+1)=A(I)+H
      CALL GAUSS5(I,A,T,F,G,NPTS,AMT,PK,XLAM,VARC,SIGA,NL)
      E=0
      DO 105 J=1,5
 105  E=DMAX1(E,F(I,J)/T(I,J))
      IF(E.LT.0.00002)GOTO 120
 110  CONTINUE
 120  NINT=I
C**********************************************************************
C    PRODUCE DISPLAY OF OUTPUT
C**********************************************************************
 200  WRITE(7,201)EXHBT
 201  FORMAT('1',2A8,T31,'COLLECTIVE RISK MODEL'//
     &T9,'EXPECTED   CLAIM SEVERITY     CONTAGION    ',
     &'CLAIM COUNT   CLAIM COUNT'/
     &' LINE      LOSS      DISTRIBUTION     PARAMETER      ',
     &'MEAN       STD DEV'/)
      DO 210 I=1,NL
      IEX=IDINT(EXLOSS(I)+.5)
 210  WRITE(7,211)I,IEX,NAME(I),VARC(I),XLAM(I),SIGP(I)
 211  FORMAT(T3,I2,T9,I8,T20,2A8,T39,F7.4,T49,F10.3,T63,F10.3)
      IXMUA=IDINT(XMUA+.5)
      ISIGA=IDINT(SIGA+.5)
      WRITE(7,221)VARB,IXMUA,ISIGA
 221  FORMAT(//' MIXING PARAMETER',T22,F8.4/
     &' AGGREGATE MEAN  ',T22,I8/
     &' AGGREGATE STD DEV ',T22,I8//
     &'     AGGREGATE',6X,'ENTRY',5X,'CUMULATIVE',7X,'EXCESS PURE',5X,
     &'EXCESS PURE'/
     &'   LOSS AMOUNT',5X,'RATIO',5X,'PROBABILITY',8X,'PREMIUM',6X,
     &'PREMIUM RATIO'//)
C**********************************************************************
C    STEP 6
C**********************************************************************
      DO 310 I=1,NUMX
      CALL PCTEPP(X(I),VARB,XMUA,SIGA,A,T,F,G,NINT,PCT,EPP)
      TBM=EPP/XMUA
 310  WRITE(7,311)X(I),ER(I),PCT,EPP,TBM
 311  FORMAT(3X,F11.2,4X,F7.4,6X,F7.4,7X,F11.2,8X,F7.4)
C**********************************************************************
C    PRINT TECHNICAL INFORMATION
```

3

```
C*******************************************************************
      EPPERR=2*SIGA*E/(3.1415926S*XMUA)
      WRITE(7,401)EXHBT,H,NINT,EPPERR
  401 FORMAT('1',2A8,T31,'COLLECTIVE RISK MODEL'//
     &' TECHNICAL INFORMATION'/
     &' H=',T45,F12.3/
     &' NUMBER OF INTERVALS=',T45,I12/
     &' ESTIMATED TRUNCATION ERROR IN EPP RATIO=',T45,F12.6)
      END
C
C     END OF MAIN PROGRAM - SUBROUTINES FOLLOW
C
C*******************************************************************
C     FIND POINTS WHERE THE AGGREGATE CHARACTERISTIC MUST BE EVALUATED
C     CALLED FROM THE MAIN PROGRAM
C*******************************************************************
      SUBROUTINE GAUSS5(I,A,T,F,G,NPTS,AMT,PK,XLAM,VARC,SIGA,NL)
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 AMT(128,32),PK(128,32),VARC(32)
      REAL*8 A(1),T(256,5),F(256,5),G(256,5),S(5),XLAM(32)
      INTEGER NPTS(32)
      DATA S/-.90617985,-.53846931,0.0,.53846931,.90617985/
C
      DO 100 J=1,5
      T(I,J)=(A(I+1)-A(I))*S(J)/2.+(A(I+1)+A(I))/2.
      TS=T(I,J)/SIGA
      DO 100 K=1,NL
      CALL AGGCHR(NPTS,AMT,PK,K,XLAM,VARC,TS,FL,GL)
      F(I,J)=F(I,J)*FL
  100 G(I,J)=G(I,J)+GL
      RETURN
      END
C*******************************************************************
C     EVALUATE THE AGGREGATE CHARACTERISTIC
C     CALLED FROM GAUSS5
C*******************************************************************
      SUBROUTINE AGGCHR(NPTS,AMT,PK,K,XLAM,VARC,T,F,G)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER NPTS(32)
      REAL*8 AMT(128,32),PK(128,32),XLAM(32),VARC(32),PZ(2)
      COMPLEX*16 Z
      EQUIVALENCE (PZ,Z)
C  PZ(1)=REAL PART OF Z.  PZ(2)=COMPLEX PART OF Z.
C
      CALL SEVCHR(NPTS,AMT,PK,K,T,XH,XK)
      PZ(1)=1.0-VARC(K)*XLAM(K)*XH
      PZ(2)=-VARC(K)*XLAM(K)*XK
      Z=-1./VARC(K)*CDLOG(Z)
C  LOG OF MODULUS=REAL PART OF COMPLEX LOG
C  ARGUMENT=COMPLEX PART OF COMPLEX LOG
      F=DEXP(PZ(1))
      G=PZ(2)
      RETURN
      END
```

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C**************************************************************************
C     EVALUATE THE CHARACTERISTIC OF THE SEVERITY DISTRIBUTION
C     CALLED FROM AGGCHR
C**************************************************************************
      SUBROUTINE SEVCHR(NPTS,AMT,PK,K,T,XH,XK)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER NPTS(32)
      REAL*8 AMT(128,32),PK(128,32)
C
      S2=0.0
      C2=1.0
      TH=0.0
      TK=0.0
      NPT=NPTS(K)
      DO 100 L=2,NPT
      A=AMT(L,K)*T
      S1=S2
      C1=C2
      S2=DSIN(A)
      C2=DCOS(A)
      TH=TH+PK(L-1,K)*(S2-S1)
  100 TK=TK+PK(L-1,K)*(C1-C2)
      XH=TH/T-1.0+PK(NPT,K)*C2
      XK=TK/T+PK(NPT,K)*S2
      RETURN
      END
C**************************************************************************
C     INTEGRATE TO GET CDF AND EXCESS PP BY GAUSSIAN QUADRATURE
C     CALLED FROM THE MAIN PROGRAM
C**************************************************************************
      SUBROUTINE PCTEPP(X,VARB,XMUA,SIGA,A,T,F,G,NINT,PCT,EPP)
      IMPLICIT REAL*8 (A-H,O-Z)
      REAL*8 A(1),T(256,5),F(256,5),G(256,5),W(5)
      DATA W/.23692689,.47862867,.56888889,.47862867,.23692689/
C
      EPP=0.0
      PCT=0.0
      R=1.0+1.0/VARB
      DO 200 I=1,NINT
      P1=0.0
      P2=0.0
      DO 100 J=1,5
      XP1=1.0+(X*T(I,J)/(SIGA*R))**2
      ATX=DATAN(X*T(I,J)/(SIGA*R))
      P1=P1+W(J)*F(I,J)*XP1**((-1.-R)/2.)*DSIN((1.+R)*ATX-G(I,J))/T(I,J)
  100 P2=P2+W(J)*F(I,J)*(DCOS(G(I,J))-XP1**(-R/2.)*DCOS(R*ATX-G(I,J)))/
     &    T(I,J)**2
      PCT=PCT+(A(I+1)-A(I))*P1/2.
  200 EPP=EPP+(A(I+1)-A(I))*P2/2.
      PCT=.5+PCT/3.14159265
      EPP=XMUA-X/2.+EPP*SIGA/3.14159265
      RETURN
      END
```