THE 1999 TABLE OF INSURANCE CHARGES

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"The problem is all inside your head,
She said to me.
The answer is easy if you
Take it logically.
I'd like to help you in your struggle
To be free;
There must be fifty ways
To leave your lover."

—Paul Simon

Abstract

This paper describes the development of the 1999 Workers Compensation Table of Insurance Charges (Table M), filed in NCCI states to be effective November 1, 1998.

It presumes the reader knows what Table M is, and how it is used in retrospective rating. Familiarity with the NCCI Retrospective Rating Plan (the Plan) is helpful.

Development of the 1999 Table M is described in steps, beginning with the sample data and how it was manipulated, followed by the algorithm used to model loss ratios, methods for developing the loss ratio distribution, graduation of the excess ratios and derivation of Expected Loss Size Ranges used in the Plan.

The impact on premium of the proposed new Table M is estimated.

1. BACKGROUND

At the heart of retrospective rating is a table of excess ratios commonly called Table M. Details on the definition and use of

Table M are provided much more fully elsewhere in the literature. See [1], [2], [3] and [4] among the references to this paper. The reader is expected to know the vocabulary and basic significance of the table.

The Workers Compensation Table of Insurance Charges, the proper name of Table M, was last changed in 1984. Derivation of the 1984 Table M was never documented in *PCAS*, as was done for the 1964 Table M by LeRoy Simon, but it served well for almost 15 years. Its passing is hereby lamented, if a bit satirically, in the song above, fittingly by another Simon. (One of fifty ways: "Don't need to be coy, Roy.")

Since 1984, annual updates have been made to account for inflation in the average cost per case, which was quite significant during the late 1980s. The body of Table M was not changed, but only the expected loss sizes necessary to qualify for specific columns of the table. Increasing skewness in the severity distribution, as discussed below, impacted the loss ratio distribution, and this needed to be reflected in the body of Table M; changes of this sort are not accounted for in inflationary updates. Even if the table was approximately adequate in 1998, which our research verified, the need to update the body of Table M was evident.

The changes in the loss size distribution were recognized early on and led to non-trivial updates in the calculation of excess loss factors (ELFs), also used in the retrospective rating plan. Three revisions were made (in 1987, 1992, and 1996) to the model distributions used in the calculation of ELFs. The changes are documented in [5] and [6]. In general, each step involved recognition of increasing skewness in the distribution of serious claims by size.

The changes in loss severity are a sign of the times. Underwriting results in the workers compensation line of business during the last two decades of this century are a matter of record.

Volatility in premium adequacy was driven by changes in legal rules, program administration, benefits, and salaries, as well as a generally increasing feeling of entitlement among the public starting in the 1970s. During the late 1980s, this led to the need for large rate increases, relatively more large compensation awards and a heavier tailed severity distribution.

2. OUTLINE

This is a short description of the basic steps in the creation of the 1999 Table of Insurance Charges. There is a section of the paper for each step.

A. *Sample Data*—Premium and loss information was assembled for a sample of 450,156 insureds from policy year 1988 at fifth report. The sample was grouped into 25 overlapping adjusted expected loss size ranges. Risk expected loss size is adjusted by formula: a product of standard expected loss and the appropriate state and hazard group relativity. The empirical loss ratio distribution of each group was normalized to a mean of unity.

B. *Modeling Sample Excess Ratios*—For each sample group, the empirical excess ratio distribution was fitted to excess ratios based on a Heckman–Meyers (HM) model distribution, as described in [7] and [8]. The severity distribution used in the model was exactly the one underlying the empirical fifth report, and the frequency parameters were selected to effect a fit.

C. *Development to Ultimate*—The fifth report severity distribution was replaced with one developed to ultimate. The severity uncertainty parameter was increased to account for loss ratio uncertainty, i.e., parameter risk. An ultimate excess ratio distribution was produced for 26 groups. (The 26th distribution was based on a hypothetically large expected number of claims and, as such, had no empirical sample.)

D. *Graduating the Table*—Inverse exponential polynomials were used to graduate 26 model excess ratio distributions.

E. *The 1999 Table of Insurance Charges*—This is it!

F. *Derivation of Size Ranges*—Sample risk average (formula) adjusted size and HM model frequency were used to derive nominal average severity by sample group. By selecting one average severity, we were able to assign a 1988 expected loss size, frequency times severity, to each of 26 mother curves. Interpolation was used to create boundaries for (adjusted) expected loss size ranges, indexed by charges at entry ratio unity of 0.095 to 0.975. Estimated severity trend was used to make size ranges appropriate for 1999.

G. *Estimating the Impact*—The algorithm described in [4] was used to estimate premium recovered by using Table M.

3. THE PROCESS

Sample Data

We used the latest available statistical plan data at fifth report for the review. The unit statistical information includes the following information for each policy in each state: payroll by class, manual premium (which is an extension of payroll along the respective class rates), experience modification, standard premium and loss. We were able to group this information by risk to allow the tabulation of standard expected loss (standard premium times permissible loss ratio), actual loss, loss ratio and hazard group of each risk (which can occasionally vary by state).

Exhibit 1 shows the actual policy periods by state used for this analysis. These are close to policy year 1988, but vary by state according to the filing schedules.

The exhibit also shows state and hazard group severity relativities (S&HGRs), effective 10/1/91. In order to assign a risk to a column of Table M, the risk's adjusted expected loss size is used. Starting with standard expected loss by state, the adjustment is accomplished by application of the appropriate S&HGR. This should account for known differences in scale of severity distributions and is part of the current retrospective rating plan. Ideally, we would have used values calculated for 1988, but 1991 was the first year the filing was effective and these were the earliest calculated, so we used these to adjust expected losses. We believe using the relativities is essential to be consistent with the use of Table M in the retrospective rating plan, notwithstanding the discrepancy in effective date. Experience has shown the S&HGRs, which are relativities to the average, do not change much from year to year.

Using adjusted expected losses by risk, we grouped sample risks into 25 size ranges. To maximize the number of risks in each group, we allowed the size ranges to overlap, so some risks fall into two different size ranges. Exhibit 2 shows the 1988 expected loss size ranges used. Column 1 shows the applicable indices for columns of the table. As described in [1], columns of Table M are indexed by the charge at entry ratio 1, in percent. So for the third row, applicable columns have charges at unity of 0.16 to 0.22. This corresponds to seven size ranges:

Index	1988 Expected Loss Minimum	1988 Expected Loss Maximum
16	4,386,336	5,565,157
⋮	⋮	⋮
21	1,544,131	1,872,497
22	1,281,534	1,544,130

Risks with adjusted loss within the total range formed a sample group of loss ratios from which empirical excess ratios were calculated.

Embedded in the 1988 risk data used is a fifth report severity distribution, all states combined. This distribution became an integral part of the next step.

Modeling Sample Excess Ratios

Each sample group of risks exhibited an empirical distribution of loss ratios, $F[x]$. The loss ratios x could easily be converted into entry ratios r by dividing x by the average, so that $\mathrm{E}[r] = 1.0$. The excess ratios $X(r) = \sum_{s=r}^{\infty}(s-r)f(s)$, where f is the normalized density, were calculated directly from the data. See [2] or [3] for a more detailed treatment of the topic of excess ratios.

This is a summary of the HM model as it pertains to this application: Using the collective risk model from risk theory, the HM algorithm creates a loss ratio distribution from underlying frequency and severity distributions. The algorithm uses the moment generating function of the frequency and the characteristic function for the severity to derive the characteristic function of the loss ratio distribution, then inverts it to generate the aggregate distribution. Using simplifying assumptions, the input data are an expected claim count λ and a contagion parameter c to model the frequency distribution, and a piecewise linear severity distribution with a severity uncertainty parameter b to model severity. See [7], [8], and [9] for details.

We used the fifth report severity distribution along with choices of λ, c, and b to fit the empirical sample of excess ratios.

Each sample excess ratio distribution was fit directly to one based on the HM model. Exhibit 3 shows results of the modeling process. (Each page shows results of 25 different fits at entry ratios 1.0 and 3.0.) There was no special technique used to effect the fit. It turned out that using the appropriate frequency to match the excess ratio at the entry ratio $r = 1$ assured a fairly good fit to the entire sample excess ratio distribution. We started with λ proportional to the average adjusted expected loss size of the sample. A severity uncertainty parameter $b = 0.001$ worked well in the fit. Such a small value makes sense given that the empirical sample severity distribution and normalized loss ratio are determinate. There was more room to adjust the contagion parameter. We started with $c = 0.30$ for the small size groups. To fit the distribution for larger risks, we needed to vary the contagion parameter c downward, as can be seen in Exhibit 3. We made fine-tuning adjustments to λ or c to extend the fit to all entry ratios for all 25-size groups.

Development to Ultimate

We did not change frequency parameters λ and c after fifth report, assuming that change in the claim frequency distribution is insignificant after fifth report. This is a reasonable assumption, borne out by empirical evidence of very little frequency development from fourth to fifth report. In practice, of course, some claims may close with no payment or emerge as IBNR, but this could be considered a matter of parameter risk as discussed below. We thus retained the fifth report model parameters λ and c.

The development of the claim severity distribution is another matter. We had learned a lot about loss severity development in excess loss factor (ELF) studies, first in 1992 and carried further in 1996, as described in [6]. Underlying the ELF procedure are three indemnity claim size distributions by injury group, developed to ultimate. We also have one for medical-only claims. We were able to create an ultimate severity distribution consistent with the 1988 data by weighting scaled component distributions. Each state has its own (estimated) ultimate scale and injury weight for each of these distributions.

We created an ultimate severity distribution using techniques much the same as in the ELF procedure [5]. We were able to develop average costs per case at ultimate and injury type weights by state. We used those severities to scale the underlying distributions and the weights to combine them across injury group by state and then across states.

1. Empirical average severity by state and injury type was calculated from the 1988 data.
2. Fifth to ultimate severity development factors were calculated for serious injury types by state. This was done by attributing the fifth to ultimate loss development factors from ratemaking entirely to serious injury claim size.
3. The development factors were applied respective of state and injury type.
4. Developed permanent total (PT) and major permanent partial (Major) claim types were combined, as well as fifth report minor permanent partial (Minor) and temporary total (TT), to obtain average severities for fatal, PT/Major, Minor/TT and medical-only injury groups by state.
5. Loss weights by injury group and state were calculated.
6. Average severities and loss weights by injury group were used with respective ultimate loss size distributions from the ELF procedure, and an associated distribution for medical-only, to make a weighted average severity distribution for all claims combined by state.
7. All states were weighted together to create one ultimate 1988 severity distribution. This was fit by a piecewise linear model for use in the HM algorithm.

Now, using this derived ultimate severity distribution,[1] we were able to use HM to create an ultimate loss ratio distribution with corresponding excess ratios. We did this first retaining $b = 0.001$ as at fifth report. The impact of changing to an ultimate severity distribution was considerable. This can be seen in Exhibit 4 by comparing column 5 to column 4. We saw increases of up to 5

[1]Both the Table of Insurance Charges and the underlying severity distribution are products for sale by NCCI; hence they are not included in this paper.

percentage points in excess ratios for entry ratio 1, applicable to risks in the size ranges most impacted by retrospective rating (25 to 60). We saw even larger increases at the higher entry ratios, reflecting the increased skewness of the loss ratio distribution based on ultimate severity.

To account for parameter risk, we chose to increase the severity uncertainty parameter b from 0.001 to 0.015. This is a judgment call, and based on our estimates of loss ratio uncertainty, not simply scale uncertainty. We needed to account for the fact that the expected loss ratio for each risk is only an estimate. The flexibility of the HM model to allow such an adjustment is a huge advantage of HM over competing models. Even though $b = 0.015$ represents a 12.2% uncertainty in expected loss ratio, which is large, the resulting increase in charges (about half a percentage point) did not seem that excessive. A comparison of columns 7 and 5 shows the impact of this choice is much smaller than the change from column 4 to 5.

The result of the process is 25 sample excess ratio tables based on 25 loss ratio distribution models with underlying frequency and severity distribution. A 26th sample was created using the ultimate severity distribution and enough expected claims to produce a charge at unity of less than 0.095.

Graduating the Table

Having 26 columns of an excess ratio table based on HM model loss distributions is a wonderful thing, but in practice the functional form of the associated insurance charges is more complex than practitioners may have wanted. They did want more of other qualities: ease of data entry and at least 80 columns with charges at unity in even percents. (The charges at unity of the 26 models were not necessarily integral percents.)

The 1984 table could be generated by interpolating between a sample of 19 inverse exponential polynomials, and two boundary functions. A similar algorithm to generate the new table was needed. This was accomplished in the following manner, a slightly simplified version of the prior technique.

1. Each sample HM excess ratio table was modeled. This was done by catenating three models:

   a. $X(r) = 1 - r$ for small values of r (at least for the larger size groups).

      The HM samples verified this simple expression for X, so it was better not to try and extend the fit further than necessary.

   b. $X(r) = \exp[\sum_{k=1}^{8} a_k r^k]$ for medium values for r. The coefficients are derived from a regression on the HM model excess ratios, and of course differ by size range. By limiting the fit to these critical values of r, very close approximations are possible.

   c. $X(r) = X(r_l)^{k(r)} X(r_u)^{1-k(r)}$, where

   $$k(r) = \left[\frac{r_u - r}{r_u - r_l}\right], \qquad \text{and} \qquad r_l \le r \le r_u.$$

      $X(r_u)$ is taken from the fitted curve in (b), and $X(r_l)$ is taken from the underlying HM sample tables. (r_l, r_u) is the interval of (largest) entry ratios where this simple decay works best.

   These provide sample curves for interpolating the final table. For curves 29.35 and 33.16, Exhibit 5 shows results of this modeling.

2. Two more mother curves were defined to be used as boundary values.

$$X_0(r) = \begin{cases} 1 - r & 0 \le r \le 1 \\ 0 & \text{for all} \quad r \ge 1, \\ & \text{where } r \text{ is the entry ratio} \end{cases}$$

$$X_{100}(r) = 1 \qquad \text{for all} \quad r \ge 0$$

   Now there are 28.

3. Linear interpolation between the 28 mother curves was used to generate the columns of the table with integral percent p charge at unity entry ratio. For any entry ratio r, the charge for the column indexed by p is:

$$X_p(r) = X_l(r) + \left[\frac{X_p(1) - X_l(1)}{X_u(1) - X_l(1)}\right][X_u(r) - X_l(r)]$$

Exhibit 6 is a graph of the values used to interpolate X_{32}.

The 1999 Table of Insurance Charges

After jumping through hoops, standing on our heads, and spitting wooden nickels to create this table, it is time to take a break and enjoy a picture. Exhibit 7 is a three-dimensional graph of the Table (r, X, I). From the point of view of the reader, the graph is a concave surface. The vertical X axis is the charge. The entry ratios r from 0.0 to 3.2 go from left to right coming towards the reader across the left half of the page, and the size group column shows indices from 0 to 100, going away from left to right across the right half.

The surface is flat (planar) in the upper left, where entry ratios are low and risks are large. In this region, $X(r) = 1 - r$, which implies loss ratios are always at least rE. The curved isoclines denote constant charges of $0.90, 0.80, \ldots, 0.10$ from top to bottom. Note that there is an implied isocline for $X = 0.0$.

The foreground cross-section of the surface is concave and increasingly so for larger and larger values of r, as it will tuck in closer and closer to the line $(r, 0, 1)$ behind the surface on the right hand side of the page. This is because for all size groups bigger than the boundary where $X(1) = 1$, the charge approaches 0 as r increases. Within the contoured surface, there is a straight line where $r = 1$, and the charge is 1/100 of the index $(1, X, 100X)$.

On Derivation of Size Ranges

Thus far we have developed a table with columns indexed by the (percent) insurance charge at unity entry ratio. As explained above, this is based on 26 loss ratio distributions, complete with frequency and severity parameters.

Table M was to be filed effective November 1, 1998. It was necessary to determine size ranges to be used for selection of the columns of the table applicable to an individual risk. These ranges would of course be adjusted going forward for trend in average severity.

The HM model severity is scale free in the sense that the loss ratio distribution, and consequent table of excess ratios, depends on the expected claim count and the shape, but not the size, of the severity distribution. If we could attach a scale to this distribution, we could use frequency times adjusted average severity to determine a dollar size corresponding to each model.

Exhibit 8 shows the first step in the estimation of the implicit average adjusted severity. We have already calculated the average adjusted expected loss of each of 25 empirical sample groups in Exhibit 2. Our modeling process assigned a frequency (expected claim count) to each group which was needed to match the sample loss ratio distribution. In Exhibit 8, we simply divide the adjusted expected losses by the expected claim count to produce an expected average adjusted severity. This of course varies with each sample group, but, except for a small upward tick in the largest size ranges, the estimated severity is remarkably flat.

We selected an average adjusted severity value consistent with the 1988 samples. Using expected claim counts from the models (including the hypothetical model), the product is the point estimate of adjusted expected loss size for the 26 samples in 1988. This is shown in Exhibit 9.

Exhibit 10 shows how we developed 1988 size ranges. In short, we used interpolation between the 26 points to estimate adjusted expected losses corresponding to the boundaries of the ranges (i.e., even percents +0.005).

We wanted to adjust these average sizes to a point in 1999. Using statistical plan data, we were able to determine that the actual severity trend between 1988 and 1994 was about +25%. Independent analysis of the most recent available data showed severity trend to be nearly flat from 1993 through 1996, so we projected no severity trend after 1994. Using the 1.25, we determined boundaries of expected loss size ranges applicable in 1998/99. This is column 7 of Exhibit 10.

Estimating the Impact

The 1999 Table of Insurance Charges was filed effective 11/1/98, replacing the 1984 Table. The aggregate impact on expected retrospective rating premium was not great.

In the body of Table M, for the low entry ratios associated with the run of the mill retrospective rating contracts sold, the changes in the table values were fairly small. The change to the expected loss size ranges, although not a simple linear inflation, was also moderate. This can be seen in Exhibit 11. For the high charge/small expected loss size columns, the inflationary impact was minimal, with less than a 7% increase in the expected loss size ranges 72 to 46. This encompasses 1999 expected losses of $17,000 to $132,500. The size of a risk needed to qualify for the lower charge columns grew significantly, so that to qualify for column 20, a risk had to be 60% larger ($5.9 vs. $3.7 million). We assume not many risks this size are written on a straight retro, even before this change.

Using methods described in [4], we were able to estimate an impact of about +1% on expected retrospectively rated premium. Exhibit 12 shows the evaluation. Assuming the new table is a correct measure of excess ratios, we began with sample plans for representatives of each range, calculated based on the old Table M and size groups. The expected retrospective premium written under those plans was evaluated with the proposed table and size ranges applicable to actual losses. The estimated shortfall is about 1% of premium which would (theoretically) be recovered if the new table is implemented.

4. CONCLUSION

The new Table of Insurance Charges is a significant improvement to the former table. This is not a matter of pricing adequacy, as the estimated overall impact is small. What matters more is the increase in individual risk equity due to the associated nonlinear update of expected loss size ranges, but even this is only part of the story.

The use of explicit underlying frequency and severity distributions is a great advance in the science, making the table more useful in new as well as standard applications. It allows for much more facile future updates, not only for inflation, but also for changes in workers compensation law, administration or environment. There must be 50 ways.

REFERENCES

[1] Simon, LeRoy J., “The 1965 Table M,” *PCAS* LII, 1965, p. 1.

[2] Gillam, William R., and Richard H. Snader, “Fundamentals of Individual Risk Rating,” monograph published by NCCI, 1992.

[3] Skurnick, David, “The California Table L,” *PCAS* LXI, 1974, p. 117.

[4] Gillam, Willam R., Discussion of Skurnick: “The California Table L,” *PCAS* LXXX, 1993, p. 353.

[5] Gillam, William R., “Retrospective Rating: Excess Loss Factors, *PCAS* LXXVIII, 1991 p. 1.

[6] Gillam, William R., “Retrospective Rating: 1997 Excess Loss Factors,” *PCAS* LXXXIV, 1997, p. 450.

[7] Heckman, Philip E., and Glenn G. Myers, “The Calculation of Aggregate Loss Distributions from Claim Severity and Claim Count Distributions,” *PCAS* LXX, 1983, p. 22.

[8] Venter, Gary G., Discussion of Heckman and Myers: “The Calculation of Aggregate Loss Distributions from Claim Severity and Claim Count Distributions,” *PCAS* LXX, 1983, p. 67.

[9] Klugman, Stuart A., Harry H. Panjer, and Gordon E. Willmot, *Loss Models: From Data to Decisions*, New York: John Wiley & Sons, Inc., 1998.

EXHIBIT 1

State and Hazard Group Relativities
Used to Determine Expected Loss Size Group
NCCI Retrospective Rating Manual, Effective 10/1/91

State Name	Policy Year Beginning	Relativity by Hazard Group			
		I	II	III	IV
AL	5/1/88	1.677	1.512	1.161	0.936
AK	4/1/88	1.142	0.955	0.712	0.565
AZ	3/1/88	1.264	1.139	0.867	0.706
AR	4/1/88	1.326	1.197	0.912	0.732
CO	3/1/88	1.097	0.972	0.712	0.547
CT	1/1/88	1.418	1.294	0.954	0.748
DC	4/1/88	1.322	1.160	0.859	0.682
FL	10/1/87	0.831	0.750	0.560	0.500
GA	2/1/88	1.182	1.049	0.800	0.645
HI	6/1/88	1.487	1.293	0.958	0.777
ID	3/1/88	1.350	1.203	0.923	0.754
IL	4/1/88	1.353	1.236	0.960	0.792
IN	12/1/87	1.844	1.701	1.343	1.104
IA	3/1/88	1.627	1.474	1.105	0.888
KS	1/1/88	1.432	1.280	0.967	0.775
KY	1/1/88	1.352	1.211	0.917	0.737
LA	4/1/88	0.874	0.813	0.611	0.500
ME	6/1/88	1.210	1.099	0.820	0.643
MD	4/1/88	1.398	1.276	0.974	0.801
MI	4/1/88	1.098	0.991	0.748	0.595
MS	1/1/88	1.368	1.229	0.932	0.751
MO	1/1/88	2.000	1.879	1.505	1.260
MT	11/1/87	1.066	0.968	0.727	0.579
NE	2/1/88	1.425	1.253	0.942	0.757
NH	4/1/87	1.424	1.275	0.948	0.750
NM	1/1/88	1.132	0.982	0.744	0.595
NC	4/1/88	1.575	1.438	1.107	0.900
OK	6/1/87	1.310	1.187	0.927	0.766
OR	1/1/88	1.013	0.938	0.723	0.594
RI	1/1/88	1.171	1.035	0.765	0.611
SC	1/1/88	1.353	1.235	0.939	0.760
SD	1/1/88	1.273	1.139	0.849	0.674
TN	1/1/88	1.401	1.283	1.001	0.835
UT	5/1/87	1.479	1.297	0.971	0.779
VT	4/1/88	1.521	1.337	1.003	0.806
VA	2/1/88	1.323	1.207	0.915	0.738
WI	1/1/88	1.900	1.771	1.976	1.144

EXHIBIT 2

1988 RISK ADJUSTED SAMPLE SIZE RANGES

1988 ELG Range (1)	No. of Risks in Sample (2)	Adjusted Expected Loss Range ($) (3)	Average Adjusted Expected Loss ($) (4)
5–14	98	7,152,383 – & above	110,489,802
9–19	369	2,286,901 – 49,031,955	12,000,542
16–22	646	1,281,534 – 5,565,157	2,921,544
21–26	1,248	640,985 – 1,872,497	1,385,528
24–29	1,973	398,112 – 1,069,773	742,680
28–33	3,809	219,916 – 544,970	424,437
31–36	5,961	144,215 – 341,870	252,281
35–39	6,116	107,226 – 190,702	154,055
38–42	5,584	85,218 – 125,725	111,337
41–46	8,894	63,128 – 99,263	88,321
44–49	10,965	50,529 – 79,016	67,843
48–52	11,514	40,455 – 58,604	52,322
51–56	17,564	30,005 – 46,921	41,980
54–57	13,435	27,822 – 37,557	32,220
58–63	28,663	17,465 – 27,821	22,867
63–65	18,360	14,858 – 18,908	17,458
65–69	38,026	10,599 – 16,116	13,629
69–73	50,227	7,364 – 11,554	10,584
71–77	84,492	4,932 – 9,701	8,059
75–82	106,705	2,760 – 6,688	5,478
79–85	82,613	1,824 – 4,427	3,410
84–87	37,374	1,329 – 2,419	1,980
87–90	35,669	752 – 1,562	1,227
90–95	70,888	171 – 922	586
94–99	55,485	0 – 352	177

EXHIBIT 3

PAGE 1

EXCESS RATIO DISTRIBUTION MODELING RESULTS

			Entry Ratio 1.0	
1988 ELG Range	λ	c	(1) Empirical Group Avg. ϕ	(2) HM-5th (b = .001) ϕ
N/A	75,000	0.040	N/A	
5–14	20,000	0.075	0.106	0.1111
9–19	2,200	0.140	0.159	0.1590
16–22	600	0.190	0.205	0.2008
21–26	310	0.190	0.229	0.2206
24–29	170	0.190	0.268	0.2479
28–33	100	0.190	0.298	0.2818
31–36	65	0.190	0.325	0.3172
35–39	42	0.190	0.362	0.3610
38–42	32	0.190	0.389	0.3922
41–46	24.25	0.190	0.427	0.4268
44–49	19.50	0.205	0.458	0.4577
48–52	14.25	0.205	0.500	0.5009
51–56	11.00	0.220	0.539	0.5390
54–57	9.55	0.220	0.559	0.5590
58–63	6.35	0.250	0.619	0.6187
63–65	5.00	0.300	0.654	0.6540
65–69	3.80	0.300	0.690	0.6895
69–73	2.75	0.300	0.729	0.7288
71–77	1.98	0.300	0.766	0.7657
75–82	1.25	0.300	0.811	0.8113
79–85	0.87	0.300	0.843	0.8425
84–87	0.56	0.300	0.874	0.8741
87–90	0.37	0.300	0.902	0.8978
90–95	0.15	0.300	0.952	0.9338
94–99	0.03	0.300	0.978	0.9743

EXHIBIT 3

PAGE 2

EXCESS RATIO DISTRIBUTION MODELING RESULTS

1988 ELG Range	λ	c	Entry Ratio 3.0 (1) Empirical Group Avg. ϕ	Entry Ratio 3.0 (2) HM-5th (b = .001) ϕ
N/A	75,000	0.040	N/A	
5–14	20,000	0.075	0.000	0.0001
9–19	2,200	0.140	0.002	0.0001
16–22	600	0.190	0.015	0.0020
21–26	310	0.190	0.015	0.0068
24–29	170	0.190	0.054	0.0150
28–33	100	0.190	0.048	0.0272
31–36	65	0.190	0.053	0.0434
35–39	42	0.190	0.076	0.0688
38–42	32	0.190	0.089	0.0905
41–46	24.25	0.190	0.120	0.1183
44–49	19.50	0.205	0.147	0.1455
48–52	14.25	0.205	0.198	0.1898
51–56	11.00	0.220	0.237	0.2331
54–57	9.55	0.220	0.258	0.2581
58–63	6.35	0.250	0.335	0.3378
63–65	5.00	0.300	0.384	0.3880
65–69	3.80	0.300	0.444	0.4431
69–73	2.75	0.300	0.503	0.5071
71–77	1.98	0.300	0.568	0.5698
75–82	1.25	0.300	0.648	0.6493
79–85	0.87	0.300	0.705	0.7046
84–87	0.56	0.300	0.758	0.7631
87–90	0.37	0.300	0.807	0.8088
90–95	0.15	0.300	0.903	0.8804
94–99	0.03	0.300	0.954	0.9486

EXHIBIT 4

PAGE 1

EXCESS RATIO MODEL DEVELOPMENT TO ULTIMATE

			Entry Ratio = 1.0				
(1) 1988 ELG Range	(2) λ	(3) c	(4) HM-5th (b = .001) ϕ	(5) HM-Ult. (b = .001) ϕ	(6) HM-Ult. (b = .01) ϕ*	(7) HM-Ult. (b = .015) ϕ*	(8) HM-Ult. (b = .02) ϕ*
N/A	75,000	0.040	0.0946				
5–14	20,000	0.075	0.1111	0.1144	0.1203	0.1234	0.1265
9–19	2,200	0.140	0.1590	0.1737	0.1777	0.1798	0.1819
16–22	600	0.190	0.2008	0.2278	0.2308	0.2325	0.2341
21–26	310	0.190	0.2206	0.2557	0.2584	0.2599	0.2613
24–29	170	0.190	0.2479	0.2899	0.2923	0.2936	0.2948
28–33	100	0.190	0.2818	0.3284	0.3305	0.3316	0.3327
31–36	65	0.190	0.3172	0.3660	0.3678	0.3688	0.3698
35–39	42	0.190	0.3610	0.4101	0.4117	0.4125	0.4133
38–42	32	0.190	0.3922	0.4406	0.4420	0.4427	0.4435
41–46	24.25	0.190	0.4268	0.4737	0.4749	0.4756	0.4763
44–49	19.50	0.205	0.4577	0.5027	0.5037	0.5043	0.5049
48–52	14.25	0.205	0.5009	0.5429	0.5438	0.5443	0.5448
51–56	11.00	0.220	0.5390	0.5777	0.5784	0.5789	0.5793
54–57	9.55	0.220	0.5590	0.5959	0.5966	0.5970	0.5974
58–63	6.35	0.250	0.6187	0.6489	0.6495	0.6498	0.6501
63–65	5.00	0.300	0.6540	0.6799	0.6804	0.6807	0.6810
65–69	3.80	0.300	0.6895	0.7115	0.7120	0.7123	0.7126
69–73	2.75	0.300	0.7288	0.7473	0.7477	0.7479	0.7481
71–77	1.98	0.300	0.7657	0.7816	0.7819	0.7821	0.7823
75–82	1.25	0.300	0.8113	0.8247	0.8249	0.8251	0.8252
79–85	0.87	0.300	0.8425	0.8543	0.8545	0.8546	0.8546
84–87	0.56	0.300	0.8741	0.8843	0.8844	0.8845	0.8846
87–90	0.37	0.300	0.8978	0.9063	0.9064	0.9064	0.9065
90–95	0.15	0.300	0.9338	0.9382	0.9382	0.9383	0.9383
94–99	0.03	0.300	0.9743	0.9748	0.9748	0.9748	0.9748

*b parameter is increased to account for loss ratio uncertainty.

EXHIBIT 4

PAGE 2

EXCESS RATIO MODEL DEVELOPMENT TO ULTIMATE

			Entry Ratio = 3.0				
(1) 1988 ELG Range	(2) λ	(3) c	(4) HM-5th (b = .001) ϕ	(5) HM-Ult. (b = .001) ϕ	(6) HM-Ult. (b = .01) ϕ*	(7) HM-Ult. (b = .015) ϕ*	(8) HM-Ult. (b = .02) ϕ*
N/A	75,000	0.040	0.0000				
5–14	20,000	0.075	0.0001	0.0001	0.0001	0.0001	0.0001
9–19	2,200	0.140	0.0001	0.0016	0.0018	0.0020	0.0021
16–22	600	0.190	0.0020	0.0148	0.0155	0.0159	0.0163
21–26	310	0.190	0.0068	0.0314	0.0323	0.0327	0.0332
24–29	170	0.190	0.0150	0.0537	0.0547	0.0553	0.0559
28–33	100	0.190	0.0272	0.0810	0.0822	0.0828	0.0835
31–36	65	0.190	0.0434	0.1098	0.1111	0.1118	0.1125
35–39	42	0.190	0.0688	0.1463	0.1477	0.1485	0.1492
38–42	32	0.190	0.0905	0.1733	0.1747	0.1755	0.1763
41–46	24.25	0.190	0.1183	0.2046	0.2060	0.2068	0.2076
44–49	19.50	0.205	0.1455	0.2326	0.2341	0.2349	0.2357
48–52	14.25	0.205	0.1898	0.2760	0.2774	0.2781	0.2789
51–56	11.00	0.220	0.2331	0.3162	0.3175	0.3183	0.3190
54–57	9.55	0.220	0.2581	0.3390	0.3403	0.3410	0.3417
58–63	6.35	0.250	0.3378	0.4099	0.4110	0.4116	0.4122
63–65	5.00	0.300	0.3880	0.4540	0.4550	0.4555	0.4560
65–69	3.80	0.300	0.4431	0.5023	0.5031	0.5035	0.5040
69–73	2.75	0.300	0.5071	0.5574	0.5581	0.5585	0.5588
71–77	1.98	0.300	0.5698	0.6106	0.6112	0.6115	0.6119
75–82	1.25	0.300	0.6493	0.6781	0.6787	0.6790	0.6793
79–85	0.87	0.300	0.7046	0.7271	0.7275	0.7277	0.7279
84–87	0.56	0.300	0.7631	0.7806	0.7809	0.7811	0.7813
87–90	0.37	0.300	0.8088	0.8235	0.8238	0.8239	0.8240
90–95	0.15	0.300	0.8804	0.8908	0.8909	0.8909	0.8910
94–99	0.03	0.300	0.9486	0.9508	0.9508	0.9509	0.9509

*b parameter is increased to account for loss ratio uncertainty.

EXHIBIT 5

Insurance Charges for Curve 29.35				Insurance Charges for Curve 33.16			
Entry Ratio (r)	Heckman Meyers Model	Graduated	Equation # Used	Entry Ratio (r)	Heckman Meyers Model	Graduated	Equation # Used
0.01	0.9900	0.9900	—	0.01	0.9900	0.9900	—
0.02	0.9800	0.9800		0.02	0.9800	0.9800	
0.03	0.9700	0.9700		0.03	0.9700	0.9700	
0.04	0.9600	0.9600		0.04	0.9601	0.9600	$1-r$*
0.05	0.9600	0.9500		0.05	0.9601	0.9500	
0.06	0.9501	0.9400	$1-r$*	0.06	0.9502	0.9400	
0.07	0.9401	0.9300		0.07	0.9403	0.9300	
0.08	0.9302	0.9200		0.08	0.9304	0.9200	—
0.09	0.9203	0.9100		0.09	0.9206	0.9102	
0.10	0.9104	0.9000		0.10	0.9108	0.9005	
0.11	0.9005	0.8900	—	0.25	0.7632	0.7629	
0.25	0.7669	0.7580		0.50	0.5732	0.5733	
0.50	0.5543	0.5543		0.75	0.4325	0.4326	
0.75	0.4017	0.4016		1.00	0.3316	0.3316	
1.00	0.2936	0.2935		1.25	0.2596	0.2595	
1.25	0.2187	0.2188		1.50	0.2080	0.2079	
1.50	0.1671	0.1672		1.75	0.1704	0.1704	
1.75	0.1312	0.1312		2.00	0.1427	0.1427	
2.00	0.1058	0.1058		2.25	0.1217	0.1217	
2.25	0.0874	0.0874		2.50	0.1056	0.1056	
2.50	0.0737	0.0737	IEP†	2.75	0.0930	0.0930	IEP†
2.75	0.0634	0.0634		3.00	0.0828	0.0828	
3.00	0.0553	0.0553		3.25	0.0746	0.0746	
3.25	0.0489	0.0489		3.50	0.0678	0.0678	
3.50	0.0437	0.0437		3.75	0.0620	0.0620	
3.75	0.0394	0.0394		4.00	0.0571	0.0571	
4.00	0.0357	0.0357		4.25	0.0529	0.0529	
4.25	0.0326	0.0326		4.50	0.0493	0.0493	
4.50	0.0300	0.0300		4.75	0.0460	0.0460	
4.75	0.0276	0.0276		5.00	0.0432	0.0432	
5.00	0.0256	0.0256		5.25	0.0406	0.0406	
5.25	0.0237	0.0237		5.50	0.0383	0.0383	
5.50	0.0221	0.0221		5.75	0.0362	0.0362	
5.75	0.0206	0.0206		6.00	0.0343	0.0343	—
6.00	0.0192	0.0192	—	7.00	N/A	0.0288	
7.00	N/A	0.0152		8.00	N/A	0.0242	ED‡
8.00	N/A	0.0120	ED‡	9.00	N/A	0.0204	
9.00	N/A	0.0095		10.00	N/A	0.0171	—
10.00	N/A	0.0075	—				

*Equation (2)—Straight Line (see Appendix)
†Equation (1)—Inverse Exponential Polynomial (see Appendix)
‡Equation (3)—Exponential Decay (see Appendix)

EXHIBIT 6

PAGE 1

1999 TABLE OF INSURANCE CHARGES

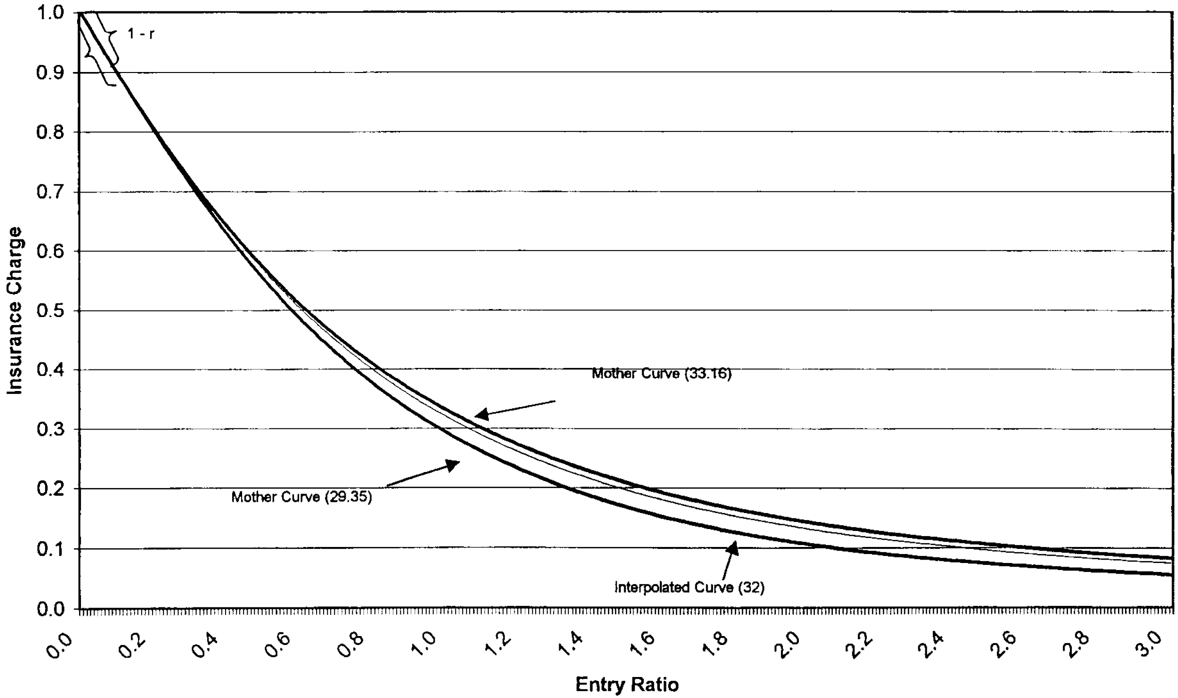

EXHIBIT 6

PAGE 2

1999 TABLE OF INSURANCE CHARGES

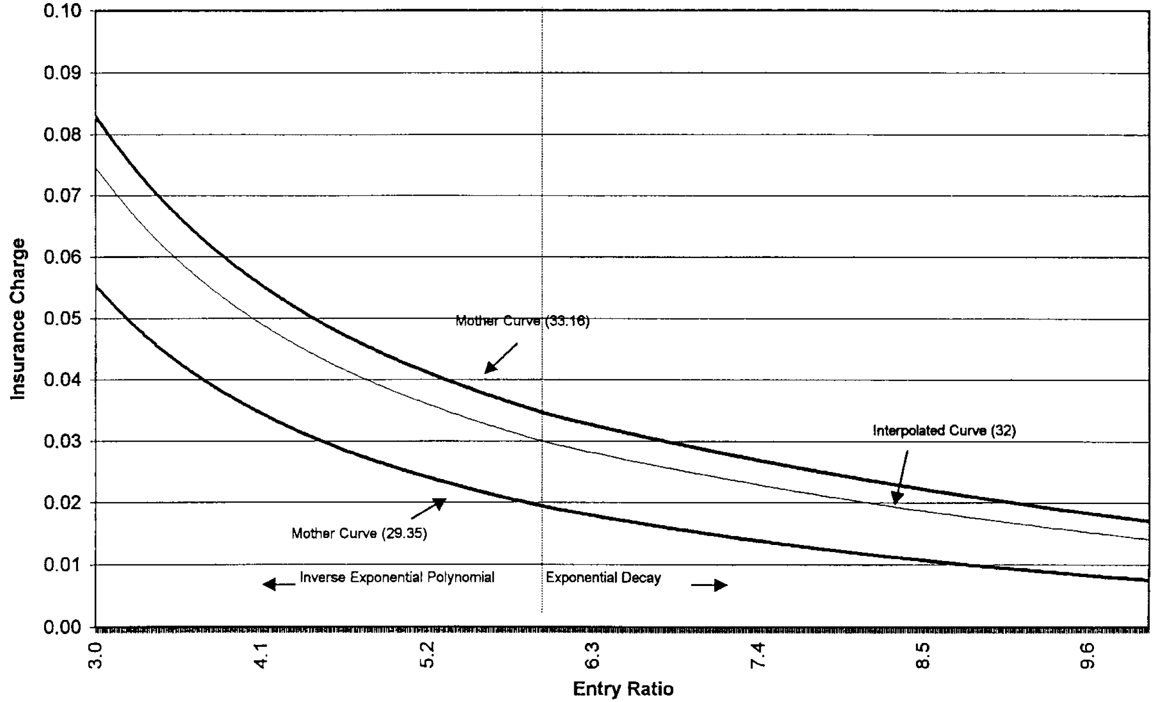

EXHIBIT 7

GRAPH OF TABLE OF INSURANCE CHARGES

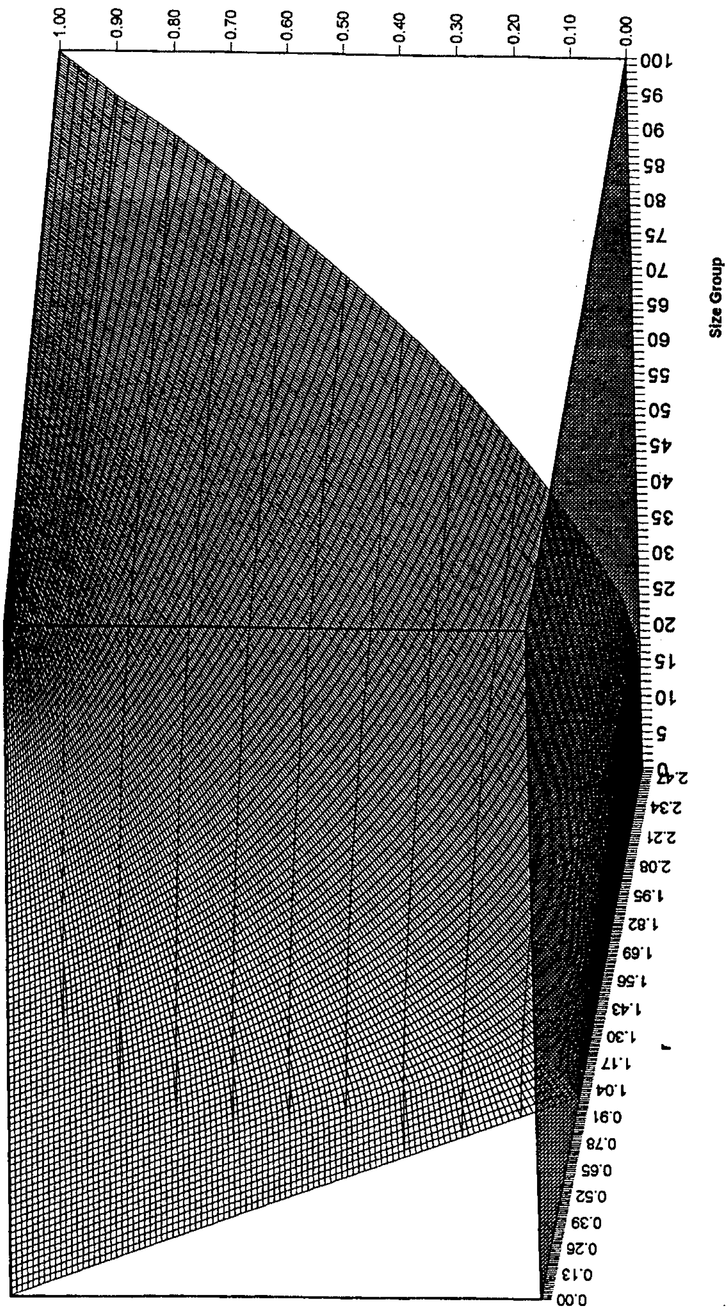

EXHIBIT 8

DETERMINATION OF 1988 AVERAGE ADJUSTED SEVERITY

1988 ELG Range (1)	Average Adjusted Expected Loss (2)	Model Expected No. of Claims (3)	Average Severity (4) = (2)/(3)
5–14	$110,489,802	20,000	$5,524
9–19	$12,000,542	2,200	$5,455
16–22	$2,921,544	600	$4,869
21–26	$1,385,528	310	$4,469
24–29	$742,680	170	$4,369
28–33	$424,437	100	$4,244
31–36	$252,281	65	$3,881
35–39	$154,055	42	$3,668
38–42	$111,337	32	$3,479
41–46	$88,321	24	$3,642
44–49	$67,843	20	$3,479
48–52	$52,322	14	$3,672
51–56	$41,980	11.00	$3,816
54–57	$32,220	9.55	$3,374
58–63	$22,867	6.35	$3,601
63–65	$17,458	5.00	$3,492
65–69	$13,629	3.80	$3,587
69–73	$10,584	2.75	$3,849
71–77	$8,059	1.98	$4,081
75–82	$5,478	1.25	$4,382
79–85	$3,410	0.87	$3,920
84–87	$1,980	0.56	$3,549
87–90	$1,227	0.37	$3,317
90–95	$586	0.15	$3,808
94–99	$177	0.03	$5,907
		Overall Avg	$4,031
		Selected	$4,000

EXHIBIT 9

Calculation of Expected Losses Corresponding to 1988 Claim Counts in Model

(1) Insurance Charge at Unity ϕ	(2) Expected Claim Count in Model	(3) = (2) × 4,000* Expected Total Losses
0.0946	75000	300,000,000
0.1234	20000	80,000,000
0.1798	2200	8,800,000
0.2325	600	2,400,000
0.2599	310	1,240,000
0.2935	170	680,000
0.3316	100	400,000
0.3688	65	260,000
0.4125	42	168,000
0.4427	32	128,000
0.4756	24.25	97,000
0.5043	19.5	78,000
0.5443	14.25	57,000
0.5790	11	44,000
0.5971	9.55	38,200
0.6501	6.35	25,400
0.6811	5	20,000
0.7127	3.8	15,200
0.7484	2.75	11,000
0.7828	1.975	7,900
0.8257	1.25	5,000
0.8552	0.87	3,480
0.8850	0.558	2,232
0.9068	0.37	1,480
0.9382	0.154	616
0.9749	0.03	120

*4,000 = Average Severity from Exhibit 8

EXHIBIT 10

INTERPOLATION OF 1998 EXPECTED LOSS RANGES

(1) Expected Loss Group Boundary	(2) Lower Point Used	(3) Upper Point Used	(4) Total Losses for Lower Point 1988	(5) Total Losses for Upper Point 1988	(6) Expected Losses 1988	(7) = (6) × 1.25* Trended Expected Losses (1998)
0.095	0.0946	0.1234	300,000,000	80,000,000	294,542,927	368,178,659
0.105	0.0946	0.1234	300,000,000	80,000,000	186,136,775	232,670,969
0.115	0.0946	0.1234	300,000,000	80,000,000	117,629,371	147,036,714
0.125	0.1234	0.1798	80,000,000	8,800,000	75,144,198	93,930,248
...	...	...	...	...	...	...
...	...	...	...	...	...	...
...	...	...	...	...	...	...
...	...	...	...	...	...	...
0.285	0.2599	0.2935	1,240,000	680,000	791,614	989,518
0.295	0.2935	0.3316	680,000	400,000	665,942	832,428
0.305	0.2935	0.3316	680,000	400,000	579,363	724,204
0.315	0.2935	0.3316	680,000	400,000	504,041	630,051
0.325	0.2935	0.3316	680,000	400,000	438,511	548,139
0.335	0.3316	0.3688	400,000	260,000	384,557	480,696
0.345	0.3316	0.3688	400,000	260,000	342,506	428,133

*severity trend from 1988 to 1998 = 1.250

EXHIBIT 11

PAGE 1

TABLE OF EXPECTED LOSS SIZE RANGE COMPARISON

Present Table			Proposed Table		
Expected Loss Group	Expected Loss Range		Expected Loss Group	Expected Loss Range	
80	6,922 –	7,773	80	7,795 –	8,670
79	7,774 –	8,690	79	8,671 –	9,646
78	8,691 –	9,681	78	9,647 –	10,645
77	9,682 –	10,747	77	10,646 –	11,720
76	10,748 –	11,891	76	11,721 –	12,904
75	11,892 –	13,130	75	12,905 –	14,180
74	13,131 –	14,452	74	14,181 –	15,525
73	14,453 –	15,878	73	15,526 –	16,996
72	15,879 –	17,406	72	16,997 –	18,609
71	17,407 –	19,042	71	18,610 –	20,314
70	19,043 –	20,802	70	20,315 –	22,158
69	20,803 –	22,679	69	22,159 –	24,168
68	22,680 –	24,696	68	24,169 –	26,204
67	24,697 –	26,849	67	26,205 –	28,304
66	26,850 –	29,162	66	28,305 –	30,573
65	29,163 –	31,635	65	30,574 –	33,021
64	31,636 –	34,280	64	33,022 –	35,665
63	34,281 –	37,114	63	35,666 –	38,519
62	37,115 –	40,149	62	38,520 –	41,603
61	40,150 –	43,404	61	41,604 –	44,933
60	43,405 –	46,884	60	44,934 –	48,540
59	46,885 –	50,612	59	48,541 –	52,483
58	50,613 –	54,610	58	52,484 –	56,666
57	54,611 –	58,894	57	56,667 –	61,055
56	58,895 –	63,490	56	61,056 –	65,784
55	63,491 –	68,426	55	65,785 –	70,879
54	68,427 –	73,720	54	70,880 –	76,640
53	73,721 –	79,406	53	76,641 –	82,891
52	79,407 –	85,521	52	82,892 –	89,654
51	85,522 –	92,100	51	89,655 –	96,966
50	92,101 –	99,181	50	96,967 –	104,636
49	99,182 –	106,809	49	104,637 –	112,895
48	106,810 –	115,032	48	112,896 –	121,865
47	115,033 –	123,912	47	121,866 –	132,583
46	123,913 –	133,498	46	132,584 –	144,243
45	133,499 –	143,873	45	144,244 –	156,928
44	143,874 –	155,101	44	156,929 –	171,488
43	155,102 –	167,271	43	171,489 –	187,645

EXHIBIT 11

PAGE 2

TABLE OF EXPECTED LOSS SIZE RANGE COMPARISON

Present Table			Proposed Table		
Expected Loss Group	Expected Loss Range		Expected Loss Group	Expected Loss Range	
42	167,272 –	180,485	42	187,646 –	205,325
41	180,486 –	194,841	41	205,326 –	226,345
40	194,842 –	210,468	40	226,346 –	250,134
39	210,469 –	227,507	39	250,135 –	276,423
38	227,508 –	246,785	38	276,424 –	305,474
37	246,786 –	283,076	37	305,475 –	339,621
36	283,077 –	325,233	36	339,622 –	381,318
35	325,234 –	374,326	35	381,319 –	428,133
34	374,327 –	431,669	34	428,134 –	480,696
33	431,670 –	498,861	33	480,697 –	548,139
32	498,862 –	577,847	32	548,140 –	630,051
31	577,848 –	671,049	31	630,052 –	724,204
30	671,050 –	781,446	30	724,205 –	832,428
29	781,447 –	912,772	29	832,429 –	989,518
28	912,773 –	1,069,714	28	989,519 –	1,183,249
27	1,069,715 –	1,258,177	27	1,183,250 –	1,414,910
26	1,258,178 –	1,485,737	26	1,414,911 –	1,744,291
25	1,485,738 –	1,762,082	25	1,744,292 –	2,219,661
24	1,762,083 –	2,099,838	24	2,219,662 –	2,824,583
23	2,099,839 –	2,515,497	23	2,824,584 –	3,609,321
22	2,515,498 –	3,030,945	22	3,609,322 –	4,618,468
21	3,030,946 –	3,675,490	21	4,618,469 –	5,909,766
20	3,675,491 –	4,488,912	20	5,909,767 –	7,562,105
19	4,488,913 –	5,525,974	19	7,562,106 –	9,676,428
18	5,525,975 –	6,863,311	18	9,676,429 –	13,273,220
17	6,863,312 –	8,609,855	17	13,273,221 –	19,630,986
16	8,609,856 –	10,923,744	16	19,630,987 –	29,034,073
15	10,923,745 –	14,039,278	15	29,034,074 –	42,941,163
14	14,039,279 –	18,312,631	14	42,941,164 –	63,509,638
13	18,312,632 –	24,300,443	13	63,509,639 –	93,930,248
12	24,300,444 –	32,901,239	12	93,930,249 –	147,036,714
11	32,901,240 –	45,622,243	11	147,036,715 –	232,670,969
10	45,622,244 –	65,106,001	10	232,670,970 –	368,178,659
9	65,106,002 –	96,243,920	9	368,178,660 –	& over
8	96,243,921 –	148,702,022			
7	148,702,023 –	243,230,605			
6	243,230,606 –	429,365,314			
5	429,365,315 –	& over			

EXHIBIT 12

Premium Impact of 1999 Table M for Retrospectively Rated Risks

Sample distribution of risks and plans

Premium Range	Risks	Average Standard Premium	Expected Loss Ratio (E)	Tax Multiplier (T)	Expense Ratio (e)	LCF (c)	Minimum Retro Prem (H)	Maximum Retro Prem (G)
\$25,001– 50,000	58	\$35,874	0.620	1.070	0.227	1.125	0.80	1.20
\$50,001–100,000	71	\$72,371	0.620	1.070	0.220	1.125	0.70	1.20
\$100,001–250,000	89	\$154,037	0.620	1.070	0.210	1.125	0.65	1.10
\$250,001–500,000	53	\$360,223	0.620	1.070	0.203	1.125	0.55	1.10
Over \$500,000	27	\$1,290,138	0.620	1.070	0.188	1.125	0.45	1.10
	298	\$251,187						

Calculation of the Premium Impact of Changes in Retro Parameters

	Calculation of current plan rating values								*Evaluation of plan under proposed change						
Average Standard Premium	(1) ELG	(2) $r_G - r_H$	(3) $X_H - X_G$	(4) r_G	(5) r_H	(6) X_G	(7) S_H	(8) B	(9) EXP(R)	(10) E^*	(11) ELG*	(12) X_G^*	(13) S_H^*	(14) EXP(R^*)	(15) (14)/(9)-1.0
\$35,874	69	0.54	0.142	0.81	0.27	0.724	0.136	0.560	0.907	0.620	69	0.7247	0.1367	0.907	0.0000
\$72,371	60	0.67	0.266	0.78	0.11	0.653	0.031	0.576	0.898	0.620	61	0.6604	0.0306	0.893	−0.0056
\$154,037	50	0.60	0.319	0.70	0.10	0.595	0.014	0.538	0.888	0.620	51	0.6003	0.0128	0.884	−0.0045
\$360,223	39	0.74	0.443	0.87	0.13	0.435	0.009	0.423	0.881	0.620	41	0.4528	0.0066	0.866	−0.0170
\$1,290,138	29	0.87	0.555	1.04	0.17	0.276	0.003	0.301	0.865	0.620	30	0.2861	0.0031	0.857	−0.0092
Average									0.877					0.868	−0.0103

(1) Expected Loss Group, based on present table; see Exhibit 11. For example (.620)(360,223) = 223,338, which is in Expected Loss Group 39.

(2) $r_G - r_H = (G - H)/cET$. See Gillam and Snader [2].

(3) $X_H - X_G = (e + E - H/T)/cE$. See Gillam and Snader [2].

(4)–(7) Solve for the set of entry ratios that match the desired differences of entry ratios in (2) and charges in (3), as described in Gillam and Snader [2].

(8) $B = e - (c-1)E + c(X_G - S_H)E$. See Gillam and Snader [2].

(9) Represents the expected retrospective premium that would result if the current Table M were a correct model of the loss process. Exp $(R) = T(B + cE(1 - X_G + S_H))$. See Gillam [4].

(10) Actual Expected Loss Ratio (for evaluating the new table, we assume premium is adequate).

(11) Expected Loss Group, based on proposed Table M; see Exhibit 11.

(12)–(13) Charge in Maximum and Savings at Minimum, as per columns (6) and (7), but based on the proposed Table M.

(14) As per column (9), but expected retrospective premium if the proposed Table M correctly models the loss process.

(15) The premium impact of not updating the table is determined using the ratio of column (14) to column (9) minus unity.