ACTUARIAL DOCUMENTATION OF

MULTIPLE PERIL CROP INSURANCE

RATEMAKING PROCEDURES

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INTRODUCTION

Milliman & Robertson, Inc. (M&R) was engaged by the Risk Management Agency (RMA) of the U.S. Department of Agriculture (USDA) to provide documentation of the current Multiple Peril Crop Insurance (MPCI) ratemaking procedures along with references and a discussion of the actuarial basis for each of the key steps in the process. Actuarial documentation helps to ensure the integrity of the process and provides an authoritative source of reference of actuarial problems.

Our report focuses on the development of rates for the Actual Production History (APH) program. While many of the concepts presented herein apply also in the development of rates for other coverages (for example, Crop Revenue Coverage), the latter are not discussed in this report. This report provides a description of each key step of the rate calculation along with illustrative examples and a discussion of the actuarial justification for the calculation.

RATEMAKING – ACTUARIAL CONCEPTS

The development of rates for property and casualty insurance companies has long been the province of Casualty Actuaries. There is a vast body of literature that has been developed on ratemaking topics, much of it is incorporated into publications of the Casualty Actuarial Society ("CAS"). In this report, we will refer to two documents addressing actuarial ratemaking concepts. The first document is the *Statement of Principles Regarding Property*

and Casualty Insurance Ratemaking ("Statement of Principles"). The purpose of this document (which was developed by the CAS Committee on Principles of Ratemaking and adopted by the CAS Board of Directors in 1988) is to "identify and describe principles applicable to the determination and review of property and casualty insurance rates". A copy of the *Statement of Principles* is attached. The second document is a textbook, developed by the CAS Textbook Steering Committee in 1989, titled *Foundations of Casualty Actuarial Science (Foundations).* The text "is intended as an introduction to casualty actuarial concepts and practices." *Foundations* has one chapter dedicated to ratemaking. For many of the key steps in the MPCI ratemaking process, we will refer to these two documents to identify the actuarial basis for the calculation.

It is important to understand that there is no single ratemaking approach that will apply to all insurance coverages. *Foundations* states that "...manual rates are estimates of average costs based upon a combination of statistical methods and professional judgment." For MPCI, as is the case for most insurance coverages, the ratemaking process has evolved over time as information and research have become available. For each of the steps in the process, there may be alternative approaches that could be used and which could produce reasonable results. It is not our intent to try to identify all possible alternatives to the current approach. However, in many cases we discuss alternatives that we believe may be appropriate.

A third reference, which provides additional background and discussion of MPCI ratemaking procedures, is the paper *"Ratemaking Procedures for Multiple Peril Crop Insurance",* which

was published in the winter 2000 edition of the CAS Forum. (This paper can be downloaded from the CAS website, www.casact.org.)

M&R has been providing research to the FCIC/RMA since 1983. We have attached a bibliography of reports that we have provided.

DETERMINATION OF EXPOSURE, LOSS, AND PREMIUM

Before discussing the ratemaking process, we introduce two important values that are used in the MPCI rate development. These values are liability and indemnity.

Liability is a measure of the insurer's exposure to loss for a given producer or group of producers. Liability represents the total insured value of the crop, calculated as:

Liability =

Acres planted
x Expected Yield (called APH Yield)
x Selected Coverage Level
x Base Price
x Price Election Percentage.

Indemnity is the amount paid under MPCI coverage for a producer suffering a covered loss. Indemnity is paid when the value of production is less than the liability purchased. In this

case, the amount of indemnity paid is equal to the liability minus the value of the production where the latter is calculated as:

Value of Production =

Acres Planted
x Actual Yield
x Base Price
x Price Election Percentage.

The premium paid by a producer is derived as follows:

Premium =

Liability
x Rate
x Adjustment Factor.

The ultimate objective of the ratemaking process is to derive the premium rate used in the above formula. We discuss the derivation in the next section.

MPCI RATEMAKING OVERVIEW

The *Statement of Principles* identifies a fundamental principle of insurance ratemaking as: "A rate is an estimate of the expected value of future costs." Typically, the largest component of the rate is the provision for losses. While there are other, non-trivial considerations in rate

development, most of the actuarial foundations of ratemaking are intended to provide a framework for estimating the expected loss component of the rate.

For MPCI rates, other expenses and capital costs are provided for in separate agreements. Therefore, the ratemaking procedure deals strictly with deriving the expected loss component. This component is represented by the Loss Cost Ratio (LCR), which is derived by dividing indemnity by liability. The LCR is a measure of loss per unit of exposure. Thus, one of the objectives of MPCI ratemaking is to derive LCR's that are representative of the expected losses for a given unit of exposure.

Because different crops are subject to different perils and therefore varying loss costs, the MPCI procedure establishes rates for each crop separately. It is rare that a single insured, for any insurance coverage, will be sufficiently large such that expected losses can be derived solely from the insured's own loss history. Thus, it is common and appropriate to consider the aggregate experience of a group of similar risks in developing rates. For MPCI the aggregation is done geographically. Rates are developed by geographic area, usually county. Thus, for each crop, the MPCI ratemaking process typically derives LCR's (and consequently rates) by county. There are other determinants used to tailor the rate to an individual producer, depending on utilization of certain farming practices. These will be discussed in a later section.

The MPCI ratemaking procedure can be broken into five steps:

1. Adjusting the Loss (Indemnity) and Exposure (Liability) to a common coverage level;
2. Derivation of County Unloaded Base Rates;
3. Base Rate Loading;
4. Capping Rate Changes; and
5. Updating the Type/Practice and Group factors.

In the illustration and discussion that follows, we will use Adams County, Illinois actual production history (APH) corn data as an example for purposes of describing and performing actuarial calculations. We will also discuss and consider the actuarial principles underlying each of the significant steps.

COUNTY RATING – DISCUSSION

As noted above, MPCI rates are most commonly developed by county. County rating is an historical element of the MPCI ratemaking process; federal crop insurance evolved as a county based program. As will be discussed later in this report, county loss costs are often unstable, and the ratemaking process includes several steps intended to smooth some of the fluctuation. This could suggest that an alternative geographical rating unit, larger than county, might be considered.

In addition to its historical basis, however, there are other reasons for maintaining the county as the basic ratemaking unit. In the *Foundations* text, chapter 5 discusses risk classification

and identifies several criteria for selecting rating variables. These include (pages 235-244) Actuarial Criteria, Operational Criteria, Social Criteria and Legal Criteria. The variability in county loss costs may suggest that alternative rating units might better satisfy the actuarial criteria. However, county rating has certain operational aspects that may be more difficult to achieve with other units. *Foundations* identifies operational criteria such as objectivity, ease of administration, and exclusive and exhaustive, all of which are met by the use of county. In addition, social criteria would also support county rating. In addition to being historically accepted, the county is a benchmark for many other agricultural activities. For example, farm programs are often administered by county and crop yields are generally reported by county (and used in MPCI rating for producers without an actual production history). Finally, we understand that fairly recent attempts to depart from county rating were not well received by field offices and insurance providers.

We would note that, while the classification unit is the county, as will be illustrated in later sections, information from broader units are used in deriving the county rates.

In our opinion, there are other areas of the ratemaking process that may lend themselves to more fruitful research than alternatives to county rating.

ADJUSTING LOSS AND EXPOSURE TO A COMMON COVERAGE LEVEL

MPCI is offered at various coverage levels, generally ranging from 50% to 75%. In order to make the greatest use of the historical data; one of the first steps in the ratemaking process is

to adjust the data to a common coverage level. With this adjustment, liability and indemnity data of producers with different coverage levels can be combined to develop the rates. For most crops, data is adjusted to the most commonly purchased coverage level of 65%.

For coverage levels other than 65%, indemnity and liability are adjusted to reflect the values that would have been reported had the coverage been purchased at the 65% level. (As will be discussed below, the rates for the other coverage levels are derived from the rates developed at the 65% level.)

Adjusting the liability is fairly simple. For any specific coverage level, we take the aggregate liability at that coverage level and multiply by the ratio of the common coverage level to that specific coverage level. For example, to adjust the liability from a 75% coverage level to a common coverage level of 65%, we would multiply all liability at the 75% coverage level by the ratio 0.65/0.75. Exhibit 1 shows that this produces the correct value.

Two separate cases of adjusting indemnity need to be considered; adjusting the higher coverage levels down to the 65% coverage level (Case 1), or adjusting the lower coverage levels up to the 65% coverage level (Case 2). Indemnity amounts obtained at the 65% coverage level need no adjustment.

Case 1 – Adjusting indemnity from a higher coverage level down to the 65% coverage level

As described above, indemnity is paid when the value of production is less than the liability.

RMA defines production ratio as the ratio of the actual value of production to the liability. Thus, indemnity is paid only when the production ratio is less than the coverage level. Because we are adjusting to the 65% coverage level, there will be no indemnity at this coverage level when production ratios are greater than 65%. Therefore, for Case 1 we need only to consider the indemnity related to production ratios less than 65%.

For production ratios less than the common coverage level of 65%, every dollar decrease in coverage (liability) would have reduced the amount indemnified by one dollar. For example, suppose a producer had purchased a 75% coverage level that implied $100 of liability. If this producer's actual production was $60, the indemnification would be $40. If that producer had purchased a coverage level of 65%, the liability would have been $87 = $100 * (0.65/0.75) and the indemnification would be $27 = $87 - $60. In going from the 75% coverage level to the 65% coverage level, both the liability and indemnity went down by the same dollar amount, $20.

Exhibit 2 presents a hypothetical example which illustrates that, for all production ratios less than 65%, the adjusted indemnity (in going from 75% coverage to 65% coverage) is equal to the unadjusted indemnity minus the reduction in liability. For production ratios exceeding 65%, the adjusted indemnity will be $0. The RMA adjustment process is based on the above relationships.

Case 2 – Adjusting from a lower coverage level up to the common coverage level

Case 2 is more difficult since we are increasing indemnity to the amount that would have applied had a higher coverage level been chosen. Case 2 has two components. The first is for indemnity related to production ratios up to the lower (50%) coverage level. This adjustment is relatively straightforward, and analogous to the Case 1 example above. Specifically, for production ratios up to 50%, the adjusted indemnity is equal to the unadjusted indemnity plus the increase in liability. This is illustrated on Exhibit 3.

Exhibit 3 also displays the adjusted indemnity for production ratios above 50%. However, since no indemnification is made for these production ratios at the 50% coverage levels, RMA does not actually capture the production value information required to make this adjustment. In actual RMA data, the production value column of Exhibit 3 would be blank for production ratios above 50%. Therefore, these indemnity adjustments need to be approximated.

RMA's current approach to handling this problem is to develop minimum and maximum bounds to the adjusted indemnity and interpolating between the two. The minimum adjustment assumes that there are no production ratios between 50% and 65%. The minimum is then derived by adding the liability adjustment calculated based only on the liability related to production ratios less than 50% to the unadjusted indemnity. We know that we would have had at least this much indemnity at the higher common coverage level, the question is how much more would result from production ratios of 50% to 65% (for which no indemnification was paid and therefore no yield information collected). For these production ratios, the

maximum adjustment would occur if all non-indemnified production ratios were at 50%. Thus, to derive the maximum adjustment we would calculate the total liability adjustment regardless of production ratio (since we are assuming all production ratios between 50% and 65% are at 50%). We would then add this adjustment to the unadjusted indemnity to get the maximum adjusted indemnity.

In order to interpolate between the maximum and minimum indemnity, the indemnity is totalled over all production ratios less than or equal to the specific coverage level that we are adjusting from. The liability is totalled in the same way and the LCR is calculated. This ratio is applied to the liability that was not subject to a loss under the lower coverage level (i.e. liability related to production ratios greater than 50%) to determine the related additional indemnity at the higher coverage level. Adding this amount to the minimum indemnity approximates the adjusted liability. This approximation of the adjusted indemnity is then subject to the maximum bound as determined above. Exhibit 4 illustrates the indemnity adjustment using this approximation technique.

The following table illustrates the results of the adjustments for Adams County corn. Columns 3 and 4 are unadjusted data. Columns 6 and 7 are adjusted data. Other columns are not used in the calculation, but are included for illustration.

TABLE 1: ADJUSTED INDEMNITY Adams County Illinois							
1	2	3	4	5	6	7	8
Crop Year	Net Acres	Indemnity	Liability	LCR	Average Cov Lvl.	Adjusted Indemnity	Adjusted Liability
1975	11,508.00	25,867	954,368	0.0271	0.6500	25,867	954,368
1976	11,664.00	83,230	1,133,267	0.0734	0.6500	83,230	1,133,267
1977	10,822.00	196,559	1,104,678	0.1779	0.6500	196,559	1,104,678
1978	7,853.00	1,516	776,273	0.0020	0.6500	1,516	776,273
1979	7,270.00	1,503	825,168	0.0018	0.6500	1,503	825,168
1980	8,179.78	71,952	979,716	0.0734	0.6778	57,361	933,501
1981	9,569.74	44,635	1,368,243	0.0326	0.7171	36,610	1,232,335
1982	8,247.01	29,686	1,193,112	0.0249	0.7140	21,332	1,084,981
1983	5,121.45	440,321	795,481	0.5535	0.7230	370,530	712,218
1984	20,536.93	307,177	3,941,985	0.0779	0.7341	189,261	3,490,799
1985	23,360.27	22,324	4,317,435	0.0052	0.7192	13,674	3,897,513
1986	27,753.28	31,743	4,330,324	0.0073	0.7065	19,193	3,979,198
1987	24,854.77	22,045	3,460,542	0.0064	0.6917	15,407	3,250,849
1988	25,027.35	458,200	3,547,678	0.1292	0.6882	361,489	3,350,736
1989	44,661.30	944,430	7,555,038	0.1250	0.6927	742,506	7,054,559
1990	41,182.34	84,176	6,192,243	0.0136	0.6885	64,990	5,809,174
1991	32,770.97	112,740	5,115,210	0.0220	0.6893	90,655	4,819,363
1992	37,440.26	54,667	6,066,375	0.0090	0.6905	28,889	5,714,961
1993	32,300.36	687,775	5,452,763	0.1261	0.6852	658,436	5,177,813
1994	42,541.45	5,944	7,599,101	0.0008	0.6698	4,508	7,352,287
1995	42,110.51	531,576	6,460,633	0.0823	0.6603	526,503	6,362,352
1996	54,397.36	100,447	11,457,322	0.0088	0.6551	105,439	11,372,363
1997	39,719.70	27,304	7,741,718	0.0035	0.6472	23,266	7,778,276
Summary	568,891.83	4,285,817	92,368,673	0.0689	0.6826	3,638,724	88,167,032

Actuarial Justification

The concept of adjusting exposures and losses to a common coverage level is valid and appropriate. Without adjustment, combining the data for different coverage levels would produce rates that were not representative of any single coverage level. Rates would reflect the past mixture of the various coverage levels and would not be appropriate in the future if the distribution of coverage levels changes.

An alternative would be to treat each coverage level separately, and develop rates for each. This may be appropriate if there are differences in loss experience for producers who select different coverage levels. For example, if producers who have better experience insure with lower coverage levels in order to save on premiums, and producers with poor experience insure to higher levels of coverage in order to protect against persistent losses, loss cost ratios may vary by coverage level. On the other hand, segregating the data by coverage level can result in less stability and predictability of expected losses due to the greater statistical variation. In addition, the consideration of differences in expected losses between coverage levels is considered in the coverage level relativities, which are discussed later in this report.

There are two actuarial concepts involved here: homogeneity and credibility. Homogeneity refers to the degree to which data has been segregated into similar groupings. The *Statement of Principles* discusses homogeneity as follows: "Ratemaking accuracy often is improved by subdividing experience into groups exhibiting similar characteristics... subdividing or combining the data so as to minimize the distorting effects of operational or procedural changes should be fully explored" (page 7).

Credibility is discussed as follows, "Credibility is a measure of the predictive value that the actuary attaches to a particular body of data. Credibility is increased by making groupings more homogeneous or by increasing the size of the group analyzed." (page 8).

The two criteria for increasing credibility often conflict. Generally, the data can be refined into increasingly homogeneous groups, but as it is refined there is less data in each separate group. This results in greater statistical variation, and hence a lesser degree of confidence in the predictive value of the data.

Adjusting the data to a common coverage level allows the Risk Management Agency (RMA) to utilize as large a base as possible while also maintaining the homogeneity of the data. In our opinion, the concept utilized by RMA is actuarially sound.

The Indemnity Coverage Level Adjustment was discussed in the M&R report titled "Federal Crop Insurance Corporation Ratemaking Overview" dated June 14, 1996. In that report we discussed possible alternatives to that adjustment approach. The current RMA approach differs from that used at the time of the earlier study. However, it still requires a fairly significant approximation in going from a lower to higher coverage level. Although we believe this approximation to be reasonable given the current availability of data, we continue to recommend additional analysis to determine feasible alternatives. As stated in the June 14, 1996 report, two possible approaches would be to convert all data to a 50% coverage level or to examine a distribution of yield data to evaluate an approximation approach.

DERIVATION OF COUNTY UNLOADED BASE RATES

After adjusting the data to a common coverage level, the next step is to derive the LCR for each county. In the table below, Columns 2 and 3 display the adjusted indemnity and liability

data from the previous section.

TABLE 2: LOSS COST RATIOS Adams County Illinois			
1	**2**	**3**	**4**
Crop Year	**Adjusted Indemnity**	**Adjusted Liability**	**Adjusted LCR**
1975	25,867	954,368	0.0271
1976	83,230	1,133,267	0.0734
1977	196,559	1,104,678	0.1779
1978	1,516	776,273	0.0020
1979	1,503	825,168	0.0018
1980	57,361	933,501	0.0614
1981	36,610	1,232,335	0.0297
1982	21,332	1,084,981	0.0197
1983	370,530	712,218	0.5202
1984	189,261	3,490,799	0.0542
1985	13,674	3,897,513	0.0035
1986	19,193	3,979,198	0.0048
1987	15,407	3,250,849	0.0047
1988	361,489	3,350,736	0.1079
1989	742,506	7,054,559	0.1053
1990	64,990	5,809,174	0.0112
1991	90,655	4,819,363	0.0188
1992	28,889	5,714,961	0.0051
1993	658,436	5,177,813	0.1272
1994	4,508	7,352,287	0.0006
1995	526,503	6,362,352	0.0828
1996	105,439	11,372,363	0.0093
1997	23,266	7,778,276	0.0030
Summary	3,638,724	88,167,032	0.0631

Column 4 (Adjusted LCR) is the ratio of the adjusted indemnity to adjusted liability. For each year, this ratio reflects the percentage of liability that would have been paid to producers had they all purchased 65% coverage.

A. Number Of Years Used In Loss Cost Projection

One of the first steps in any ratemaking process is to specify the number of years that will be used in deriving the rates. The MPCI process uses years 1975 and subsequent.

Actuarial Justification

Two of the more significant considerations in the determination of number of years are:

1) Year-to-year variability in loss costs;
2) Long term trends, or changes in the underlying exposures or costs.

The *Foundations* text discusses the length of the experience period as follows. "The determination of the loss experience period to be used in the manual ratemaking process involves a combination of statistical and judgmental elements. There is a natural preference for using the most recent incurred loss experience since it is generally the most representative of the current situation... Where the business involved is subject to catastrophe losses...the experience period must be representative of the average catastrophe incidence. Finally, the experience period must have sufficient loss experience that the resulting indications will have statistical significance or credibility."(Page 41). In more general terms, the Statement of Principles asserts, "This experience is relevant if it provides a basis for developing a reasonable indication of the future." (page 7).

In examining Table 2, we observe that the loss costs exhibit considerable variability over the history presented. In addition, we observe that the loss costs do not appear to exhibit a long-term trend. This may be expected since the general inflation component of loss (indemnity) is directly related to the exposure base (liability). Because they are directly related, their dollar cost trends should be the same and should therefore produce LCR's with no dollar cost trend. Any residual trend would relate to changes in farming procedures or other changes that affect yield variability.

In considering the MPCI exposure and coverage, we believe it is important to consider that weather patterns and crop conditions tend to be cyclical, such that several good years of experience can be followed by several poor years. As such, a long-term average may be needed to adequately capture the loss history. In a 1983 study, performed for the FCIC, M&R evaluated the length of the experience period. That study concluded "…. the FCIC should continue to use all available past history in the ratemaking process with possibly greater weight given to the more recent years." At the time of the 1983 study, each year was given equal weight in the determination of the county average. The suggestion of greater weight to more recent years was made because of concerns about the impact of amendments to the FCIC Act of 1980, and the possibility that the pre-1980 experience may not be relevant.

An alternative to equal weighting would be a liability weighted LCR. In periods of increased participation (as in recent years), this would have the effect of giving more weight to recent years, as the M&R study suggested. However, an argument could be made that each year's

results (i.e., LCR) reflects a sample value which is used to estimate the mean value. In this context, the sample value might not be influenced by the participation volume, and therefore equal weighting is appropriate. The issue was addressed again by M&R in 1995 ("Multiple Peril Crop Insurance Ratemaking Experience Period", dated August 25, 1995), and in 1996 ("Federal Crop Insurance Company Ratemaking Overview", referred to above). In the latter report we recommended no changes to equal weighting of all years.

B. Excess Loss Adjustment

While the long-term average (shown in the column 4 summary row of Table 2) is 0.0631, the average is adversely affected by a few years with much higher than average LCRs. RMA has developed a procedure that is intended to reduce the impact that a single year will have on the average loss cost of each county. Under this procedure, the adjusted average LCR for any single year is capped at the 80^{th} percentile LCR of all years. The following table shows the uncapped and the capped LCR's.

TABLE 3: CAPPED LCRs AND CAT INDEMNITY Adams County Illinois			
1	**2**	**3**	**4**
Crop Year	**Adjusted LCR**	**Capped LCR**	**Excess Indemnity**
1975	0.0271	0.0271	0
1976	0.0734	0.0734	0
1977	0.1779	0.0918	95,113
1978	0.0020	0.0020	0
1979	0.0018	0.0018	0
1980	0.0614	0.0614	0
1981	0.0297	0.0297	0
1982	0.0197	0.0197	0
1983	0.5202	0.0918	305,114
1984	0.0542	0.0542	0
1985	0.0035	0.0035	0
1986	0.0048	0.0048	0
1987	0.0047	0.0047	0
1988	0.1079	0.0918	53,947
1989	0.1053	0.0918	95,237
1990	0.0112	0.0112	0
1991	0.0188	0.0188	0
1992	0.0051	0.0051	0
1993	0.1272	0.0918	183,295
1994	0.0006	0.0006	0
1995	0.0828	0.0828	0
1996	0.0093	0.0093	0
1997	0.0030	0.0030	0
Summary	0.0631	0.0379	732,706

In Table 3, the Capped LCR (Column 3) is calculated by linear interpolation to the 80th percentile of the Adjusted LCR. In this case there are 23 years of data, so we need to interpolate between the 18th and 19th highest Adjusted LCR's. The interpolated value (80th percentile) is 0.0918. For each year, the Capped LCR is the minimum of the Adjusted LCR and the 80th percentile (or 0.0918). Column 4, identified as Excess Indemnity, is the amount of indemnity that is excluded from the capped LCR. For example, Crop Year 1977 Excess

Indemnity = (0.1779 – 0.0918) x 1,104,676 = 95,113. This will be used later in the ratemaking process.

Actuarial Justification

The adverse affect of a single year, or several years, is not uncommon for a property coverage, in particular one in which weather can affect loss experience. The *Statement of Principles* states, "Consideration should be given to the impact of catastrophes on the experience and procedures should be developed to include an allowance for the catastrophe exposure in the rate" (page 8). This step removes those losses that are identified as excess from the county experience. It will be seen later that the excess losses are built back into the rates by spreading them over a broader base. This is an appropriate concept.

The 80th percentile originated with M&R's 1983 report to the FCIC (Task 3, "Analysis of Catastrophe Provisions"). The MPCI catastrophe procedure was revisited by M&R in September, 1995 ("Analysis and Recommendations for FCIC Catastrophe Procedure"). In that study, we supported the general concept of the excess losses procedure, including the use of a percentile threshold for identifying excess losses. We recommended, however, that the 80% threshold may be too invasive for some crops/states, and that a threshold that varies by state and crop should be considered.

C. *Credibility*

As discussed above, credibility is a measure of the predictive value of the loss experience.

Generally, the greater the volume and homogeneity of the data, the greater the credibility. MPCI has a process whereby each county's capped LCR is assigned credibility based on the number of policies indemnified in the experience period. Credibility values range from 0% to 60% based on the following formula:

$$Z \equiv \sqrt{\frac{Min(P_1,271)}{271}} x 0.60$$

where P_1 = Policies indemnified

(A county with 271 or more policies indemnified will receive the maximum credibility of 60%). The remaining amount (100% minus county credibility) is assigned to what is referred to as the simple circle LCR.

The Simple Circle LCR is a weighted average of surrounding counties' Simple County LCR's (weighted by each county's Total Adjusted Liability). In other words, it is the sum of the product of Total Adjusted Liability and Simple County LCR divided by the sum of Total Adjusted Liability. In mathematical notation:

$$\frac{\sum_{Surrouding\_Counties} (County\_Total\_Adjusted\_Liability) * (Simple\_County\_LCR)}{\sum_{Surrounding\_Counties} (County\_Total\_Adjusted\_Liability)}$$

The following displays an example of the calculation of the Simple Circle LCR for Adams County Illinois:

TABLE 4: SIMPLE CIRCLE LCR Adams County Illinois			
1	**2**	**3**	**4**
Surrounding County Name	**Adjusted Liability**	**Simple County LCR**	**(2) x (3)**
Brown	33,087,483	0.0336	1,111,596
Hancock	121,904,576	0.0236	2,882,778
Pike	35,882,331	0.0251	902,051
Schuyler	23,459,717	0.0459	1,077,311
Totals	214,334,107		5,973,735
Simple Circle LCR [Total Column (4) / Total Column (2)]:			0.0279

The County Unloaded Rate is calculated as Z% of the Simple County LCR plus (100%-Z) of the Simple Circle LCR. For Adams County, this is as follows:

TABLE 5: CALCULATION OF COUNTY UNLOADED RATE			
1	**2**	**3**	**4**
	LCR	**Weight**	**(2) * (3)**
Simple County	0.0379	60%	0.0227
Simple Circle	0.0279	40%	0.0112
County Unloaded Rate			0.0339

Actuarial Justification

Credibility is one of the most complex actuarial concepts. It is sufficiently important to command a full chapter in the *Foundations* text. As noted earlier, credibility is a measure of predictive value attaching to a specific item (in this case, the county LCR). The credibility process is the weighting together of different estimates to come up with a combined estimate. The credibility formula, in general, is:

$$I = Z \times I_1 + (100\% - Z) \times I_2$$

In the above formula : I is the item being estimated (e.g., county LCR);

I_1 is an indication from that item's own experience (e.g., Simple County Average LCR);

Z is the credibility attached to I(1)

I_2 is an alternative indication (e.g., Simple Circle LCR)

Credibility (Z) can range from 100% (full credibility; full weight) to 0% (no credibility; no weight). For an item with credibility less than 100%, it is important to identify an appropriate item to receive the remaining weight. The *Foundations* text states that "The complement of credibility (100% - Z) should be applied to an indication which can be expected to reflect consistent trends in the same general way as the underlying data."

As noted above, the MPCI procedure assigns maximum credibility if a county has 271 claims (policies indemnified). The threshold of 271 claims was developed by a former Assistant Manager for the Actuarial and Underwriting Services division of the USDA Economic Research Service (ERS). As of this writing, the specific documentation for the 271 claim threshold is not available, however it appears to be taken from one of the seminal papers on credibility theory in the Casualty Actuarial Society literature (*An Introduction to Credibility Theory)*.

The number of claims is a common measure of credibility for property/casualty insurance ratemaking. Number of claims may be considered analogous to number of observations of data in a sample in estimating a particular statistic (e.g., LCR). However, there are certain characteristics of multiple peril crop insurance that suggest that number of claims may not be the best measure of credibility. For example, the credibility formula will result in greater credibility being assigned to a county in a state with high average loss costs (and consequently a greater claim frequency) than in a state with low average loss costs. At a minimum, the threshold for maximum credibility (271 claims) may need to vary, by state or region, to reflect the expected claim frequency.

It is clear that the MPCI procedure utilizes the formula above for Z, with all counties assigned credibility (Z) of up to 60%. The complement of credibility (100%-Z) is assigned to the Simple Circle LCR. We would expect the surrounding counties to have consistent trends with those of the central county, so this measure meets the general requirement presented in the *Foundations* discussion above. Thus, in general the approach used in the MPCI process is actuarially supported. Refinements might consider varying the weights of surrounding counties based on comparative soil or climatological characteristics.

Based on the above discussion, we believe that credibility is an area that may warrant additional study by RMA.

BASE RATE LOADING

The LCR derived above for Adams County (0.0339) represents an estimate of the expected capped loss cost ratio for the forthcoming year. Several adjustments are required to derive the base rate. These include: Disaster Reserve Factor

State Excess Load

Prevented Planting Load

Unit Division Load

An example is given in the following table for a sample of Illinois counties:

TABLE 6: IMPLIED BASE RATES

1	2	3	4	5	6	7	8
State	**County**	**Simple County LCR**	**Simple Circle LCR**	**County Unloaded Rate**	**State Excess Load**	**Prevented Planting Load**	**Implied Base Rate [(5)/.88+(6)+(7)]/.9**
Illinois	Adams	0.0379	0.0279	0.0339	0.0127	0.0040	0.0614
Illinois	Alexander	0.1436	0.0569	0.1089	0.0127	0.0060	0.1583
Illinois	Bond	0.0479	0.0268	0.0395	0.0127	0.0040	0.0684
Illinois	Boone	0.0161	0.0131	0.0149	0.0127	0.0060	0.0396
Illinois	Brown	0.0336	0.0299	0.0321	0.0127	0.0040	0.0591
Illinois	Bureau	0.0055	0.0098	0.0072	0.0127	0.0040	0.0276
Illinois	Calhoun	0.0426	0.0211	0.0340	0.0127	0.0040	0.0615

Each of these adjustments will be discussed in more detail below.

A. Disaster Reserve Factor

The first step in going from the County Unloaded Rate to the Implied Base Rate is to divide

the unloaded rate by the Disaster Reserve Factor (0.88). This reserve factor is intended to meet the Congressional requirement that rates be adequate to pay expected losses and to build a reasonable reserve.

Actuarial Justification

Actuarial procedures often incorporate a risk load or contingency load in order to build in an additional margin of protection against future adverse experience. The *Statement of Principles* states, "The rate should include a charge for the risk of random variation from the expected costs." In Table 3 it can be seen that even after removing the extreme portions of the historical loss cost ratios, the annual LCR's may vary significantly from the long-term average of 0.0379. There is no single approach that will produce an appropriate risk margin in all circumstances. Factors that need to be considered include: variability in loss costs from year to year, accumulated funds that have been earmarked to pay claims if indemnified losses exceed premium revenues, and availability of funds from other sources to pay claims should the accumulated funds be depleted.

While we have not evaluated the reserve factor, we understand that it was based on assumptions relating to the probability distribution of national crop insurance losses. RMA management has attributed the reserve factor to a former Assistant Manager for Actuarial and Underwriting Services, but appropriate documentation does not currently exist.

In light of the variability of MPCI losses, we believe it is prudent and appropriate to include a risk load.

B. State Excess Load

The next step in loading the base rates consists of calculating the state excess. The State Excess Load adds a provision for the Excess Indemnity excluded from the loss cost in the unloaded rate calculation. The following table summarizes the state excess calculation for Illinois:

TABLE 7: STATE EXCESS				
1	**2**	**3**	**4**	**5**
State	**Adjusted Liability**	**Excess Indemnity**	**Implied State Excess (3) / (2)**	**State Excess Min{Max [(4),0.01],0.05}**
Illinois	7,575,001,361	96,286,560	0.0127	0.0127

Adjusted liability and cat indemnity amounts are totaled by state by summing across all counties (e.g., the adjusted liability for IL includes 88,167,032 from Adams county; the Excess Indemnity includes 732,706 from Adams County), "Implied State Excess" is calculated as Excess Indemnity divided by Adjusted Liability. "State Excess" is then calculated by limiting the state excess ratio to a maximum of 5% (capping) or a minimum of 1% (cupping). Any state excess above the 5% cap is distributed back to each county from which the excess came.

Actuarial Justification

The Excess Indemnity for each county is essentially pooled for the entire state and then spread back evenly to each county. As noted earlier, the actuarial justification for the capping process is that extreme LCR's are generally due to catastrophic events and as such are infrequent, lack statistical credibility, and may not be reflective of the county's expected value. Since they have been removed from the county experience, it is appropriate to add them in at a broader level. The State Excess calculation accomplishes this.

The imposition of capping on the excess factor is somewhat inconsistent with the general premise that excess losses are random and not predictable at the county level. The capping process essentially takes the most extreme amounts (i.e., those causing the state factor to exceed 5%) and "gives" them back to the county. It isn't clear that this step is necessary.

In M&R's 1995 analysis of the Catastrophe Procedure, we discussed the additive approach used by the FCIC, that is, the state excess is added to each county's LCR. This can result in a large disparity in the percentage of the rate that represents the catastrophe component, and possibly an inequitable shift of catastrophe exposure to lower loss cost areas. In that report, we recommended a blended approach to reflect the state excess, with a portion added directly to the loss cost (present approach) and the remainder incorporated proportionately.

We also suggested consideration be given to pooling a portion of the catastrophe loss on a nationwide level. We recognize that there may be public policy implications that

preclude this.

C. Prevented Planting Load

The Prevented Planting Load adds a provision for losses due to crops never planted because of external factors "which are not directly related to yield loss."

Actuarial Justification

The prevented planting loss data is not included in the data underlying the rates. Nevertheless, since prevented planting is an indemnifiable event, the rates should include a provision for this type of loss, so the concept of the adjustment is appropriate.

The prevented planting load is based on RMA studies of the effect of prevented planting. We have not reviewed the underlying calculations.

D. Unit Division Load

The Unit Division Load takes into account the fact that indemnity is not computed for an entire farm, but rather for each division of a farm. For example, if a farm is divided into four equal segments where one segment had zero percent production and the other three had 100% production, the producer would receive indemnity for the unproductive segment at a 75% coverage level, whereas, if the farm was insured as a whole, there would be no indemnity at the 75% coverage level.

Actuarial Justification

Maintaining the indemnity data separately by unit or field, as would be necessary to avoid the Unit Division Load correction factor, would probably be more accurate but also more cumbersome and less cost efficient. It is often necessary to balance the benefits of more accurate results and the costs of obtaining those results. We believe the procedure of deriving rate indications based on data at the field level instead of the field unit level is a reasonable simplification as long as the adequacy of the Unit Division load is monitored.

DETERMINING CAPPED RATE CHANGES

A. Initial Rate Changes

The implied base rates calculated above are compared to the current base rates to get initial rate changes by county. An example of these rate changes is displayed in the table below for a sample of Illinois counties:

TABLE 8: RATE CHANGES

1	2	3	4	5	6
State	**County**	**Implied Base Rate (From above)**	**Current Base Rate**	**Initial Rate Change [(3)/(4)-1]**	**Capped and Cupped**
Illinois	Adams	0.0614	0.0730	-15.9%	-5.0%
Illinois	Alexander	0.1583	0.1100	43.9%	10.0%
Illinois	Bond	0.0684	0.0620	10.3%	10.0%
Illinois	Boone	0.0396	0.0480	-17.5%	-5.0%
Illinois	Brown	0.0591	0.0680	-13.0%	-5.0%
Illinois	Bureau	0.0276	0.0370	-25.3%	-5.0%
Illinois	Calhoun	0.0615	0.0690	-10.9%	-5.0%

B. Capped Rate Changes

Although rate increases are limited to 20% by federal law, in recent years the initial rate changes, as shown, have been capped at 10% and cupped at 5%.

Actuarial Justification

It is not uncommon for rates to be limited to specified increases or decreases. This is addressed in the *Foundations* text, as follows: "Occasionally, due to regulatory requirements or marketing considerations, it is necessary that individual rate changes be limited to a maximum increase or decrease." For MPCI, the imposition of a limit (cap or cup) may be a public policy consideration, to stabilize premiums for producers from year to year. It may also be a reflection of the fact that ratemaking is an imprecise process; even with the long-term averaging, and the application of catastrophe and credibility procedures, rates can vary significantly from one valuation to the next. The use of limitation procedures is an accepted approach.

However, when rates for individual classes (e.g., county) are limited to a specified increase or decrease, there is a potential that the resulting overall rate level (e.g., state) may be too low or too high. It is common for a final step in the process to be the incorporation of an "off-balance" factor, to adjust for the effects of capping. The process is similar to that used in building back the catastrophe losses. We would recommend that RMA incorporate a final off-balance adjustment in the rates.

TYPE / PRACTICE AND GROUP FACTORS

The rates developed to this point have used data aggregated for all types of farming practices. In addition, as noted above the rates reflect the 65% coverage level. Finally, the rates reflect those for producers with a long-term average yield similar to the average yield for Adams County. Each of these items (practice type, coverage level, and average yield) can affect a producer's expected indemnification and, consequently, needs to be reflected in the individual producer's rates.

A. *Practice Factors*

Practice factors reflect the fact that different farming practices increase or reduce the risk of loss. For example, irrigation reduces the risk of loss due to inadequate moisture. For each practice, the rate is multiplied by a factor representing the relative risk. Type/Practice factors are derived from MPCI data that is aggregated at a level greater than the county level. This is appropriate, since the county data would likely lack sufficient credibility. In addition, we would not expect that the relative impact of specific practices would vary significantly from one county to the next (although the impact could vary across broader regions). Finally, we note that this approach – subdividing data, and aggregating at a broader level, is commonly used in insurance ratemaking.

Actuarial Justification

The practice factors are derived by dividing the practice specific LCR by the combined LCR where the combined LCR is calculated over all practices in the rating area. This is a

reasonable approach. We would recommend that RMA monitor the practice factors over time to determine whether there are any trends emerging in the factors.

B. *Average Yield Differentials*

The county rates developed to this point reflect rates for producers with APH yields at or near the county average yield. RMA research has demonstrated that, on average, the probability of a loss is greater for producers with a yield lower than the average for an area and vice versa. Thus, rates based on the average LCR for a county may be too low for producers with a lower APH and too high for producers with a higher APH. To address this, the RMA has developed a formula to adjust the base rate for yield differentials

$$Base\ Rate = \frac{\frac{County\ Unloaded\ Rate \times (Yield\ Span)^{Exponential}}{Reserve\ Factor} + Catastrophe\ Rate}{Unit\ Division\ Factor}$$

Yield span is the ratio of the producer's expected yield to the county average. In practice, spans are divided into nine categories. The exponential is a factor varying from –1 to –1.5.

Actuarial Justification

The use of the exponential factor dates back to the time when yield guarantees were based on average yields established for all farmers in a specific area. Thus, the rates would vary inversely with average yield (this is equivalent to an exponent of –1). M&R's analysis in 1983 ("Analysis of Area Average Yield and Individual Yield Coverage Programs" concluded that a

lower exponent (which would result in a lower premium per acre as yields increase) was indicated by the data.

The exponentials were revisited in M&R's report, *Federal Crop Insurance Corporation Ratemaking Overview*, dated June 14, 1996. In that report, we supported the general approach, but suggested possible alternatives to the above formula to reduce some of the discontinuities that exist in rates in adjacent yield intervals. We also noted that it is very important to periodically evaluate the formula, particularly the exponential, to reflect current experience.

C. *Coverage Level Differentials*

The rates derived above are for the 65% coverage level. Rates for other coverage levels are derived from these rates using coverage level differentials. The differentials are based on the historical experience of the various coverage levels. Presently, a common set of differentials is used for most crops and states.

Actuarial Justification

Coverage level differentials have been the subject of several M&R analyses. The first study was "Analysis of Coverage Level Rate Relativities" dated September 9, 1993. Subsequent analyses were conducted in "Analysis and Recommendation for the FCIC Coverage Level Rate Relativities" dated June 23, 1995, and in the report "Federal Crop Insurance Corporation Ratemaking Overview", dated June 14, 1996. In addition to these analyses,

RMA has conducted research into the coverage level relativity factors.

The most recent M&R work suggests that relativities differ by crop and area. In addition there were indications that the relativities among coverage levels vary with yield span (yield spans were discussed in the previous section).

It is appropriate to adjust rates to reflect different levels of indemnification under the various coverage levels. We believe this is an area where continued analysis is warranted, in order to identify and reflect the appropriate rate relationships for the different crops and classes.

PERFORMANCE MEASUREMENT

One item that appears to be absent in the MPCI ratemaking process, is a final test or calculation to determine whether the target rate level has been achieved. Most property and casualty rates are developed using a "top down" approach. With this approach, an average rate, or percentage rate change, is developed at an aggregate level (e.g., State). The rates for lower levels (e.g., county) may then be derived separately, but in the end balanced to the aggregate target.

This final balancing seems appropriate for the MPCI rates, since many of the steps along the way involve limiting the data, applying caps/cups, and otherwise causing potential departures from the aggregate rate requirement. We would encourage RMA to develop a process for measuring the ultimate rate schedules against some aggregate target.

FREQUENCY OF RATE REVIEWS

One final issue that we were asked to address was how often MPCI rate reviews should take place. Presently rates are reviewed and revised annually for most major crops.

There is no "right answer" to this question. Less frequent reviews would reduce administrative costs, or allow more resources to be used for research on improving the ratemaking process. Less frequent rate changes may or may not provide more stability in rates (i.e., rates would not change between rate reviews).

However, less frequent reviews would likely cause more significant rate changes from one review to the next. The present caps (+10%) and cups (-5%) may need to increase to reflect the longer time period between reviews. For example, for a three-year rate cycle, an equivalent cap would be about 30%. RMA will want to consider the affect on procedures and participation of such large increases.

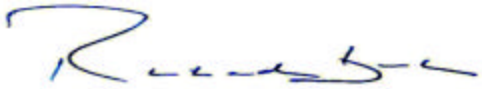
If the overall rate indication performance measure discussed in the previous section can be developed, one option would be to only modify rates if the overall indicated change is greater than a specified threshold (±5%), with perhaps an automatic review every 3rd year.

* * * * *

We would like to acknowledge and thank Jim Driscoll and LeWayne Jansonius, of RMA, for their assistance in providing information and responding to our many questions as we prepared this report. We appreciate the opportunity to be of service to RMA and will be happy to respond to any questions.

Sincerely,

Gary R. Josephson, F.C.A.S., M.A.A.A.
Consulting Actuary



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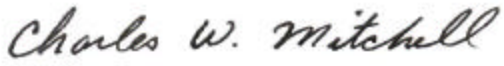

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August 1, 2000

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Exhibit 1

ADJUSTING LIABILITY TO COMMON COVERAGE LEVEL

1) Liability (L)= Acres x APH x Price x Coverage Level

2) Define : Value = Acres x APH x Price

3) Then : L = Value x Coverage Level

4) At 75% Coverage Level : L_{75} = Value x .75

5) At 65% Coverage Level : L_{65} = Value x .65

6) Therefore : L_{65} = Value x .75 x ($^{.65}/_{.75}$)

$L_{65} = L_{75}$ x ($^{.65}/_{.75}$)

Exhibit 2

ADJUSTING INDEMNITY FROM A HIGHER TO A LOWER COVERAGE LEVEL

Coverage Level	75%	65%	Difference
Liability*	$9,000	$7,800	$1,200

Yield per Acre	Production Ratio	Production Value	Indemnity* Coverage Level 75%	65%	Difference
0	0.0%	$0	$9,000	$7,800	$1,200
15	12.5	1,500	7,500	6,300	1,200
30	25.0	3,000	6,000	4,800	1,200
45	37.5	4,500	4,500	3,300	1,200
60	50.0	6,000	3,000	1,800	1,200
75	62.5	7,500	1,500	300	1,200
78	65.0	7,800	1,200	-	1,200
85	70.8	8,500	500	-	-
90	75.0	9,000	-	-	-
105	87.5	10,500	-	-	-

* Acres = 100
APH = 120
Price = $1.00

Exhibit 3

ADJUSTING INDEMNITY FROM A HIGHER TO A LOWER COVERAGE LEVEL

Coverage Level	50%	65%	Difference
Liability*	$6,000	$7,800	$1,800

Yield per Acre	Production Ratio	Production Value	Indemnity* Coverage Level 50%	65%	Difference
0	0.0%	$0	$6,000	$7,800	$1,800
15	12.5	1,500	4,500	6,300	1,800
30	25.0	3,000	3,000	4,800	1,800
45	37.5	4,500	1,500	3,300	1,800
50	41.7	5,000	1,000	2,800	1,800
55	45.8	5,500	500	2,300	1,800
60	50.0	6,000	-	1,800	1,800
65	54.2	6,500	-	1,300	1,300
70	58.3	7,000	-	800	800
75	62.5	7,500	-	300	300
78	65.0	7,800	-	-	-
85	70.8	8,500	-	-	-
90	75.0	9,000	-	-	-
105	87.5	10,500	-	-	-

* Acres = 100
APH = 120
Price = $1.00

Exhibit 4

ADJUSTING INDEMNITY FROM A HIGHER TO A LOWER COVERAGE LEVEL (APPROXIMATION TECHNIQUE)[1]

Adjusting Indemnity to Higher Coverage Level (50% to 65%)			
Production Ratios	**Liability**	**Indemnity**	**Adjusted Liability[2]**
<50%	$150,000	$30,000	$195,000
>=50%	400,000	0	520,000

1) The above values are created to illustrate the calculation. They are not true RMA data.
2) Liability x ($.65/.50$)

Adjusted Indemnity Calculation

The minimum adjusted indemnity is equal to the unadjusted indemnity plus the liability adjustment for production ratios less than 50%.

Minimum Adjusted Indemnity = $30,000 + ($195,000 - $150,000) = $75,000

The maximum adjusted indemnity is equal to the unadjusted indemnity plus the liability adjustment for all production ratios.

Maximum Adjusted Indemnity =
$30,000 + ($195,000 - $150,000) + ($520,000 - $400,000) = $195,000

The loss cost ratio used in the interpolation is based on the liability and indemnity for production ratios less than 50%.

Loss Cost Ratio = $30,000 / $150,000 = 20%

The interpolated adjusted indemnity is then the minimum indemnity 20% of the liability adjustment for production ratios greater than or equal to 50%.

Interpolated Adjusted Indemnity = $75,000 + .20 * ($520,000 – $400,000) = $99,000

If necessary, the interpolated adjusted indemnity would be subject to the maximum adjusted indemnity.

Statement of Principles Regarding
Property and Casualty Insurance Ratemaking

(Adopted by the Board of Directors of the CAS May 1988)

The purpose of this Statement is to identify and describe principles applicable to the determination and review of property and casualty insurance rates. The principles in this Statement are limited to that portion of the ratemaking process involving the estimation of costs associated with the transfer of risk. This Statement consists of four parts:

I. DEFINITIONS
II. PRINCIPLES
III. CONSIDERATIONS
IV. CONCLUSION

The principles contained in this Statement provide the foundation for the development of actuarial procedures and standards of practice. It is important that proper actuarial procedures be employed to derive rates that protect the insurance system's financial soundness and promote equity and availability for insurance consumers.

Although this Statement addresses property and casualty insurance ratemaking, the principles contained in this Statement apply to other risk transfer mechanisms.

I. DEFINITIONS

Ratemaking is the process of establishing rates used in insurance or other risk transfer mechanisms. This process involves a number of considerations including marketing goals, competition and legal restrictions to the extent they affect the estimation of future costs associated with the transfer of risk. This Statement is limited to principles applicable to the estimation of these costs. Such costs include claims, claim settlement expenses, operational and administrative expenses, and the cost of capital. Summary descriptions of these costs are as follows:

—*Incurred losses* are the cost of claims insured.

—*Allocated loss adjustment expenses* are claims settlement costs directly assignable to specific claims.

—*Unallocated loss adjustment expenses* are all costs associated with the claim settlement function not directly assignable to specific claims.

—*Commission and brokerage expenses* are compensation to agents and brokers.

—*Other acquisition expenses* are all costs, except commission and brokerage, associated with the acquisition of business.

—*Taxes, licenses and fees* are all taxes and miscellaneous fees except federal income taxes.

—*Policyholder dividends* are a non-guaranteed return of premium charged to operations as an expense.

—*General administrative expenses* are all other operational and administrative costs.

—The *underwriting profit and contingency provisions* are the amounts that, when considered with net investment and other income, provide an appropriate total after-tax return.

II. PRINCIPLES

Ratemaking is prospective because the property and casualty insurance rate must be developed prior to the transfer of risk.

> Principle 1: A *rate* is an estimate of the expected value of future costs.

Ratemaking should provide for all costs so that the insurance system is financially sound.

> Principle 2: A rate provides for all costs associated with the transfer of risk.

Ratemaking should provide for the costs of an individual risk transfer so that equity among insureds is maintained. When the experience of an individual risk does not provide a credible basis for estimating these costs, it is appropriate to consider the aggregate experience of similar risks. A rate estimated from such experience is an estimate of the costs of the risk transfer for each individual in the class.

> Principle 3: A rate provides for the costs associated with an individual risk transfer.

Ratemaking produces cost estimates that are actuarially sound if the estimation is based on Principles 1, 2, and 3. Such rates comply with four criteria commonly used by actuaries: reasonable, not excessive, not inadequate, and not unfairly discriminatory.

> Principle 4: A rate is reasonable and not excessive, inadequate, or unfairly discriminatory if it is an actuarially sound estimate of the expected value of all future costs associated with an individual risk transfer.

III. CONSIDERATIONS

A number of ratemaking methodologies have been established by precedent or common usage

within the actuarial profession. Since it is desirable to encourage experimentation and innovation in ratemaking, the actuary need not be completely bound by these precedents. Regardless of the ratemaking methodology utilized, the material assumptions should be documented and available for disclosure. While no ratemaking methodology is appropriate in all cases, a number of considerations commonly apply. Some of these considerations are listed below with summary descriptions. These considerations are intended to provide a foundation for the development of actuarial procedures and standards of practice.

Exposure Unit—The determination of an appropriate exposure unit or premium basis is essential. It is desirable that the exposure unit vary with the hazard and be practical and verifiable.

Data—Historical premium, exposure, loss and expense experience is usually the starting point of ratemaking. This experience is relevant if it provides a basis for developing a reasonable indication of the future. Other relevant data may supplement historical experience. These other data may be external to the company or to the insurance industry and may indicate the general direction of trends in insurance claim costs, claim frequencies, expenses and premiums.

Organization of Data—There are several acceptable methods of organizing data including calendar year, accident year, report year and policy year. Each presents certain advantages and disadvantages; but, if handled properly, each may be used to produce rates. Data availability, clarity, simplicity, and the nature of the insurance coverage affect the choice.

Homogeneity—Ratemaking accuracy often is improved by subdividing experience into groups exhibiting similar characteristics. For a heterogeneous product, consideration should be given to segregating the experience into more homogeneous groupings. Additionally, subdividing or combining the data so as to minimize the distorting effects of operational or procedural changes should be fully explored.

Credibility—*Credibility* is a measure of the predictive value that the actuary attaches to a particular body of data. Credibility is increased by making groupings more homogeneous or by increasing the size of the group analyzed. A group should be large enough to be statistically reliable. Obtaining homogeneous groupings requires refinement and partitioning of the data. There is a point at which partitioning divides data into groups too small to provide credible patterns. Each situation requires balancing homogeneity and the volume of data.

Loss Development—When incurred losses and loss adjustment expenses are estimated, the development of each should be considered. The determination of the expected loss development is subject to the principles set forth in the Casualty Actuarial Society's *Statement of Principles Regarding Property and Casualty Loss and Loss Adjustment Expense Reserves*.

Trends—Consideration should be given to past and prospective changes in claim costs, claim frequencies, exposures, expenses and premiums.

Catastrophes—Consideration should be given to the impact of catastrophes on the experience and procedures should be developed to include an allowance for the catastrophe

exposure in the rate.

Policy Provisions—Consideration should be given to the effect of salvage and subrogation, coinsurance, coverage limits, deductibles, coordination of benefits, second injury fund recoveries and other policy provisions.

Mix of Business—Consideration should be given to distributional changes in deductibles, coverage limitations or type of risks that may affect the frequency or severity of claims.

Reinsurance—Consideration should be given to the effect of reinsurance arrangements.

Operational Changes—Consideration should be given to operational changes such as changes in the underwriting process, claim handling, case reserving and marketing practices that affect the continuity of the experience.

Other Influences—The impact of external influences on the expected future experience should be considered. Considerations include the judicial environment, regulatory and legislative changes, guaranty funds, economic variable, and residual market mechanisms including subsidies of residual market rate deficiencies.

Classification Plans—A properly defined classification plan enables the development of actuarially sound rates.

Individual Risk Rating—When an individual risk's experience is sufficiently credible, the premium for that risk should be modified to reflect the individual experience. Consideration should be given to the impact of individual risk rating plans on the overall experience.

Risk—The rate should include a charge for the risk of random variation from the expected costs. This risk charge should be reflected in the determination of the appropriate total return consistent with the cost of capital and, therefore, influences the underwriting profit provision. The rate should also include a charge for any systematic variation of the estimated costs from the expected costs. This charge should be reflected in the determination of the contingency provision.

Investment and Other Income—The contribution of net investment and other income should be considered.

Actuarial Judgment—Informed actuarial judgments can be used effectively in ratemaking. Such judgments may be applied throughout the ratemaking process and should be documented and available for disclosure.

IV. CONCLUSION

The actuary, by applying the ratemaking principles in this Statement, will derive an estimation of the future costs associated with the transfer of risk. Other business considerations are also a part of ratemaking. By interacting with professionals from various fields including underwriting,

marketing, law, claims, and finance, the actuary has a key role in the ratemaking process.

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September 9, 1983	Milliman & Robertson, Inc. Analysis of Catastrophe Provisions	Michael A. McMurray
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December 1, 1983	Milliman & Robertson, Inc. Specification of an Actuarial Data Base	James R. Berquist Michael A. McMurray
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January 30, 1995	FCIC Catastrophe Procedure White Paper	Michael A. McMurray
February 14, 1995	Analysis and Recommendation for The FCIC Catastrophe Procedure	Michael A. McMurray
March 20, 1995	Analysis and Recommendations for The FCIC Catastrophe Procedure	Michael A. McMurray
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September 27, 1995	Analysis and Recommendations for the FCIC Catastrophe Procedure	Richard B. Lord Michael A. McMurray

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