White Paper on Data Quality
by the CAS Committee on Management Data and Information

WHITE PAPER ON DATA QUALITY

The CAS Committee on Management Data and Information is pleased to present this White Paper on Data Quality. This paper presents a discussion of data quality standards applicable to actuaries and insurance data managers; expands on data quality issues faced by actuaries and insurance data managers; and, elaborates on various data quality tools and practices used in preparing actuarial analyses and work products.

This paper is the result of a joint team of insurance professionals representing the Casualty Actuarial Society and the Insurance Data Management Association. The members of the project team are:

Arthur R. Cadorine, Chairperson
Mark S. Allaben
Holmes M. Gwynn
Richard W. Nichols
Dr. Richard A. Marr
Richard T. Schulz.

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The Committee's charge includes furthering the development and dissemination of data management theory and principles; identifying topics for research and discussion; monitoring

professional developments and regulatory activities; establishing liaisons with other organizations working in this area; and sponsoring panels, seminars, and other public forums on data management issues.

CAS Committee on Management Data and Information

Arthur R. Cadorine, Chairperson

Jonathan D. Adkisson

Mark S. Allaben

Randall E. Brubaker

William E. Burns

Richard N. Gibson

Holmes M. Gwynn

Larry A. Haefner

Israel Krakowski

Richard W. Nichols

Robert F. Wolf

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WHITE PAPER ON DATA QUALITY

I. Introduction

A. Data as an Asset

Today, more than ever before, insurers have the ability to tap into the detailed information which they collect as a result of the insurance contract. Access to this information has changed in the last decade due to the rapidly improving capabilities of computer technology, the declining cost of computer hardware & software products, and the expanding knowledge of data systems designers and programmers. The proliferation of the personal computer, compact disc (CD-ROM) storage drives, hookups to local area network (LAN) computer environments and the ever increasing pace of computer chip and data storage technology has allowed access to not only an organization's in-house detailed data but to broad based insurance aggregate data (i.e., industrywide data) and external non-insurance data useful to insurers (e.g., motor vehicle reports, geographic information, construction information).

In addition, the declining role of rate bureaus in the pricing of insurance risks has increased the need of the individual company to rely more on their own internal information in greater detail.

The concept that data is an asset means more detailed management information leading to:

- improved business opportunities (e.g., for marketing purposes);
- greater fraud detection;
- enhanced underwriting review (e.g., via motor vehicle reports);

- greater evaluation of loss control factors or risk management procedures; and,
- greater ability to use the data in actuarial analyses (e.g., for pricing, loss reserve analyses).

The need to protect and enhance the quality of data available for use is self-evident.

B. Data Quality - Actuaries & Data Managers

In July of 1993, the Actuarial Standards Board (ASB) adopted Actuarial Standard of Practice No. 23 - Data Quality. The standard adopted was the result of over three years of discussion by an Ad Hoc Data Quality Task Force of the Specialty Committee of the Actuarial Standards Board. Exposure drafts were circulated and comments solicited from members of the American Academy of Actuaries. The resulting document established a standard which provides greater consistency in actuarial practice with respect to the responsibility of the actuary regarding the quality of the data. The standard also recognizes the diversity of actuarial work, the diversity of data available in that work and the need for judgment dependent upon the intended use of the analysis.

In the summer of 1994, the Insurance Data Management Association (IDMA) formed a working group to develop a data quality opinion framework. The resulting framework and guidelines, entitled "IDMA Data Quality Certification Model for Insurance Data Management" was released on March 9, 1995. This framework is designed to give guidelines to an insurance data manager in order to monitor, measure, and, potentially, certify the quality of data in his/her organization.

Using these two documents, this White Paper attempts to broaden and merge the collective thinking on this subject for

insurance actuaries and data managers. Specifically, the paper will discuss issues relating to:

1. the importance of data collection and processing;
2. reviewing the data for appropriateness, reasonableness and comprehensiveness relevant to the analysis undertaken;
3. certifying the accuracy and validity of the data;
4. materiality considerations of imperfect data;
5. the standards and procedures used to determine the extent of imperfect data; and,
6. the responsibility of certification and disclosure.

II. Data Quality Standards

A. Actuarial Standard of Practice No. 23

The stated purpose of Actuarial Standard of Practice No. 23 is to give guidance to the actuary in:

a. selecting the data which underlie the actuarial work product;
b. reviewing these data for appropriateness, reasonableness, and comprehensiveness; and
c. making appropriate disclosures.

The Standard discusses the current practices and historical issues. It then reviews and analyzes alternative practices to determine the recommended practice for an actuary in undertaking actuarial analyses. The Standard recognizes that completely accurate, appropriate, and comprehensive data is not always available. The actuary must understand the intended use of the analysis being performed in order to thoroughly evaluate the appropriateness of the data. In addition, the Standard discusses the selection of the data relevant to the reasonableness and consistency of the necessary data elements, any limitations of

the data available, and the cost & feasibility of alternatives (including timeliness considerations).

By comprehensiveness of the data, the Standard refers to the availability of each data element and record needed for the analysis; that doesn't mean that every record is necessary (because a sample of records may suffice for the analysis undertaken) or that every data element in the record needs to be accessible, but it does mean that the necessary records and data elements to do a proper analysis are available.

By appropriateness, the Standard means that the data is:

1) the information needed for the analysis;

2) homogeneous so as to allow evaluation; and,

3) consistent with the purpose of the study.

By reasonableness, the Standard means that it's consistent with prior data or other information.

Taken together, the actuary must ask the following questions.

1) Is all the data necessary for the analysis, in fact, available for use in the analysis?

2) Is the quality of the data appropriate to accomplish the intended purpose of the analysis?

3) Is the data reasonable and consistent with prior data, other homogeneous data sources, and other knowledge?

The Standard leaves open the door that imperfect data may still be usable - but only after careful scrutiny. The key question is: Will incomplete, inaccurate or inappropriate data (i.e., imperfect data) result in material biases in the study's conclusions? If "yes", the data is not usable unless the bias can be quantified; if "no", the data is usable. If "maybe", then further work needs to be done. Effort must be made to identify the nature of the imperfection. Once identified, the imperfect data can be corrected, excluded, or adjusted using an appropriate mathematical or actuarial method (e.g. minimum bias techniques,

confidence ranges, distributional adjustments), depending on the extent and nature of the imperfection.

Data with a known imperfection in a field not pertinent to the study undertaken, is not considered imperfect data. If, however, it affects the perception of the credibility of the data in use, the user of the data should be prepared to address the situation.

The Standard discusses the actuary's reliance on data supplied by others and concludes that the data must be accurate and complete for the analysis under study. The data must be reviewed for reasonableness and consistency. This actuarial review of the data will be based on the specific circumstances - the intended use of the data, the data available, extent of known data limitations, timeframes and other factors.

An actuary's review of the data should:

1. determine the extent of checking, verification and auditing done by the data manager/supplier;
2. identify questionable or inconsistent relationships; and,
3. determine the materiality of imperfections on the study's results.

Furthermore, the actuary should comment on the confidence, reliability and the value of the data quality procedures done by the data manager/supplier. Toward that purpose, the extent of audits and control procedures should be reviewed and noted. For instance, if the source data has been subjected to rigorous internal audits or monitoring by a Statistical Data Monitoring System (SDMS), as described later in this paper, then greater confidence in the source data may be assumed. On the other hand, if in the judgment of the actuary greater checking should be performed, then it should be done if practicable.

Standard No. 23 provides a strict disclosure standard in the actuary's report. The report should include disclosures

regarding:

1. the sources of data;
2. the materiality of any biases due to imperfect data;
3. adjustments or modifications made because of imperfect data;
4. the extent of reliance on data supplied by others;
5. any resulting limitation on the use of the analysis;
6. any unresolved concerns regarding the quality of the data.

B. IDMA Data Quality Certification Model

The "Data Quality Certification Model for Insurance Data Management" released by the Insurance Data Management Association (IDMA) is intended to provide:

1. a framework for use in attesting to the data quality of an organization; and,
2. guidelines for the insurance data manager to use in controlling, monitoring and measuring the validity, accuracy, reasonableness and completeness of data.

The IDMA Certification Model makes the insurance data manager responsible for developing a commentary on the quality of the data. The commentary should include:

a. disclosure of the results of checks/tests for validity, accuracy, reasonableness and completeness of data;
b. list of the reports and monitoring tools used in ascertaining validity, accuracy, reasonableness and completeness of data;
c. review and analysis of significant data problems using the data monitoring tools;
d. action plan for correcting data problems; and,
e. certifying statement regarding the analysis and commentary.

The commentary should also include an assessment of the materiality of the data elements, including the resulting impacts and error ratios. The IDMA Certification Model holds the insurance data manager accountable for:

a. recognizing that the users are responsible for developing standards (e.g., consistent and reasonable error tolerances);
b. knowing that standards exist; and
c. prompting the establishment of standards when they do not exist.

An actuary's reliance upon an insurance data manager who has followed these practices certainly will provide him/her a degree of confidence in the source of the data.

III. Data Quality Terms

A. Ascertaining Data Quality

Most often, an assessment of data quality consists of an assessment of the following four components listed by the IDMA Certification Model:

- Validity;
- Accuracy;
- Reasonableness; and,
- Completeness.

Validity means that value of a given data element is one of all allowable ones. Data values that are valid are determined by edit checks. The most basic check is known as a field edit. For example, a State code is valid if it is one of the codes allowable under the data element "State". If two digit postal

code defines the allowable values for "State" then NY would be a valid value for this data element. Validity checks also include relationship edits involving two or more fields. For example, territory code "10" may be valid in one state but not in another. Valid values are checked through the use of automated edit checks via internal and external edit packages that access tables of allowable values. Error performance reports are typically generated for review. While necessary to the data quality environment, validity checks, by themselves, can only guarantee that the field has an allowable code, not necessarily the correct one.

Accuracy means that each data transaction record or code is a true and accurate representation of what it's intended to represent. In other words, does it accurately reflect the correct information for the policy or claim it represents? A good example to illustrate accuracy is class code; the class code for a florist is accurate if the risk is a florist; it would be inaccurate if the risk were a pharmacy, however it may a valid class code (namely, the code for a florist). How do you know that you have accurate data? To ensure accurate data, a system of effective controls, including periodic audits and sampling checks at all stages of the data collection process must be established. This system of checks can only be accomplished through a thorough understanding of all data handling and collection activity in the organization. Independent comparisons with source documents, validity and other edit checks, as well as periodic audits are essential elements for ascertaining the accuracy of reported data. These essential elements are inherent in rigorous and high quality self monitoring audit programs and in the Statistical Data Monitoring System (SDMS), which are discussed later in this paper; as such, self monitoring audit programs would be a valuable aide in confirming the accuracy of

the data.

Another essential component of the assessment of the quality of the data is the concept of reasonability. This component of data quality requires some summarization or aggregation of records in order to determine the data's reasonableness. For example, a single large fire loss may not look unusual by itself, but in the context of hundreds or thousands of large losses it may be an indication of a coding problem. The key questions are: Is the data reasonable compared to our prior and current knowledge? Is it reflective of prior established patterns? For example, does this quarter's territory premium distribution look similar to prior quarters? Does it jibe with our general knowledge about the data? For example, if this year's territory distribution doesn't match the profile, might it be because of a change in the company's marketing or underwriting policies? Distributional analyses and profiles, trend analyses, average rate checks, and loss ratio comparisons are examples of tests to determine the reasonableness of the data.

Completeness of data has three essential elements:

1. each transaction record contains all the necessary data for the business needs for that record (i.e., no information that's necessary or required is left blank);
2. each transaction record is consistently processed once and only once; and,
3. each transaction record is processed properly through every necessary portion of the system and only through those necessary portions.

In other words, complete data can only be realized when every area involved in the data collection and processing process handles it correctly. This requires proper coding at the source and effective controls at each step along the way. Reconciliation of statistical data to financial data helps ensure the

completeness of the data since it provides a valid basis for comparison of the information. When material discrepancies arise in reconciliation results, every effort must be made to reconcile the discrepancy and take corrective action if necessary.

B. Accuracy of Data

Usable data can be classified in three levels or degrees of accuracy:

1. Absolute Accuracy;
2. Effective Accuracy; and,
3. Relative Accuracy (i.e inaccurate but consistent over time).

The definition of Absolute Accuracy is simply that the data is 100% correct. There are no known defects in the data. Each and every data element on each and every transaction record is properly and accurately coded. It can be used down to transaction level detail.

Most data are of the Effective Accuracy type where there are some imperfections in the data but are generally usable in most analyses. There are two categories or types of Effective Accuracy. First, where the coding of a specific data element may be incorrect, analyses not involving the incorrectly coded data element (either, in any intermediate calculations, or in the aggregate result) may be unaffected. For example, territory coding may be inaccurate, but for analyses of statewide (all territories combined) data, the data may be suitably accurate for use; however, if territory is used in calculating Premium at Present Rates (PPR) where the rate differs by territory and the analysis involves this calculated premium, then it would affect the statewide analysis. Analyses requiring a high level of detail (either, in the intermediate calculations, or in the

aggregate result) need to be accurate enough to that level of detail. A second type of Effective Accuracy is dependent upon whether the imperfect data will materially impact the result. For example, returning to the territory PPR calculation above, if a small amount of territory data (relative to the overall volume included in the analysis) appears to be incorrectly coded, there may be no material effect as to the results of the analysis; on the other hand, this may indicate that there may be substantial unknown data problems. Whether it's an immaterial anomaly in the quality of the data, or an indication of additional unknown data quality problems is what the actuary needs to decide.

Defining Relative Accuracy is a bit trickier. Data coded inaccurately as to its definition but reported consistently over time are data that are relatively accurate. For example, the definition of what's included as allocated loss adjustment expenses (ALAE) may vary by company, and by statistical agent; a company may not strictly adhere to the statistical agent's definition of ALAE in reporting its statistical data, yet the data may be reported consistently over time and with proper recognition can be used in various analyses. An analogous example can be made regarding loss reserving procedures (i.e., case vs. case with a loading). With proper recognition of differences in data definition, relatively accurate data is generally usable. The problem with relatively accurate data is that when a procedural change is instituted the data will no longer be consistent over time.

IV. Data Reliability Tools

A. Reliability of Data & Data Audits

One of the key tools to ascertain the accuracy of the data is periodic auditing. The reliability of the data used in an

actuarial work product will be higher if there are periodic and comprehensive internal or external audits of the data quality process.

Besides checking the accuracy and completeness of the data, audits help to:

- ensure consistent handling;
- determine the quality of systems control procedures;
- measure and improve timeliness of data; and,
- increase the reliability of results.

Successful audits, both internal and external, include the following elements:

1. are properly planned;
2. measure results according to established standards;
3. are statistically sound, regarding the sampling technique;
4. perform data checks from source to end product and end product back to source;
5. verify data according to their intended use and definition, including assuring that all data elements resulting from calculations, mappings and other programming algorthyms are correct as intended;
6. audit the data preparation & data entry processes, and reviews all program and output controls (assuring that the input and output data balances, as well as reconciles with prior data processed);
7. determine whether the company's entire process detects errors adequately and corrects them properly; and,finally
8. provide adequate documentation of the results with recommendations for improvement (if any) and follow-up implementation review.

B. Statistical Data Monitoring System (SDMS)

In 1982, the New York Insurance Department, acting on a commissioned analysis by an independent accounting firm, set up a system of procedures designed to control the quality of data submitted to and processed by statistical agents. The objective of this system, known as the Statistical Data Monitoring System (SDMS), is to assure the reliability of the data collection process for statistical data used in statistical and ratemaking filings. SDMS is a self-monitoring system which was adopted not only by the New York Insurance Department but subsequently by the insurance departments of Rhode Island and Connecticut. Currently, the SDMS functions for the Personal Automobile line of insurance, but the procedures inherent in the system can be applied to all lines of insurance.

The System mandates a set of procedures that must be followed by insurance companies and statistical agents. Each company is responsible for various data quality tests and documentation, with each company certifying their own data. Likewise, each statistical agent must collect and summarize specified reports from its reporting companies, carry out specified monitoring system tests and compile documentation. The statistical agents perform data quality checks on their own internal systems, as well as certify their reporting companies' monitoring activities. State regulators have overall responsibility for an effective program.

The Statistical Data Monitoring System (SDMS) has 6 basic components which jointly serve to increase the reliability of the data for statistical, ratemaking and actuarial analyses:

1. process description and review of control procedures;
2. detailed data verification via sampling tests;
3. summary data verification via reasonability reviews;

4. financial reconciliation;
5. annual review and certification;
6. review and evaluation by state examiners.

The first component, the process description and review of control procedures is accomplished by requiring system flowcharts and narratives, using standardized procedural control checklists and reviewing specific checklist functions in detail.

To accomplish the detailed data verification, a random sample representative of the data is taken for both premium and loss claim transactions. For each transaction, every data element is verified. When an error is found, the source and cause of the error are identified and corrective action taken. Sample sizes are determined such that data errors which affect more than 1% of the transactions will be discovered with a 99% probability.

Summary data verification is accomplished through a review for reasonableness of the essential data elements to be used in the actuarial ratemaking review - premiums, losses, claims - by the main components of the review - territory and coverage. The most questionable (or inconsistent) experience is then researched to determine any errors and their cause; if errors are uncovered, corrective action is taken.

As respects data reconciliation, each company must reconcile its statistical data (as reported to its statistical agent) to the company's financial data (reported in the Annual Statement).

Finally, the annual review and certification requires documentation of the monitoring activities conducted and the error incidence statistics of the data. The certification document must be signed by the company's Data Quality Officer.

Taken together, the system provides an effective self monitoring tool which allows state examiners to independently review the data quality of each company's data and the processing

of it by the statistical agents. By providing a clear set of procedures, the SDMS system provides a structure on which actuaries and insurance data managers can rely on the quality of data, thereby increasing the accuracy and credibility of actuarial, ratemaking and other statistical data analyses.

V. Professional Responsibilities

A. The Responsibility of the Actuary on Reasonability

Almost all statistical data used in actuarial analyses undergo various validity checks as a matter of routine company or statistical agent procedures. Whether the data is sufficiently accurate, reasonable and complete is generally the key determinant of the quality of the data. While this paper has discussed various ways to monitor and improve the accuracy or completeness of the data, the actuary should be aware of and prepared to perform various additional summary checks, edits and tests designed to determine the reasonableness of the data. In short, a good reasonability review provides the answer to the question: Does the data make sense?

A good reasonability review starts with good judgment based on experience and supplements it with objective measures. First and foremost, does the data look right? For instance, if the actuary is performing a Statewide Rate Level analysis, the resulting current indication should make sense relative to last year's indication after accounting for various differences and factors in the ratemaking formula as well as any known experience changes (such as the effect of a major hurricane on property losses); if it doesn't make sense, then this raises further questions that should be resolved satisfactorily.

Some key tests or checks that should be considered in a review of the reasonableness of the data are:

- distributional edit review;
- consistency checks;
- statistical tests, such as, chi-square goodness of fit tests or non-parametric rank tests;
- graphical tests; and,
- industry comparisons, including reasonable range of results comparisons.

A bird's eye view of the data can be had by reviewing summary data by key field relative to a profile of that data based on prior experience. Known as a Distributional Edit Review (DER), data is compared for consistency to a prior quarter's or year's data. A DER helps detect data anomalies and inconsistencies. An extreme example would be: if coverage is sold statewide (i.e., in all territories) then a data problem resulting from data coded all under territory "001" is easily found. Of course, most data problems are more subtle than this example, so automated statistical tests should be used. For example, chi-square tests between current data and the profile can be used. These automated statistical tests help to provide the best review of the distribution of the data by providing an objective measure of the data elements that seem to match or not match the distributional profile; those with the highest chi-square values fit the distributional profile the least. Although helpful, oftentimes the actuary doesn't have the historical data to perform this type of review on the data; on the other hand, if the provider of the data does perform this type of data review before providing the source data, then the actuary may have improved confidence in the data.

An easier yet more limited check are comparison tests, done by comparing the premium/exposure/loss/claim volumes by the highest order data variables (e.g., state, coverage, year, etc.)

either to each other or to prior reported volumes. If the volumes appear inconsistent across years, or if there are divergent exposure/premium or loss/claim relationships, further review of the data may be necessary.

Range comparison tests, non-parametric rank tests or graphical views of the data can be used to supplement the reviewer's judgment. An example of a range comparison test is a test of premium-to-exposure ratios; these ratios can be compared to average rates in effect and values falling outside a reasonable range (depending on the level of summarization) can be flagged. Used far less often, non-parametric rank tests (like Kendall's Tau or Spearman's Rho) similarly can detect inconsistent or divergent patterns in the data and can provide an objective measure of the quality of the data. Graphs provide a quick, visual aid to ascertaining unusual relationships; computer software that allows pivot table calculations and graphical views of various ratios can be invaluable in spotting data problems, thereby enhancing the reasonability review of the data.

Finally, company data can be compared to industrywide data. However, this is only useful if distributional differences between the company's book of business and the industry average are reasonably expected to be similar.

In the end, the actuary must be confident that he/she can rely upon the data for the specific analysis and circumstances. He/she should document all reasonability checks and tests performed, highlighting any known or suspected deficiencies in the data.

B. Responsibilities of the Data Manager on the Quality of Data

The ability to form decisions and conclusions based on an actuarial analysis is dependent upon the quality of the data and the specifics of the analysis. Oftentimes, the underlying data

of the study is imperfect in some respect. Once imperfections in the data are uncovered, the insurance data manager providing the source data should take the following steps.

1. Determine the reasons and cause(s) of the error.
2. Inform the actuary undertaking the current study and incorporate needed adjustments, modifications or corrections to the source data for use in the current analysis.
3. Stop the error by fixing the system or revising the data handling and collection process.
4. Quantify, if possible, the impact and magnitude of the error on the data underlying the current study.
5. Decide if the error may materially impact prior analyses and whether these prior analyses may need to be retroactively corrected.
6. Finally, if it is materially significant, make disclosures regarding past analyses appropriately. On an external basis, this may mean notification of insurance regulators, or insurance statistical agents. On an internal basis, company management may need to rethink financial, policy or pricing decisions.

Regarding this last step, note that in almost every situation, if the extent of imperfect data might change the conclusions or the results of the analysis using this data then there is an obligation to disclose the data imperfections to all potentially affected parties. Further, there is a duty to raise "red flags" in all situations where there are significant imperfections in the data.

VI. Concluding Remarks

A. What's Next?

There's been much discussion in various Casualty Actuarial Society (CAS), IDMA and other data quality forums regarding the use of a self monitoring audit system as a way of responding to various regulatory concerns raised by state officials and the National Association of Insurance Commissioners (NAIC). A frequent suggestion is that an industry self monitoring system, with a rigorous audit program that checks the statistical records submitted to statistical agents back to company source documents, would satisfy the various regulatory concerns. A starting point (but perhaps not the ideal model) for such a system might be the SDMS, described above. The appropriate forms and procedures necessary would be available on demand by State Financial Examiners. This approach may be advanced further in the upcoming months, but much work needs to be done regarding the details of such a self monitoring audit model, as there are divergent opinions as to its scope and necessity.

Undoubtedly, future data quality efforts will be the result of the impact of continually improving technology. The synthesis of technology and knowledge allows improved concepts in data base design and automation.

Current topics include:

1. Data Warehouse Concept - which allows broad use of data in great detail by many areas of the company;
2. Greater use of complementary databases - ZIP Code, motor vehicle reports, geographic mapping - in improving data validation and accuracy; and,
3. Pattern Recognition/Expert Systems/Fuzzy Logic Systems - that enhance automation efforts and allow graphical views of the data.

What's next? The challenge for both actuaries and insurance data managers is to keep up with the improved technology and to use it as an aid to improving data quality.

B. Conclusion

Data quality has long been a concern of the insurance industry and the regulator. However, data quality must be administered in a cost efficient manner. The more rigorous statistical plans are subject to some degree of interpretation versus financial data accounting. As technology has improved, better data quality (and better reconciliation of statistical & financial data) can be realized more economically and efficiently by both data managers and actuaries. Managements have recognized that high quality data provide them accurate controls of their businesses.

Two professional groups - data managers and actuaries - have developed formal standards to better recognize the importance of data quality. Both standards have been reviewed in this paper. The data manager's responsibility is specifically stated to go beyond the production of the data. Error detection, evaluation, and disclosure are now part of that responsibility. The actuary cannot simply accept data and rely on the work of others regarding it's quality. Data must be reviewed for reasonableness and consistency, and data imperfections must be addressed.

Formal professional education is available to both professions, and it can be expected that data quality will continue to be an issue addressed by each professional organization.