ISSN: 2995- 4010

Research Article

Current Trends in Business Management

The Impact of Sample Measurement Error on Two Types of Risks Cannot Be Ignored: An Accurate Calculation Method for the Probability of Wrong Judgment of Inspection Batch

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Submitted: 2024, Apr 01; **Accepted**: 2024, Apr 22; **Published**: 2024, Apr 26

Citation: Tu, R. (2024). The Impact of Sample Measurement Error on Two Types of Risks Cannot Be Ignored: An Accurate Calculation Method for The Probability of Wrong Judgment of Inspection Batch. *Curr Trends Business Mgmt, 2*(1), 01-07.

Abstract

Measurement errors exist in samples. It can lead to misjudgment of individual conclusions and sample quality determination. Assuming that there is no measurement error, the risk determined is not the true risk borne by both the supplier and the buyer. The total risk borne by both the supplier and the buyer for quality misjudgment is determined by the probability of the event of batch misjudgment and the event of sample misjudgment. An accurate calculation method for detecting the probability of batch misjudgment is provided. A counting sampling inspection scheme considering the risk of misjudgment of sample test results is introduced. This provides direction for revising ISO 2859 standard.

Keywords: Individual Event Conclusion Misjudgment, Sample Misjudgment, Lot Misjudgment, Total Risk, Sampling Scheme

1. Introduction

There is a 5% risk of misjudgment in the test results of the samples. When the difference between the value of one item in the test result of the sample and the standard limit is within the measurement uncertainty range of that item, it has an impact on the determination of batch qualification. However, existing sampling standards for attributes have not taken into account this impact.

The process of sampling inspection by attributes mainly consists of two stages: the first stage is to obtain the test results of the sample through sampling inspection; The second is to determine the qualification of the batch based on the sample testing results. Both stages of operation may lead to misjudgment. Considering the cost of inspection, we allow for a confidence level of not 100% in the results of both stages of operation. The permissible concession in the confidence level of the results of these two operations is a determining factor for the misjudgment of the sampling inspection plan (Quantitatively speaking, the misjudgment risk of the sampling inspection plan is composed of two components of misjudgment risk: one is the risk component caused by the representativeness of the extracted samples; The other is the risk component of misjudgment in the sample testing results).

The current sampling method standards have not taken into account the detection risk component. For example, GB/T2828.1~4-2021 Sampling inspection procedure by attributes and ISO 2859.1~4:2020 Sampling procedures for inspection by attributes. In this case, the risk borne by the supplier or demander may be an inaccurate risk. Without increasing the cost of testing, it is difficult to eliminate the 5% risk of sample testing results. This risk can be considered in the standards of the sampling inspection procedure. This article provides specific methods.

2. Defects in the Existing Sampling Plan

The existing sample inspection methods and standards stipulate that the inspection results should reach a 95% confidence level within a certain confidence interval. When the critical value (or specification limit) is within the range of true value + confidence interval, the detection error of the sample and the misjudgment rate of individual conclusions can also lead to significant supplier or demand risks. For cases where the true value is exactly equal to the critical value (or specification limit) specified by the standard, the misjudgment rate of a single conclusion is as high as 50%, and the supplier or demand risk of a single conclusion is close to 50%. This risk is caused by sample measurement errors. If the risk caused by measurement errors is not considered in the quality judgment process of inspection batches, and only the risk caused by avoiding full inspection, i.e. the risk caused by sampling, is

considered unscientific.

The quality misjudgment risk A of inspection batches during sampling inspection can be divided into two subcategories: B is determined to avoid the sampling plan for full inspection; C is the risk of quality misjudgment of samples, including the risk of misjudgment of single test conclusions. B and C jointly decide A. In other words, the total risk of quality misjudgment in inspection batches is the joint contribution of the probability of misjudgment caused by sampling and the probability of misjudgment in sample testing results. If factor C can be considered but cannot be ignored, it is unreasonable to forcibly ignore C.

The design of existing sampling inspection plans is based on the premise that the accuracy of sample testing results is 100%. In the process of determining and implementing the sampling plan, it is assumed that the number of non-conforming products *d* (or *c*, or *Ac*, the same below) obtained through inspection corresponding to the discriminant number x in the following two equations is 100% certain. For example, the sampling plans of ISO 2859 and GB2828 are calculated based on the following probability formula [1-3].

$$\alpha_{\text{batch}} = 1 - L(p_0) \approx 1 - \sum_{x=0}^{c} \left[\begin{matrix} n \\ x \end{matrix} \right] p_0^x (1-p_0)^{n-x} \tag{1}$$

$$\beta_{\text{batch}} \approx \sum_{x=0}^{c} \left[\begin{matrix} n \\ x \end{matrix} \right] p_1^x (1-p_1)^{n-x} \tag{2}$$

The risk of misjudgment of inspection batch quality is calculated based on equations (1) and (2), assuming no measurement error. However, p_0 is the average of multiple tests, and its value is very close to the actual situation (the more batches sampled for inspection, the closer it is to the actual situation). Assuming the p_0 value is absolutely true, *x*, as the discriminant in a sampling plan, is the true number of non-conforming products among *n* products. However, when comparing the actual number of non-conforming products *d* with *x* to determine whether the inspection batch is qualified, the reliability of *d* corresponding to *x* is related to the measurement technology, and the existence of measurement errors determines that it is not a completely reliable value. Due to the fact that both the production and receiving risks are determined by the risks of batch misjudgment and sample misjudgment, as long as the probability of misjudgment of d compared to x is not zero, it may affect the total risk of the supplier α_{total} total risk with the demand side β_{total} here is a serious impact, and if this impact is not considered, only a portion of the total risk caused by batch misjudgment factors can be calculated. If a risk obtained from take α_{batch} and β_{brach} treated as α_{total} the total risk and β_{total}, it is false.

Let's discuss the measurement with a lower specification limit of 12.0% for quality characteristic values and the determination of individual conclusions. The confidence level of the test results is 95.45%, with an interval of ± 0.20%. At ≈0.05, under the appropriate number of measurements and the average of different measurement results, the risks borne by both the supply and demand sides for single quality judgment are shown in Table 1. The results obtained from measuring the same quality characteristic in different laboratories also have the relationship shown in the table below (except for slight differences in $\bar{x}$ and σ).

From Table 1, it can be seen that the closer the detection result is to the standard limit, the greater the probability of misjudgment in a single conclusion; The farther the detection result is from the standard limit, the lower the probability of misjudgment in individual conclusions. It is impossible to achieve a non-conforming product rate below 0.002ppm when the measured value approaches the critical value (specification limit) specified by the standard (or the confidence interval with a tolerance <99.999998% confidence level). It is meaningless to discuss controlling the non-conforming product rate below 0.002ppm when the confidence level of the measurement result is around 95.45% (in this case, only discussing "controlling the non-conforming product rate below 2.22%").

$\bar{x}$ or μ	single conclusion	The risk of misjudging qualified products as unqualified ones	The risk of misjudging unqualified products as qualified ones
11.9	Unqualified	Due to differences in the range of true values, measurement accuracy, and number of measurements: when the true value is ≥ 12.00, at least n/2 measurement results out of n measurements are less than 12.0, or the average value of n measurements is less than 12.0. If the measurement results from different laboratories are treated as true values, the probability of the average of multiple measurement results from a laboratory being less than (or greater than) a certain value can be calculated using a normal distribution function, similar to the right column.	(1-95.45%)/2=2.22% (Reason: When μ=11.90, within the confidence interval [11.80, 12.00], with a confidence level of 95.45%, calculate the one-sided non-conforming product rate.
11.95	Unqualified		(1-68.27%)/2=15.86% (Reason: When μ =11.95, with a confidence interval of [11.95,12.00] and a confidence level of 68.27%, calculate the one-sided non-conforming product rate.
12.0	qualified	50% (Reason: When the measurement results are normally distributed) μ When the value is exactly 12.0% of the true value, there is a half chance that a measurement will determine the actual qualification as unqualified due to inspection errors; If the measurement results from different laboratories are statistically analyzed, half of the laboratories will test the actual 12.0% as<12.0%.	50% (Reason: When the measurement results are normally distributed) μ When the value is exactly 12.0% of the true value, there is a half chance in one measurement that the actual nonconformity will be judged as qualified due to inspection errors; If the measurement results from different laboratories are statistically analyzed, half of the laboratories will test the actual 12.0% as>12.0%.

12.05	qualified	(1-68.27%)/2=15.86% (Reason: Within the confidence interval of [12.00, 12.10], with a confidence level of 68.27%, calculate the one-sided non-conforming product rate).	Due to differences in the range of true values, measurement accuracy, and number of measurements: when the true value is ≥ 12.00, at least n/2 measurement results out of n measurements are less than 12.0, or the average value of n measurements is less than 12.0. If the measurement results from different laboratories are treated as true values, the probability of the average of multiple measurement results from a laboratory being less than (or greater than) a certain value can be calculated using a normal distribution function, similar to the right column.
12.1	qualified	(1-95.45%)/2=2.28% (Reason: Within the confidence interval of [12.00, 12.20], with a confidence level of 68.27%, calculate the one-sided non-conforming product rate)	
12.2	qualified	(1-99.9975%)/2=0.00315% (Reason: Within the confidence interval of [12.00, 12.40], with a confidence level of 68.27%, calculate the one-sided non-conforming product rate).	
12.3	qualified	0.001ppm (Reason: Within the confidence interval of [12.00, 12.60], with a confidence level of 99.999998%, calculate the one-sided non-conforming product rate).	

Table 1: Risk of Single Conclusion Determination with a Lower Norm Limit of 12.0% for σ ≈0.05

3. Accurate Calculation of the Risk Borne by Both Supply and Demand Parties in a Transaction of Inspection Batches

In principle, probability algorithms (especially hypergeometric distributions and the union of two events) can be used to calculate. For the point counting process (enumeration process), the hypergeometric distribution should be replaced with a Poisson distribution for calculation. Below is a brief introduction to several calculation methods.

3.1. Using Probability Algorithms to Calculate the Total Risk of Suppliers and Demanders

3.1.1. Theoretical Basis of Calculation Methods [2]

The event of misjudging a qualified batch as an unqualified batch determined by a non-full inspection sampling plan is recorded as $R_{\alpha(\text{batch})}$, while the event of misjudging a unqualified batch as a qualified batch caused by the same reason is recorded as $R_{\beta(\text{batch})}$. The probability of misjudging a qualified batch as an unqualified batch is equivalent to the probability of misjudging a qualified sample as an unqualified sample. The event of misjudging qualified samples as unqualified samples due to measurement errors is recorded as $R_{\alpha(\text{sample})}$, and the event of misjudging unqualified samples as qualified samples for the same reason is recorded as $R_{\beta(\text{sample})}$. Extracting *n* samples from a batch of products, the probability of non-conforming products occurring *P(x)* is determined by the combination of batch quality level and the probability of sample quality misjudgment caused by measurement errors:

$$P(x)=P(x_0)+P(R_{\alpha(\text{batch})})-P(x_0)\,P(R_{\alpha(\text{batch})}).$$

Among them, *P* (*x*0) is the probability of n unqualified samples being extracted from a batch with a quality level assuming a measurement error of zero. The new event composed of all sample points in $R_{\alpha(sample)}$ and $R_{\alpha(batch)}$ is their union $[R_{\alpha(batch)} \cup R_{\alpha(sample)}]$, which is the total batch quality misjudgment event borne by the supplier [recorded as Rα(total)]. So, the total risk of batch quality misjudgment borne by the supplier is α_{total} =P$[R_{\alpha(batch)} \cup R_{\alpha(sample)}]$. The quality misjudgment events of different samples are independent of each other, and the misjudgment events of different quality characteristic items in the same sample are also independent of each other. Correspondingly, there are: $\beta_{total} = P(R_{\beta(batch)} \cup R_{\beta(sample)})$.

In the case of non-counting points, the quality level p_0 also represents the probability of selecting one sample from an infinite sample batch and producing one non-conforming product. This sampled sample may also suffer from misjudgment of "misjudging qualified as unqualified" due to measurement errors, thereby increasing the probability of "selecting one sample from an infinite batch and producing one unqualified product". In other words, measurement errors leading to misjudgments are equivalent to increasing the quality level p0 value (process average). Both in p_0 **Eq.(1)** and p_1 ***Eq. (2)*** should be replaced with corresponding probabilities of the merging event. From this perspective, the probability of batch misjudgment, sample misjudgment, and a α_{total} should be evenly matched (not significantly different). Otherwise, it is meaningless to discuss controlling the probability of batch rejection within a very small range when the probability of sample misjudgment is high (or discussing the occurrence of zero defective products in a large sample size when p^0 is high). For example, in the case of p_0 =5% or a probability of misjudgment of 5% for the sample (or both are 5%), discussing "striving to avoid any non-conforming products in the 500 samples selected" is equivalent to discussing "using less stringent evaluation criteria to judge strict results."

3.1.2. For the Simplest Case where n=1 and Only One Quality Characteristic Value Approaches the Specification Limit

If the sampling plan is (1,0), only one sample needs to be inspected, and only one indicator is close to the specification limit, the supplier risk caused by inspection error is 5%, and the supplier risk caused by inspection batch quality judgment is also 5%, then the total risk borne by the supplier is 5%+5%−5% × 5%=9.75%. At least one of the two risks borne by the supplier (batch misjudgment risk and sample misjudgment risk) needs to be reduced in order to meet the requirement that the total risk borne by the supplier is ≤5%. To solve the quadratic equation of $x+x-x^2=5\%$, we obtain x=2.53%. That is to say, in the above situation, to meet the requirement that the total risk borne by the supplier for quality judgment is ≤5%, one of the possible solutions is to control the batch misjudgment risk and sample misjudgment risk below 2.53% (as shown in Table 3: there are also several combinations of 2-3, 3-2, 4-1, 1-4). More combinations of suitable batch misjudgment probabilities and sample misjudgment probabilities can be identified using Appendix 1.

Let $\alpha_{batch}=P(R_{\alpha(batch)})$, $\alpha_{sample}=P(R_{\alpha(sample)})$, $\beta_{batch}=P(R_{\beta(batch)})$, $\beta_{sample}=P(R_{\alpha(sample)})$, so we have the following relationship:

$$\alpha_{total}=\alpha_{batch}+\alpha_{sample}-(\alpha_{batch})(\alpha_{sample})=\alpha_{batch}+\alpha_{sample}(1-\alpha_{batch})=1+L(p_0)[\alpha_{sample}-1]. \quad (3)$$

$$\beta_{total}=\beta_{batch}+\beta_{sample}-(\beta_{batch})(\beta_{sample}). \quad (4)$$

3.1.3. For a Sampling Plan of (n, c)

The total risk of the supplier is

$$\alpha_{total}=\alpha_{batch}+\alpha_{sample}-(\alpha_{batch})(\alpha_{sample})=1-(1-\alpha_{batch})(1-\alpha_{sample}), \quad (5)$$

heae,

$$\alpha_{sample}=1-[(1-\alpha_i)(1-\alpha_j)(1-\alpha_k)\ldots(1-\alpha_n) \quad (6)$$

$$\left.\begin{aligned}
\alpha_i &= 1-[(1-\alpha_{\text{single item 1}})_i(1-\alpha_{\text{single item 2}})_i(1-\alpha_{\text{single item 3}})_i\cdots(1-\alpha_{\text{single item m}})_i]\\
\alpha_j &= 1-[(1-\alpha_{\text{single item 1}})_j(1-\alpha_{\text{single item 2}})_j(1-\alpha_{\text{single item 3}})_j\cdots(1-\alpha_{\text{single item m}})_j]\\
\alpha_k &= 1-[(1-\alpha_{\text{single item 1}})_k(1-\alpha_{\text{single item 2}})_k(1-\alpha_{\text{single item 3}})_k\cdots(1-\alpha_{\text{single item m}})_k]\\
&\cdots\quad\cdots\\
\alpha_n &= 1-[(1-\alpha_{\text{single item 1}})_n(1-\alpha_{\text{single item 2}})_n(1-\alpha_{\text{single item 3}})_n\cdots(1-\alpha_{\text{single item m}})_n]
\end{aligned}\right\} \quad (7)$$

The calculation of demand side risk is similar to the calculation method of corresponding supplier risk. When only one indicator in each sample approaches the specification limit, the second item to the right of the equal sign in each row of equation (7) is reduced to only the first factor. When the quality characteristic values of each sample are far from the specification limit (*i.e.*, when the difference between the detected quality characteristic value and the specification limit is greater than the detection uncertainty of the project), the risk of sample detection conclusions can be ignored: $\alpha_{total}\approx\alpha_{batch}$, $\beta_{total}\approx\beta_{batch}$.

3.2. Methods for Determining Approximation Algorithms and Sampling Plans

Before measurement, α_{sample} is just an estimate. When $(\alpha_{batch})(\alpha_{sample})$ is relatively small compared to α_{total}, using the approximate formula of $\alpha_{total}\approx\alpha_{batch}+\alpha_{sample}$ can basically meet the requirements. After measurement, further more accurate calculations require the use of equation (5). Under similar conditions, the demand side risk can also be calculated using the same approximate method.

The preparation of the sampling plan table requires replacing equations (1) and (2) with equations (8) and (9).

$$\alpha_{total}=1-L(p_\alpha)\approx 1-\sum_{x=0}^{c}\left[\begin{matrix}n\\x\end{matrix}\right]p_\alpha^x(1-p_\alpha)^{n-x} \quad (8)$$

$$\beta_{total} \approx \sum_{x=0}^{c} \begin{bmatrix} n \\ x \end{bmatrix} p_{\beta}^{x} (1 - p_{\beta})^{n-x} \quad (9)$$

here, $p_{\alpha} = p_0 + \alpha_{sample} - (p_0)(\alpha_{sample})$, $p_{\beta} = p_1 + \beta_{sample} - (p_1)(\beta_{sample})$.

Based on the series values of of α_{sample} and β_{sample} to calculate a set of sampling plans (for example, making each sampling plan in the old version of GB2828 or ISO2859 a set of sampling plans). Finally, based on the the α_{sample} and β_{sample} obtained from the first sampling measurement to assume that α_{sample}=0 and β_{sample}=0, adjust the sampling plan and re evaluate based on the adjusted sampling plan (if necessary, re sample for inspection). You can also estimate first α_{sample} and β_{sample}, re based on the size agreed upon by both the supply and demand parties α_{sample} and β_{sample} , use a sampling table to determine the sampling plan, and then based on the actual situation the size of α_{sample} and β_{sample} adjustment judgment result (if the original sample cannot meet the requirements, it must be re sampled for inspection).

For the sampling inspection of the quality and technical supervision department, p_0, p_1, α_{sample} and β_{sample}, we need to estimate in advance. The confidence interval of 95% confidence level is specified in the testing method standards. The difference between the results of two parallel measurements falls within this range, the value of α_{sample} and β_{sample} is still related to the difference between the measured value and the specification limit, rather than always being 5%. The inspection method standard stipulates that the number of parallel measurements is generally two, and it is difficult to ensure that the probability of the average measurement value being equal to the true value is greater than 95%.

The results of actual comparative experiments between different laboratories indicate that the deviation between the measured mean and true values in different laboratories also follows a normal distribution. So, in the same laboratory, measurement errors cannot be eliminated simply by increasing the number of measurements. It can be seen that measurement errors cannot be ignored under normal circumstances. As mentioned above, although it is theoretically possible to eliminate measurement errors by increasing the number of measurements, in reality, this can only eliminate accidental errors and is difficult to eliminate systematic errors. Only by increasing the number of measurements in different laboratories and taking the average of the measurement results from multiple laboratories (*i.e.*, taking the average at two levels) can measurement errors be basically eliminated. Eliminating measurement errors also comes at the cost of significantly increasing inspection costs. For the production side, the probability of sample misjudgment can be reduced by controlling the quality characteristic values far from the specification limit. But doing so will increase the difficulty of quality management and increase production costs.

4. Application Examples of Conclusions

The theoretical conclusions of this article can be immediately applied to production practice. The theoretical conclusion of this article can be immediately applied in production practice. The improvement of current standards can be divided into two aspects: first, improving product standards and inspection method standards; Secondly, improve the sampling plan.

4.1. Application in Product Standards and Inspection Method Standards

Example 1: The results of a single sampling inspection of a secondary urea sample in a certain laboratory were: total nitrogen content 46.1%, biuret content 1.54%, and moisture (H_2O) content 1.02%. Using the rounding comparison method, the sample was comprehensively judged to be qualified. Using the full number comparison method, the two items of biuret and moisture in the sample are unqualified, and it is comprehensively judged that the sample is unqualified. Due to the smaller difference between the measurement results and the specification limit, the higher the probability of misjudgment. Therefore, for situations where the specification limit is not exceeded much, the receiver (or acceptor) should relax some. For the determination of this sample and the batch it belongs to, the risk of sample testing results must be considered (especially the risks of the receiving party).

If the measured value is below the lower specification limit (or above the upper specification limit) and the difference is not greater than the length of the 95% confidence interval, it is required to increase the number of parallel measurements to 4 and determine the measurement results based on statistical rules.

Contents	Superior	First level	Second level	Measurement uncertainty	
				Same laboratory	Different laboratories
Total nitrogen (N) content,% (on a dry basis)	≥46.3	≥46.3	≥46.0	Not greater than 0.10	Not greater than ±0.15
Diuret content, %	≤0.9	≤1.0	≤1.5	Not greater than 0.05	Not greater than ±0.08
Moisture content, %	≤0.5	≤0.5	≤1.0	Not greater than 0.03	Not greater than ±0.03

Table 2: Quality Standards and Allowable Errors for Agricultural Urea (GB2440-1991)

4.2. Application in Sampling Methods

The main method is to replace the corresponding risks of the original inspection batch with. The basis is that measurement errors leading to misjudgments are equivalent to changing the quality level (process average) p_0 value, thereby increasing (or decreasing) the number of non-conforming products drawn when n remains constant, and increasing (or decreasing) the risk borne by the supplier.

The sampling table in the current standard GB 2828 (or ISO 2859) is designed based on a production risk of 5% and a user risk of 10%. Agree between supply and demand parties in a commodity transaction α_{batch} = 4%, β_{batch} = 10%, estimated α_{sample} = 1%, β_{sample} = 0. When using a sampling plan, actual measurements revealed that α_{sample} and β_{sample} were exactly equal to the estimated values. According to Table 3, it can be concluded that α_{total} =5%, β_{total} = β_{batch} =10%. Based on the known (or estimated or calculated) process average, directly check the existing GB 2828 (or ISO 2859) sampling table to determine the sampling plan. If the measured values of α_{sample} and β_{sample} in the above example are not the two estimated values, and a α_{total} is not 5%, then a sampling table with a supplier risk of not 5% should be prepared in advance (similar to GB2828) and used it. To prevent situations where the production side's risk is not 5% and the user's risk is not entirely 10%, it is necessary to pre expand sampling tables such as GB 2828 to a series of sampling tables with different α values and different β values. In this way, combined with Table 3 in this article, it is convenient to look up the table and determine the sampling inspection plan. For situations where multiple samples are taken or multiple samples are taken at once, in addition to calculating α_{total} according to equation (5), the sampling plan should also be adjusted based on the measured values α_{total} and β_{total} (for example, if the original samples are less, additional samples need to be taken; if the original samples are more, adjustments can be made by randomly removing excess samples or resampling). Both supply and demand parties can directly agree on acceptable values of α_{total} and β_{total}, and then determine sampling and implement sampling inspection based on them. If the measured value of α_{sample} is greater than the agreed value of α_{total}, it is necessary to adjust the sampling plan. For third-party sampling inspections, report the sizes of α_{sample}, β_{sample}, α_{total} and β_{total} while reporting the results (if α_{batch} and β_{batch} are selected as fixed values 5% and 10%, respectively, the values α_{batch} of β_{batch} and are not reported).

This example can also be handled by adding α_{sample} to the process average, and then directly checking GB 2828. For cases where β_{sample} =0, this can be done (for cases where α_{sample} =0 and β_{batch} ≠0, use the approach of $p_0-\beta_{batch}$).

Example 2: The supply and demand parties agree that the total risk borne by the supplier shall not exceed 7%, and the total risk borne by the demand side shall not exceed 13.6%. In actual sampling inspection, it was found that α_{batch} =2.28%, while β_{batch} =4%. According to Table 3, it can be concluded that α_{batch} =5%, β_{batch} =10%. At this point, existing sampling tables (such as GB 2828 and ISO 2859) can be directly used.

The determination of α_{sample} and β_{sample} is difficult in each specific measurement. But there are ways to overcome this (because all α_{sample} and β_{sample} are determined based on normal distribution functions and normal distribution graphs, such as Table 1 in this article) and in all standard normal distributions, the same quantile has the same probability. Even if only known σ but don't know μ, we can also calculate the confidence interval. It is recommended that the unit drafting the inspection method standards organize (or based on) a wide range of laboratory comparison results to find an approximate relationship between relative or absolute differences and the probability of misjudgment, and then compile a table for reference. The two processing methods in **Example 1** are both approximate (strict argumentation is required to determine which one is closer to reality), while the processing method in **Example 2** is strict. Many issues still require further research.

Probability of batch misjudgment (%)	**Probability of Misjudgment of Sample Quality (%)**													
	1.00	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**5.00**	**6.00**	**7.00**	**8.00**	**9.00**	**10.0**	**11.0**	**12.0**
1.0	1.99	2.98	3.48	3.97	4.46	4.96	5.95	6.94	7.93	8.92	9.91	10.9	11.9	12.9
2.0	2.98	3.96	4.45	4.94	5.43	5.92	6.90	7.88	8.86	9.84	10.8	11.8	12.8	13.8
3.0	3.97	4.94	5.42	5.91	6.40	6.88	7.85	8.82	9.79	10.8	11.7	12.7	13.7	14.6
4.0	4.96	5.92	6.40	6.88	7.36	7.84	8.80	9.97	10.7	11.7	12.6	13.6	14.6	15.5
5.0	5.95	6.90	7.38	7.85	8.32	8.80	9.75	10.7	11.6	12.6	13.6	14.5	15.4	16.4
6.0	6.94	7.88	8.35	8.82	9.29	9.76	10.7	11.6	12.6	13.5	14.5	15.4	16.3	17.3
7.0	7.93	8.86	9.32	9.79	10.3	10.7	11.6	12.6	13.5	14.4	15.4	16.3	17.2	18.2
8.0	8.92	9.84	10.3	10.8	11.2	11.7	12.6	13.5	14.4	15.4	16.3	17.2	18.1	19.0
9.0	9.91	10.8	10.3	11.7	11.1	12.6	13.6	14.5	15.4	16.3	17.2	18.1	19.0	19.9
10.0	10.9	11.8	10.2	12.7	12.1	13.6	14.5	15.4	16.3	17.2	18.1	19.0	19.9	20.8
11.0	11.9	12.8	13.2	13.7	14.1	14.6	15.4	16.3	17.2	18.1	19.0	19.9	20.8	21.7
12.0	12.9	13.8	14.2	14.6	15.0	15.5	16.4	17.3	18.2	19.0	19.9	20.8	21.7	22.6

Table 3: The Combined Risk of Batch Misjudgment Probability and Sample Quality Misjudgment Probability

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