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Application of integrity management method to improve the management level of gas flow standard facility

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Abstract

To improve the quality control performance on quantity transfer made by gas standard facility, the integrity management concept is applied to the quality control of quantity transfer in this study, and a "four-step method" is proposed. Herein, the application of calibrating a critical flow Venturi nozzle(CFN) with the *mt* gas standard facility is shown as an example. By applying the four-step method, it is possible to accurately identify the key influencing factors and quantitatively analyze their influence on the measurement results, conduct risk assessment and risk prediction for the measurement deviation of key measuring instruments and standard facility, and improve the quality control of standard management from passive disposal to active prediction, monitoring and control, so as to realize systematic, refined and intelligent management of standard quantity transfer.

1. Introduction

The standard facility is an important part of the gas flow quantity traceability system. To make sure the accuracy of the standard facility is under control, the regularly repetitive stability test and periodic verification are carried out by calibration institutions, and deviations can be found through the tests. Although the traditional quality control ways can effectively detect the accuracy and stability of the standard facility, the change in the measurement standard performance cannot be identified at the first time, and the appearance lag cannot be avoided. On account of this, the operator needs to make a reasonable test cycle based on the failure risk of the facility and test cost. To eliminate the deviation found through the test, in addition to check out and eliminating the deviation,it is also necessary to evaluate the influence of quantity transfer made by standard facility, and so as to quality traceability. If the quantity transfer involves other calibration institutions, the resulted influence would be more complicated.

Integrity management technology is to identify and evaluate the risk factors confronted in the operation of oil and gas pipelines, obtain pipeline integrity information through monitoring, testing, inspection and other methods, Equation the risk control countermeasures, and continuously improve the identified adverse influencing factors. Therefore, the risk level of pipeline operation is controlled within a reasonable range, and ensure the safe operation of pipelines economically and reasonably[2]~[3].

In this study, the accurate and reliable quantity transfer of the standard facility is taken as the control goal, and the "four-step method" measures for the quality control of the standard are formulated for reference to the pipeline integrity management idea.

2."Four-step method" for quality control of measurement standards

The standard facility completes the quantity transfer by calibrate the flowmeter. The key is to ensure the accuracy and reliability of the quantity transfer. In this study, the Integrity management concept is applied to the process of standard quantity transfer, combined with the six-step method of integrity management, to identify, analyze, conduct risk assessment, and formulate the control measures for the key factors of the standard quantity transfer, to improve the control level of the quantity transfer of the standard facility. The quality control of standard quantity transfer is divided into four steps:

1) Identification and evaluation of key factors in the standard facility quantity transfer. Analyze quantity transfer model of standard facility, and comprehensive identify the influencing factors in the process of the standard facility quantity transfer . Further carry out multivariate differentiation on the quantity transmission model, quantitatively evaluate the influence of the deviation of each influencing factor on the quantity transmission results, extract the parameters that have a significant impact on the quantity value transmission of the measurement standard facility based on the current

working conditions, and take the parameters as "key influencing factors" for further risk evaluation and quality control; Coupling calculation of the quantity transmission impact of multiple key influencing factors on the standard facility at the same time, as the basis of risk prediction.

2) Risk assessment and risk prediction of quantity transmission for standard facility. Regularly carry out risk assessment on key influencing factors, evaluate the probability that their deviation exceeds the control limit, and formulate response measures for the grading of risk assessment results. Risk prediction is used to evaluate the influence of the deviation of multiple key influencing factors on the standard facility, calculate the deviation value and probability of each key influencing factor in the next cycle through the prediction model, and calculate the quantity transmission deviation as well as its probability of the standard facility through the multi factor coupling algorithm.

3) Quality control of quantity transfer. For the key influencing factors, By the combination of the quantitative impact of their magnitude on the facility's quantity transmission results and their operating conditions, regularly online or offline monitoring measures and control limits are formulate to monitor their deviations; For the newly identified or newly added key influencing factors, research and formulate optimization measures to reduce the deviation, or reduce the impact of deviation on the quantity transmission results; formulate troubleshooting measures when the deviation of quantity transmission results exceeds the tolerance.

4) Efficiency evaluation. It is carried out efficiency regularly or when its necessary, summarize the quality control operation of the standard facility in the last cycle, reevaluate the key influencing factors according to the latest working conditions, optimize the risk assessment and risk prediction model, supplement and improve the quality control measures or put forward optimization suggestions, update the spare parts reserve plan, and evaluate the uncertainty of the implementation effect.

3.Application cases

This paper takes the calibration of critical flow Venturi nozzle(CFN) by mass-time(*mt*) gas flow standard facility as an example, Improved the level of standard facility through the "four steps" quality control of measurement standards.

3.1 Analysis of key influencing factors

3.1.1 Identification of influencing factors

3.1.1.1 Mass flow of *mt* gas flow standard facility

Mass flow of mass-time(*mt*) gas flow standard facility is calculated using the Equation (1):

$$q_m = \frac{(\Delta m_0 + \Delta m_1 + \Delta m_2 + \Delta m_3)}{(t_1 - \Delta t)} \tag{1}$$

Where: q_m is mass flow,kg/s;$\triangle m_0$ is Weighing the mass of natural gas in the spherical tank,kg;$\triangle m_1$ is mass of natural gas retained in additional pipe volume 1, kg;$\triangle m_2$ is mass of natural gas retained in additional pipe volume 2 ,kg;$\triangle m_3$ is Corrected mass affected by air buoyancy before and after weighing , kg; t_1 is time of timer,s;$\triangle t$ is Action compensation time for quick change-over valve, s.

In Equation (1),$\triangle m_1$ 和 $\triangle m_2$ is calculated using the Equation (2) :

$$\Delta m_j = V_{L,j}(\rho_{j,e} - \rho_{j,s}) \tag{2}$$

Where:$V_{L,j}$ is Volume of additional pipe volume j , m^3; $\rho_{j,e}$ is the gas density after inflation of additional pipe volume j, kg/ m^3; $\rho_{j,s}$ is is the gas density before inflation of additional pipe volume j, kg/ m^3; j=1,2.

In Equation (1),$\triangle m_3$ is calculated using the Equation (3) :

$$\Delta m_4 = V_{t,e}\rho_{0,e} - V_{t,s}\rho_{0,s} \tag{3}$$

Where:$V_{t,e}$ is Volume of spherical tank in contact with air after weighing, m^3; $V_{t,s}$ is Volume of spherical tank in contact with air before weighing,m^3; $\rho_{0,e}$ is Density of surrounding air after spherical tank inflation, kg/ m^3; $\rho_{0,s}$ is Density of surrounding air before spherical tank inflation, kg/ m^3.

3.1.1.2 Calibration of CFN with *mt* standard facility

Calibrating CFV with *mt* standard facility, discharge coefficientis calculated using the Equation (4):

$$C_d = \frac{q_m\sqrt{\left(\frac{R}{M}\right)T_0}}{AC_*P_0} \tag{4}$$

Where: C_d is discharge coefficient,1 ; R is gas constant ; M is Molecular weight of gas, kg/mol; T_0 is stagnation temperature at upstream inlet of CFN,K; A is throat area of CFN, m^2; C_* is critical flow function; P_0 is stagnation pressure at upstream inlet of CFN,Pa.

In summary equations (1) to (4), the factors affecting the calibration results of CFN by *mt* method standard facility include 28 items, such as time measurement, mass measurement, temperature, pressure and gas composition at the CFN, which will not be discussed in detail here.

3.1.2 Evaluation of the key influencing factors of standards on the accuracy of quantity transmission

3.1.2.1 Quantitative analysis of the influence of multiple factors on the mass flow of *mt* standard

According to Equations (1) ~ (3), the influence of each component on the standard mass flow of *mt* standard is

evaluated by multivariate differentiation method using the Equation (5):

$$dq_m = \frac{\partial q_m}{\partial \Delta m} d\Delta m + \frac{\partial q_m}{\partial t} dt \tag{5}$$

Evaluate each component in Equation (5) and get:

$$\frac{dq_m}{q_m} = \frac{1}{\Delta m}\left(d\Delta m_1 + \frac{\Delta m_2}{V_{L,1}} dV_{L1} + \frac{\Delta m_2}{(\rho_{le} - \rho_{ls})}\left(\frac{\rho}{P} dP + \frac{\rho}{M} dM - \frac{\rho}{T} dT - \frac{\rho}{Z} dZ \right) + \frac{\Delta m_3}{V_{L,3}} (dV_1 - dV_2 + dV_3) + \frac{\Delta m_3}{(\rho_{2,e} - \rho_{2,s})}\left(\frac{\rho}{P} dP + \frac{\rho}{M} dM - \frac{\rho}{T} dT - \frac{\rho}{Z} dZ \right) + d\Delta m_4 \right) - \frac{1}{t}(dt_1 - d\Delta t) \tag{6}$$

3.1.2.2 Quantitative analysis of the influence of multiple factors on the calibration results of CFN using *mt* standard

According to equation (1), the influence of each component on the result of calibrating the CFN using the *mt* standard is evaluated by using the multivariate differentiation method, in Equation (7):

$$dC_d = \frac{\partial C_d}{\partial q_m} dq_m + \frac{\partial C_d}{\partial T_0} dT_0 + \frac{\partial C_d}{\partial M} dM + \frac{\partial C_d}{\partial A} dA + \frac{\partial C_d}{\partial C_*} dC_* + \frac{\partial C_d}{\partial P_0} dP_0 \tag{7}$$

Equation (8) is obtained by decomposing and calculating each component:

$$\frac{dC_d}{C_d} = \frac{dq_m}{q_m} - \frac{dA}{A} + \left(\frac{1}{2T_0} - \frac{1}{C_*}(0.098(\frac{dT_0}{T_0})^{-0.004} - 0.1)\right) dT_0 - \left(\frac{1}{2M} + \frac{1}{C_*} 2\times 10^{-6} (\frac{dM}{M})^{-0.207}\right) dM - \left(\frac{1}{P_0} - \frac{1}{C_*} 3\times 10^{-9} (\frac{dP_0}{P_0})^{-0.356}\right) dP_0 \tag{8}$$

Among the Equation(8), because the calculation method of C_* is relatively complex, in order to facilitate the analysis, the fitting relationship between C_* and temperature, pressure and molar component deviation is established by data regression. After data checking and calculation, when the temperature deviation is within 0.3 ℃, the pressure deviation is within 50kPa, and the molar mass deviation is within 0.2kg/mol, the calculation deviation of the fitting result is within 0.01%, which is within the allowable range of this study.

3.1.2.3 Calculation example of factors affecting the calibration of CFN by *mt* standard

Select a large flow CFN (440m³/h) And small flow CFN (32m³/h) Take the calibration data of as an example to calculate the influence of each component deviation on the calibration results. Take the uncertainty limit of each component as an example to calculate the influence of its deviation on the calibration results:

Table1: Influence of component deviation on calibration results

Influence factor	Deviation of each factor	Relative deviation of calibration results(%)	
		Large flow	Small flow
Mass (g)	50.00	0.01	0.05
Time (s)	0.012	-0.02	0.00
Temperature (℃)	0.10	0.01	0.01
Pressure (kPa)	5.00	-0.11	-0.10
Molar mass (kg/mol)	0.012	-0.05	-0.07
Pressure of additional pipe volume 1 (kPa)	5.00	0.00	0.00
Temperature of additional pipe volume 1(℃)	0.10	0.00	0.00
Pressure of additional pipe volume 2(kPa)	5.00	0.00	0.00
Temperature of additional pipe volume 2(℃)	0.10	0.00	0.00

It is shown in table 1 that the pressure measurement deviation has the greatest impact on the *mt* standard calibration results, and a deviation equal to its uncertainty can lead to the calibration result deviation of 0.10%; The mass and time deviation are related to the inflation mass and inflation time. When the temperature measurement deviation equal to its uncertainty, the influence on the calibration result is about 0.01%; meanwhile, the deviation within the uncertainty range of the measuring instrument caused by the measurement of the additional pipe volume and buoyancy has an impact on the calibration result less than 0.01%. By calculation, when the pressure deviation of the additional pipe volume reaches 50kPa and the temperature deviation reaches 1 ℃ (10 times the uncertainty of the measuring equipment), the impact on the calibration result of the facility no more than 0.01%.

Through the above analysis, when the CFN is calibrated by the *mt* standard , the measurement deviation of mass, time, temperature, pressure and molar component can not be ignored, and the above five components are the key influencing factors.

When the components of each key factor have deviations at the same time, the influence on the facility's quantity transmission is calculated by using equations (6) and (8), and the uncertainty of each component is used as the deviation for coupling calculation. The deviation of the calculated calibration results is shown in Table 2:

Table2: Influence of multi factor coupling on calibration results

Influence factor	Deviation of each factor	Relative deviation of calibration results(%)	
		Large flow	Small flow
Mass (g)	50	-0.07	-0.03
Time (s)	0.012		
Temperature (℃)	0.1		
Pressure (kPa)	5		
Molar mass (kg/mol)	0.0124		

When multiple factors are coupled, the quantity transmission effects brought by each factor may offset each other to reduce the overall deviation, or the deviation may be larger through superposition. In addition, the *mt* standard facility is operated by a single channel. For the measurement standard facility with multiple parallel operations, the influence of the common factors (such as gas composition) deviation in the multi-channel common measurement is much

greater than that of the deviation of a certain channel standard facility.

3.2 Risk assessment and risk prediction of standard quantity transfer

Using appropriate models to make risk assessment of the key influencing factors, and make risk prediction of the standard is helpful to predict its operation status, and then evaluate the risk of key factors exceeding the tolerance, take control measures in time to avoid affecting the transmission results.

3.2.1 Risk assessment

Risk assessment is conducted on measuring instruments to assess the possibility that each measuring instrument will deviate beyond its control limit. The risk assessment can be calculated based on the following Equation :

Risk Value = Consequence Probability × Consequence. (9)

In this study, the consequence is uniformly specified as 1, that is, exceeding the control limit.

There are many risk assessment methods. According to the characteristics of the measurement standard facility and the current research results, the weighted combination of the historical data method and the trend extrapolation method are used to calculate the overrun possibility on this study. The probability algorithm is:

$$P=AP_1+BP_2 \quad (10)$$

In which:P is Probability that the consequence will occur; A is Weights of the trend extrapolation method; B is Weight of the historical data method; P_1 is Probability of exceeding the control limit/warning line determined by the historical deviation trend of the measuring instrument; P_2 is Failure probability obtained by comparing the service time of the measuring instrument with the statistical life.

Due to the lack of historical fault data for reference, A=90% and B=10% are set in this study. With the data collection, the weight parameters of the two methods are adjusted in the regular performance evaluation.

1) Probability calculation using trend extrapolation

Using the deviation results of historical comparison data of measuring instruments as basic data, a trend extrapolation model is established to predict the probability P_1 that the deviation exceeds the allowable limit in a future cycle.

Take a temperature transmitter as an example, select its daily comparison deviation results from January 6, 2020 to July 16, 2021 as the data basis, use the random forest model to carry out trend extrapolation modeling, and use the recent five comparison deviations of the temperature transmitter to predict the next comparison deviation .

Set the value of the control limit or warning limit of different measuring instruments as $\pm M$, The current daily alignment bias dataset used for forecasting is $x_1, x_2, \cdots, x_n$, and the predicted value of the next alignment bias data is $\hat{x}_{t+1}$. The probability of exceeding the next time the true value of the data exceeds the control limit or the warning limit can be regarded as the probability of the error ε of the prediction model exceeding $M-\hat{x}_{t+1}$ (Predicted value to upper warning limit or upper control limit) or $\hat{x}_{t+1}-M$ (Predicted value reaches the lower warning limit or the lower control limit), which is:

$$P_1 = 1 - P\{\varepsilon \in [M-\hat{x}_{t+1}, \hat{x}_{t+1}-M]\} \quad (11)$$

In which: $P\{\varepsilon \in [M-\hat{x}_{t+1}, \hat{x}_{t+1}-M]\}$ is The probability that the next time the true value of the data is in the range of $M-\hat{x}_{t+1}$ and $\hat{x}_{t+1}-M$; The probability of the error distribution in the interval $[-\varepsilon, \varepsilon]$ through the fitting result of the t distribution is calculated.

The comparison results on July 14 is predicted and the probability that the predicted value exceeds the control limit ±0.14 °C is calculated based on the comparison data from July 9 to July 13, 2020. The results are shown in Table 3.

Table3: Cases of the risk prediction

Date	Comparison results	Prediction results	Probability of exceeding the control limit
July 9	-0.0114	-0.0155	1.54%
July 10	0.0230		
July 11	-0.0173		
July 12	0.0446		
July 13	0.00738		

By calculating the probability that the comparison data on July 14 exceeds ±0.14°C is 1.54%, and the actual deviation value on July 14 is -0.014°C, the predicted result is consistent with the actual situation.

2) Probability calculation method of historical data method

For the same measuring instrument, the accumulated usage time and the accumulated usage time at the failure time are counted. For the measuring instrument L, its accumulated use time t_L, after statistics of the same type of measuring instrument reaches the accumulated time t_L, the intact number is k_1, and the number of faults (that is, the deviation exceeds the allowable limit) is k_2, then the probability P_2 that the deviation exceeds the allowable limit of the measuring instrument L, when its accumulated usage time is t_L, is:

$$P_2 = \left(\frac{k_2}{k_1+k_2}\right)_{t_L} \times 100\% \quad (12)$$

The risk value calculated by Equation(9) and Equation(10) is between (0 to 1), the risk value evaluation table is formulated, and the next step is formulated according to the risk value.

Table4: Risk value evaluation table

Risk value	Disposal measures
0.8-1	Confirm the quantity of measuring instruments

	immediately, and adopt the method of verification or calibration or comparison
0.6-0.8	Take an encryption test before the next comparison or check
0.2-0.6	Follow up on the next comparison or check result
0-0.2	Normal use and maintenance

3.2.2 Risk prediction

3.2.2.1 Risk prediction of measuring instruments

The risk prediction of a single measuring instrument uses the trend extrapolation method in 3.2.1.1, uses the historical data of measuring instrument deviation to model the deviation value $\hat{x}_{t+1}$ at time t in the future, and calculates the predicted probability P_1.

3.2.2.2 Risk prediction of standard quantity transmission

Take the deviation risk prediction results of each measuring instrument into equations (6) and equations (8), can get the risk prediction results of the standard , the probability of result is the probability of the deviation prediction results of each measuring instrument multiplied .

3.3 Quality control methods for quantity transfer

On the basis of fully evaluating the influence of key factors on the quantity transfer of standard , three aspects of quality control work are conducted for the quantity transfer process: 1. formulate quality monitoring measures; 2. formulate improvement measures; 3. formulate inspection measures for abnormal situations.

3.3.1 Basic quality monitoring measures based on identification of influencing factors

1) Quantitative traceability. Verify/calibrate measuring instruments such as electronic balances and timers in the standard facility regularly, and the calibration results should be within the specified uncertainty range. The natural gas reference material should be certified, and its quality should be verified.

3) Comparison of measuring instruments. Compare pressure transmitters, chromatographs, etc regularly. Compare the temperature and pressure transmitters in real time with their upstream transmitters as a reference, when CFN are calibrated. Establish the allowable deviation limits of measuring instruments according to their uncertainty.

4) Auxiliary measures. Conduct auxiliary inspections such as quick reversing valve action test, pipeline leak detection, and pipeline cleaning regularly.

4) Overall performance evaluation. Conduct periodic verification and repeatability testing of *mt* standard through CFN with relatively stable performance, as well as irregular inter-laboratory comparisons.

3.3.2 Improvement measures

It is shown from Table1 that the measurement results of the gas molar mass have a significant impact on the calibration results in CFN calibration. That a deviation of 0.01 kg/mol can cause a deviation of about (0.05%~0.07%) in the calibration results .

In order to ensure accurate measurement of mass molar mass, the influence of fluctuations in gas components should be avoided, in addition to ensuring accurate analysis results. When the component fluctuation is tiny, or when the large flow is calibrated, the components measured by the chromatograph are basically the same as the components passing through the CFN, which has little effect on the calibration results; When the small flow CFN is calibrated and the components fluctuate significantly, the fluctuation speed of the components is greater than that of the natural gas from the sampling position of the chromatograph to the position of the standard facility, which will affect the calibration results.

It can be obtained through the calculation, that the pipe volume from the sampling position of the chromatograph to the *mt* standard is 30.04266 m^3. When different flow CFNs are calibrated by the *mt* standard , the time for the natural gas from the sampling position to the *mt* standard is shown in Table 5.

Table 5: Time for the gas from sampling position to *mt* standard

	Flow of natural gas (kg/s)	Time for the gas from sampling position to *mt* standard(min)
Large flow	6	4.33
Medium flow	3	8.66
Small flow	0.1	259.79

To improve this situation, a new chromatograph is added to the upstream of the *mt* standard, and the pipe volume from the chromatographic sampling position to the *mt* standard is 1.8253m^3. When different flow CFNs are calibrated bt the *mt* standard facility, the time of the natural gas arrives from the new sampling position to the *mt* standard is shown in Table 6.

Table 6: Time for the gas from new sampling position to *mt* standard

	Flow of natural gas (kg/s)	Time for the gas from new sampling position to *mt* standard(min)
Large flow	6	0.26
Medium flow	3	0.53
Small flow	0.1	15.78

After the improvement, the time of the gas arrives from the chromatographic sampling point to the standard facility of the *mt* method is greatly shortened, and the influence of gas fluctuation on the calibration result is effectively reduced. At the same time, the fluctuation of the gaseous components during the calibration process will be followed up, and the calibration activities will be suspended once the fluctuation of the molar mass deviation within the time range of the calibration cycle exceeds the limit.

3.3.3 Inspection measures for abnormal situations

Combined with the influencing factors identified in 3.1.1 and the influence direction of the deviation of each factor calculated in 3.1.2 on the quantity of the facility, 28 deviation results inspection measures for the *mt* standard were formulated, which will not be discussed in detail here.

3.4 Efficacy evaluation

In regular efficacy evaluation, key factors evaluate should be taken based on current working condition,the risk evaluation and risk prediction model according to the management data of the previous cycle will be update, as well as the quality control and troubleshooting measures, provide a reference for the spare parts reserve plan. The uncertainty level of the facility is evaluated according to the optimization or operation of the facility in the previous cycle. The following is the uncertainty evaluation based on the operation and modification of the current cycle:

1)Standard facility hardware modification

According to the improvement measures in 3.3.2, a new chromatograph is installed at the upstream of the *mt* standard to reduce the influence of gas component fluctuations on the measurement results.

2)Evaluation of Uncertainty Value of C^*

In ISO 9300[1], the C^* value of common gases given in the standard is used for the uncertainty value of the C^*, and the relative uncertainty is 0.1% at the 95% confidence level. The uncertainty value of the C^* in special cases is specified, that is, "if the gas and its state are the same when using and verifying the CFN, the Equation $u(C^*)$ can be regarded as zero". For CFN used in high pressure natural gas conditions, its calibration and use conditions can not be same, therefor, the uncertainty of C^* shouldn't be set to zero. In order to evaluate its appropriate uncertainty, the use conditions of the CFN calibrated by the *mt* standard in its application site and the change of the C^* since the establishment of the standard of the facility are statistically analyzed as shown in the following.

A) The CFNs calibrated by the *mt* standard currently mainly include: home station, A station, B station, and C station. Taking a CFN as an example under the operating conditions of each station, the C^* value is calculated under the high and low limits within the range of the operating conditions. The calculation results are shown in Table 7.

Table7: C^* of CFN on its site

Site of CFN	C^*
A Station	0.713988
B Station	0.753270
C Station	0.725261
Home Station	0.715314

In Table 7, the maximum deviation of the C^* valueis:(0.753270-0.713988)÷0.715314×100%= 5.49 %.

B) The C^* value of the calibration CFV has been calculated since the application of the *mt* method gas flow standard facility. The maximum deviation is (0.767000 - 0.715530) ÷ 0.744762 × 100% = 6.91%, less than 7%. The results are shown in Table 8.

Table 8: The C^* of home station

Maximum C^*	Minimum C^*	Average C^*	Maximum deviation %
0.767000	0.715530	0.744762	6.91%

Combined with the above situation, the results of calibrating the CFN of the *mt* standard have been applied so far, the change of the C^* value does not exceed 7% under all working conditions of home station and corresponding to the on-site use conditions of various institutions. When evaluating uncertainty, conservatively take 20% of the maximum uncertainty of 0.1% in ISO 9300 as C^* uncertainty, which means $u(C^*)$=0.05%×20%=0.01%.

The above improvements and analysis are brought into the *mt* standard facility to evaluate the uncertainty of the CFN calibration. The uncertainty of the outflow coefficient is promote from U=0.15%, k=2 to U=0.10%, k=2.

4 Conclusion

The integrity management concept is applied to the quantity transfer's quality control in this study. Through the "four-step method" proposed herein, it is possible to accurately identify the key influencing factors and quantitatively analyze their influence on the measurement results, conduct risk assessment and risk prediction for the measurement deviation of key measuring instruments and standard facility, and improve the quality control of standard management from passive disposal to active prediction, monitoring and control. It is necessary to develop and update the method dynamically and continuously, identify and evaluate new influencing factors in a timely manner, update measures such as risk assessment and quality monitoring regularly, optimize and improve control methods continuously, so as to realize systematic, refined and intelligent management of measurement standard quantity transfer.

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