Research on Verification Algorithm and Risk Identification Method of Electric Power Measurement

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Abstract. This paper studies quality verification algorithm and risk identification method of automated verification of electric energy meter under the measurement intensive mode, including dynamic and static verification algorithm system of verification quality, and realizes automated assembly line operation and automated acquisition, conversion and analysis of status information data by ETL, OPC and other technologies, semi-quantitatively describes software and hardware, human error in the automated verification assembly line operation and risk identification method indicators for all kinds of risk critical equipment caused by external system failures in combination with the risk matrix method. The dynamic quality verification can be used to form transverse comparison for the verification sources in the verification equipment, the static quality verification can be used to vertically compare different batches of information tables, the equipment status acquisition and risk matrix algorithm can be used to effectively make the line operation state index to provide managerial personnel with auxiliary decision basis, thereby, the verification quality, the stability and reliability of the line operation of automated verification system can be effectively guaranteed.

Keywords: Electric power measurement; automated assembly line.

1. Introduction
The automated verification quality monitoring and risk assessment technology of electric energy meter is studied under the measurement intensive mode, and the system risk assessment plan and key technical indicators are studied, covering all kinds of faults at the system level, device level and table level of the automated verification system, it can quickly fix the fault point according to the risk assessment results; designing scientific and reasonable key technical indicators, collecting and analyzing the risk factors affecting the system operation, and improving the overall operational stability of system, through the collection and analysis of device status, guiding the planned maintenance, preventive maintenance, so that the device is always in the best state, faults and accidents are reduced, and production efficiency is improved.
The contents of verification quality assurance and risk assessment research mainly include quality monitoring and risk management, the quality monitoring module includes operation management, analysis management and verification quality management, the risk management module includes index management, report management and risk management. Through ETL, OPC and other technologies and external systems, such as production scheduling platform, automated storage system, automatic verification system of single-phase electric energy meter, automated verification system of three-phase electric energy meter and automated verification system of low-voltage current mutual inductor are used for information collection. Overall business structure is shown in Fig. 1.

Fig.1 Overall business architecture

2. Establish Quality Assurance System of Automated Verification Assembly Line

(a) Algorithm Research on Static Quality Verification

The transfer comparison method is adopted; one high-stability comparison electric energy meter is built in each set of verification device of electric energy meter, and it as an online synchronous measurement object, when the system carries out verification work, this comparison table and other batches of electric energy meter are synchronously verified, and then compares each verification result $y_{labi}$ with the traceability results $y_{ref}$ of comparison table values saved in the system.

Assume that expanded uncertainty ($U_{95}$ or $k = 2$) given by metering mechanism of comparison table monitoring is $U_{lab}$, when the comparison table value trace to the source, superior measurement standards gives extended uncertainty ($U_{95}$ or $k = 2$) $U_{ref}$, the coverage factor in both should be approximately equal. The monitoring results are evaluated as following formula:

$$E = \frac{|y_{labi} - y_{ref}|}{\sqrt{U_{lab}^2 + U_{ref}^2}}$$  \hspace{1cm} (1)
When the result is handled, the qualified area, warning area, unqualified area should be set for the monitoring results, namely:

When $E<0.7$, it is considered that the monitoring result meets the requirements, and the monitored verification device works normally;

When $0.7 \leq E \leq 1.0$, it is considered that the metering performance of the verification device may change or unqualified risks exists, at this time, the system should give a prompting and find the reason;

When $E>1$, the monitoring result is unqualified, and the system should notify the verification system to stop the verification.

(b) Algorithm Research on Dynamic Quality Verification

According to the offline dynamic monitoring cycle, the comparison method is adopted to select a batch of high-stability intelligent electric energy meter, which are regularly or irregularly transferred to different verification devices for verification (device comparison in unit), if the verification result of each table in different verification devices is $y_i$, the arithmetic mean of the verification results is $\bar{y}$, the measurement uncertainty of each device is $U_i$, then, the verification result of each table on the corresponding station of each device evaluates the monitoring result according to the following formula:

$$E = \frac{|y_i - \bar{y}|}{\frac{1}{n-1} \sum_{i=1}^{n} U_i}$$  \hspace{1cm} (2)

($n$ is the number of verification devices participating in the monitoring)

When the result is handled, the qualified area, the warning area, and the unqualified area should be set for the monitoring result, namely:

When $E<0.7$, it is considered that the monitoring result meet the requirements, and the monitored verification device is considered to be working normally;

When $0.7 \leq E \leq 1.0$, it is considered that the measurement characteristics of the verification device may change or unqualified risk exist, at this time, the system should give a prompting and find the cause;

When $E>1$, the monitoring result is unqualified, and the system should notify the verification system to prohibit the verification device and give a prompting.

3. Establish Online Acquisition System for Automated Verification Assembly Line Operation and Status Information

Through ETL and OPC, all kinds of information of the system are collected, and the information is collected into the buffer of the collection area, the system then classifies and queries various types of information according to the actual businesses.

The collection processing module automatically records the correlation information between the configuration item and the external data source. The collecting and processing are shown in Fig. 2.
The information obtained by the system from the MDS system and the local verification database mainly includes verification task information, verification conclusion information, verification sub-item conclusion information, and common code information, which are mainly carried out by means of ETL (Fig. 4).

(b) Automated Verification OPC Collection
The information of the automated verification system is mainly collected by OPC, which mainly includes abnormal fault information and running status information of devices (Fig. 5).

![Automated verification OPC collection](image)

**Fig. 5 Automated verification OPC collection**

4. Establish Risk Identification Index System of Automated Verification Assembly Line

The risk matrix method is used to semi-quantitatively describe the various risks caused by hardware and software, human error and external system faults in the automated verification assembly line, assess the severity of the risk through various risk values from the quality monitoring and risk identification system, and give corresponding risk control measures.

Taking the feeding robot fault risk (special machine risk) analysis as example:

(a) Risk Identification

The feeding robot fault mainly includes: robot body fault (signal line break), fixture fault, positioning transfer table fault, feeding roller line fault, feeding action fault, etc.

Sources of fault: the strain of the machine after frequent operation of the devices, the meter positioning caused by the deformation of the carton is not accurate.

(b) Risk Analysis

The main consequences of the feeding robot fault are: unsuccessful feeding, affect the verification efficiency, and even cause the overall system to be out of service.

(c) Risk Assessment

The information source of the feeding robot fault statistics is the abnormal alarm signal of the automated verification system and the fault registration report input by hand. The abnormal alarm information is shown in Table 1.

| Abnormal alarm information                                      | Source               |
|----------------------------------------------------------------|----------------------|
| robot item drop                                                | delivery system PLC  |
| robot fixture is abnormal                                       | delivery system PLC  |
| robot sucker is abnormal                                        | delivery system PLC  |
| abnormal alarm of transfer table                                | delivery system PLC  |
| feeding robot roller line box gets stuck and give an alarm      | delivery system PLC  |
| feeding robot gets stuck and gives an alarm                     | delivery system PLC  |
| feeding robot is low pressure and gives an alarm                | delivery system PLC  |
| feeding robot stops and gives an alarm                          | delivery system PLC  |
Through count the fault occurrence frequency and the fault stopping time during the assessment period, the fault occurrence frequency level and the severity level is determined, and the fault risk level of the feeding robot is determined.

Take the assessment period with one week (five working days) as an example:
The corresponding table between the number of fault and the frequency index is shown table 2.

### Table 2. Corresponding table of the number of failures and the frequency index

| number of faults | frequency index |
|------------------|----------------|
| 1                | 1              |
| 2                | 2              |
| 3                | 3              |
| 4                | 4              |
| ≥5               | 5              |

The corresponding table between stopping time and severity is shown table 3.

### Table 3. Corresponding table of stopping time and severity

| stopping time       | severity |
|---------------------|----------|
| T ≤ 15 min          | 1        |
| 15 min < T ≤ 30 min | 2        |
| 30 min < T ≤ 45 min | 3        |
| 45 min < T ≤ 60 min | 4        |
| 60 min < T          | 5        |

When the assessment period is monthly or annual, this indicator is valued at 60% of the scaling up.
The risk level assessment table is shown table 4.

### Table 4. Assessment table of risk level

| occurrence frequency | stopping time |
|-----------------------|---------------|
| 5                     | 5 10 15 20 25 |
| 4                     | 4 8 12 16 20 |
| 3                     | 3 6 9 12 15  |
| 2                     | 2 4 6 8 10   |
| 1                     | 1 2 3 4 5    |

Among them:
The risk level index which is less than 5 (green) is low risk area;
The risk level index which is greater than or equal to 5 and less than 15 (white) is medium risk area;
The risk level index which greater than or equal to 15 (red) is high risk area.

(d) Risk response
Low-risk area: the fault record needs to be registered in normal working condition.
Medium-risk area: the prompting information should be output on the risk identification interface; we should focus on the daily production inspection process, and carry out special inspections in the next quarterly maintenance work.
High-risk area: The prompting information should be output on the risk identification interface, special inspection and maintenance work of the device should be carried out immediately, and a fault analysis report should be prepared.
5. Conclusion

The quality verification and risk identification technology of electric power measurement are adopted, and the verification quality of the verification equipment is regularly tracked and evaluated through the dynamic and static quality verification methods, which can effectively improve the accuracy and stability of the verification device; through the collection and analysis of the equipment status, provide timely assistance for eliminating defects of equipment and carrying out condition maintenance operation of equipment; through assembly line risk matrix identification method, design scientific and rational key technical indicators, collect and analyze risk factors affecting system operation, and can get corresponding risk control measures according to risk identification results. Therefore, studying quality verification algorithm and risk identification method of electric power measurement can make the verification equipment of electric power measurement always keep the best condition, reduce failures and accidents, improve production efficiency, improve the operation and maintenance level of the automated verification system, and achieve cost reduction and efficiency increase.

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