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## Research on Development Status and Trend of Measurement of Highway Engineering Inspection Equipment

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# Research on Development Status and Trend of Measurement of Highway Engineering Inspection Equipment

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**Abstract.** Based on the analysis of the current situation of measurement and management of highway engineering testing equipment, the measurement system of highway engineering professional instruments has been initially formed. In order to further guarantee the quality of highway engineering testing, this paper puts forward some suggestions on the traceability and management of measurement instruments throughout their life cycle Introduction.

## 1. Introduction

Measurement is an important cornerstone of China's transition from a "big transportation country" to a "strong transportation country". Quality change is inseparable from the basic role of measurement work. Minister Li Xiaopeng pointed out that in order to build a strong transportation country, we must firmly grasp the key of high-quality development, focusing on four aspects: promoting the quality, efficiency and power transformation of transportation development; serving the people, serving the overall situation, serving the grass-roots level; building people's satisfactory transportation; and building modern transportation<sup>[1]</sup>. Facilities, trade, capital and people's hearts are all connected by accurate and consistent measurement<sup>[2]</sup>. Fair and reliable measurement is needed to build a solid and reliable bridge for the interconnection of the world. The birth and development of highway metrology has provided new possibilities for our country to develop intelligent transportation and realize intelligent city. Advanced highway metrology technology, penetrating into the city's infrastructure and intelligent transportation, is the cornerstone of urban wisdom development<sup>[3]</sup>. Intelligent transportation is the future development direction of smart city. Highway metrology, as the basic work of controlling quality and benefit, provides a platform and creates opportunities for the development of smart city.

However, with the continuous development of science and technology, the traffic industry testing instruments tend to be intelligent, many testing instruments have no verification rules/calibration specifications or rules update speed is not timely. At present, there are more than 300 kinds of testing and testing equipment in highway engineering, including more than 200 kinds of special testing instruments and equipment, but only dozens of verification/calibration rules of special equipment have been completed, and the gap is large. Because the personnel of testing and testing institutions do not fully understand the measurement management mode of instruments and equipment, they have completed the follow-up work of traceable instruments and equipment, such as measurement confirmation and verification, which directly leads to the failure of traceable instruments and equipment. There are great hidden dangers in the quality of the project.



## 2. Current status of metrological traceability of Highway Test and detection instruments

### 2.1 Institutional operation.

At present, more than ten provinces and municipalities in China have carried out the verification/calibration of highway engineering test and test instruments and equipment. Several provinces and cities such as Beijing, Shandong, Hubei, Jiangsu, Sichuan, Guangdong and Zhejiang have obtained special authorization from the statutory metrological verification agencies. In addition to 67 test and test instrument projects and 137 approved projects in Shandong Province, there is a large gap in the business scope of other cities compared with the industry demand, which is related to the late development of highway metrology.

### 2.2 Traceability of Highway Test instruments.

The testing and testing equipment used in the process of highway industry testing is mainly special testing equipment. Most of these special testing instruments are complex parameters, comprehensive quantity and dynamic on-line measuring instruments. The traceability of a single value of a special testing instrument in accordance with the general measuring instrument can not meet the requirements of the work. With the development of science and technology, the renewal of professional testing equipment is faster, and the operation of the equipment is becoming more and more complex.

At present, there is a phenomenon that the specifications and models of test and test instruments for highway engineering are not uniform, whether imported or domestic. There are two main reasons: on the one hand, the product standards are not perfect, there are no restrictions on the production enterprises, lack of product standards, and no basis for government supervision; on the other hand, lack of industry standards and verification/calibration standards, and lack of publicity and implementation.

### 2.3 The construction of traceability system of quantities.

China's metrological technology institutions at all levels have formed a public-oriented metrological verification system, which mainly undertakes the metrological verification/calibration of general instruments and equipment. In the measurement management of various industries in the country, due to the strong professionalism of many instruments and equipment in the industry, the social public measurement and verification institutions lack the corresponding measurement standards, and can not carry out effective measurement and verification of these instruments. In order to solve this problem, China has approved the establishment of a number of professional measurement stations, such as the National Rail Scale Measurement Station, the National High Voltage Measurement Station, the National Ocean Measurement Station and so on<sup>[4]</sup>, and established corresponding measurement standards to provide verification/calibration services for specialized instruments and equipment in the industry. In addition to the establishment of professional verification agencies, these industries have also issued relevant measurement management systems within the industry, and the competent industry departments have supervised and managed the measurement management within the industry, thus effectively solving the problem of traceability of the volume value of specialized instruments and equipment in these industries. In the construction of local professional verification institutions in the transportation industry, at present, Beijing, Shandong, Jiangsu, Hubei, Sichuan, Guangdong, Zhejiang and other provinces have established local professional metrological verification institutions, which have been authorized by metrological administrative departments and become legal professional metrological verification institutions.

## 3. Current Situation of Management of Highway Testing and Testing Instruments

### 3.1 Confirmation of Highway Test instruments.

Many inspectors believe that as long as there is a certificate, it shows that the instrument meets the requirements, and there is no measurement confirmation at all. When the calibration certificate is

provided, the judgement of qualified or not will not be given. It needs the technical personnel to confirm according to the requirements of the use of the testing instrument. If not, the measuring results of the testing instrument will not have any significance. When a verification certificate is provided, the certificate can only ensure that the measuring instrument will continue to meet the anticipated operational requirements after confirmation, although the conclusion of qualification is given in the certificate.

### *3.2 Intermediate Verification of Highway Test Inspection Instruments*

Due to the general misunderstanding of the inspection laboratory in the period of verification, the Period Verification of testing instruments and equipment can not be effectively implemented, and there are great hidden dangers in the road test results. In order to ensure the reliability of the calibration status of the measuring instrument in use, the equipment needs to be checked during the two calibrations.

## **4. Suggestions**

### *4.1 Improving the traceability system of transportation industry and speeding up the distribution of metering service network.*

Highlighting the characteristics of the transportation industry, focusing on solving the traceability problem of the transportation industry and testing instruments and equipment, speeding up the construction of provincial professional metrology verification institutions, improving the layout of the network of measurement services in the transportation industry, and improving the service level of the metrology industry. Scientific and reasonable service network is an effective guarantee for the smooth development of metrology. Most of the common equipment in industry can be tracked through the social public measurement system. For traceability of professional equipment, industry management should be adhered to avoid the occurrence of ineffective traceability<sup>[5]</sup>.

### *4.2 Improve the measurement standard system and enhance the operability of the regulations.*

At present, only part of Highway Test and test instruments in the transportation industry have verification rules/calibration specifications. With the development of technology and the updating of test and test instruments, it has been unable to meet the demand of traceability of instruments, further improve the measurement technology standard system in the transportation industry, increase the scientific research investment of measurement technology, and ensure the validity of the standard specifications and the ability to maintain technology.

### *4.3 Strengthen the construction of Metrology talents and increase the development potential of metrology industry.*

Establish a management training system for calibration/calibration personnel in transportation industry, do well in pre-job training and continuing education for calibration/calibration personnel (including internal school personnel), improve the measurement technical ability of measurement technicians, and constantly improve the quality of measurement work. At the same time, the training work should strengthen the publicity and implementation of industry measurement standards to promote the development of industry measurement work<sup>[6]</sup>.

### *4.4 Make measurement confirmation.*

Confirmation is a set of operations needed to satisfy the requirement that the measuring equipment is in the state of meeting the anticipated use. After obtaining the traceability certificate, the test instrument should confirm the conformity of the traceability results according to the requirements, and consider the correction factor when necessary. Firstly, according to the calibration certificate, the uncertainty is compared with the control limit of the measured parameters in the measurement process required by the testing instrument. The ratio of the uncertainty of the college certificate to the control

limit of the measured parameters is within 1/3, and the more stringent lateral process needs to be controlled within 1/10. Then, the calibration results are compared with the measurement requirements of the testing instrument to see if it is correct or not. Within the standard requirement, verification certificates also need to be confirmed. We can not simply think that certificates have given a qualified or not, but do not confirm.

#### *4.5 Effective identification of testing instruments and equipment*

All testing instruments and equipment in site laboratories should be labeled, including management and use status. The contents of the management card for testing instruments and equipment include the number, name, model specification, manufacturer, factory number, installation location, use department and main technical parameters of the testing equipment. The information should be consistent with the information in the management files of the instruments and equipment. The use status of the instruments and equipment should be uniformly identified with three color labels, which can be divided into three categories: permissive, restricted and disabled. "Green", "Yellow", "Red".

#### *4.6 It is planned to carry out the verification work during the testing and testing instruments.*

The instability of material performance, wear in use, environmental changes, movement and transportation of testing instruments may lead to changes in measuring performance of instruments and equipment in the verification or calibration cycle. If there is a problem with the test data of the testing instrument during the verification or calibration, the time of the instrument's misalignment can not be judged in the traceability period, and the reliability of the data provided by the equipment can not be guaranteed<sup>[7]</sup>. Reasonable inspection during calibration period can monitor the metering performance of equipment to a certain extent, so as to avoid the above problems. Periodic verification is not a general functional inspection, and it can not be replaced by verification or calibration. The core of verification or calibration is to evaluate the measurement performance of measuring instruments by measuring standards, and to verify during the period by using stable standards. It is only to observe whether the calibration status of the checked instruments has changed. It is a good way to measure the reliability of the instruments during the period of two calibrations or calibrations.

### **5. Summary**

Only by grasping the current situation of the measurement work of Highway Test and detection instruments, focusing on the future, gradually improving the traceability system of the transportation industry, the measurement standard system, strengthening the construction of measurement personnel, and carrying out periodic verification of instruments and equipment in a planned way, can the quality of highway engineering detection be guaranteed and the management of highway measurement be enriched and improved.

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