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## Investigation of Automatic Measurement System on Weighing Instruments

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**Abstract**—According to the test requirements of recommendation OIML R76 about non-automatic weighing instruments, an automatic measurement system on weighing instruments is studied and developed. The operators of the system can perform type evaluation tests of weighing instruments which maximum capacity are less than 3000 kg by means of mass standards combined automatically at random. The system includes automatic loading and unloading function without impact and adhesion. Therefore type evaluation tests of weighing instruments with the maximum capacity above 50 kg such as indication error test, repeatability test, tare test, static temperature test and Damp heat test can be finished automatically by the system. The system can solve the problem that type evaluation test of weighing instruments with the maximum capacity above 50 kg is not performed by means of personnel. The experimental results show the performance of system is steady. The system can avoid the disturbance of personnel factor and provide the insurance of personnel safety in the measurement.

**Keywords:** weight; type evaluation; repeatability; static temperature; damp heat

### 1 Introduction

When non-automatic weighing instruments and automatic weighing instruments with the maximum capacity above 50 kg are performed the type evaluation tests, personnel to perform the test can not finish all tests by themselves due to greater maximum capacity, unless lifting appliance can be used to move mass standards. When temperature

tests and damp heat tests are performed, it is very difficult for personnel to do the tests in the temperature and humidity controlled cabinet without auxiliary moving and lifting devices. To solve the problems of type evaluation tests, an automatic measurement system on weighing instruments is developed according to the test technical requirements of international recommendation OIML R76, R50, R61, R107 and R134. The system may complete repeatability test, weighing performance test, tare test, temperature test, damp heat test and so on for weighing instruments with the maximum capacity below 3000 kg.

### 2 The operation principle of automatic measurement system

The structure of automatic measurement system on weighing instruments is shown in figure 1. The system is comprised of automatic loading and unloading device, servo-driven device, temperature and humidity controlled cabinet, controller, the frame of nonstandard-shape weights, nonstandard-shape weights, automatic handcart and camera.

Automatic loading and unloading device is fixed on the middle of temperature and humidity controlled cabinet. To move the frame of nonstandard-shape weights, nonstandard weights and weighing instruments under test conveniently, two rails that can be seamless connected with the rails on the automatic handcart are paved on the ground of temperature and humidity controlled cabinet both sides of automatic loading and unloading device, which take as the center. According to test technical

requirements of international recommendation, weighing performance test, tare test, temperature test, damp heat test and so on are completed by the way of loading and unloading 10 different load. Because the maximum capacity and verification scale interval of each weighing instruments under test are different, 10 test loads selected are also different. Therefore, the nonstandard-shape weights as mass standards for type evaluation tests are selected at random to combine 10 test loads according to different parameters of weighing instruments. To adapt the test technical requirements of weighing instruments with different maximum capacity, the nonstandard-shape weights are comprise of 3000 kg weights and 300 kg weights. The 3000 kg weights include five weights of 500 kg, three weights of 200 kg, four weights of 100 kg, five weights of 50 kg and two weights of 25 kg. The 300 kg weights include five weights of 50 kg, three weights of 20 kg, four weights of 10 kg, five weights of 5 kg and two weights of 2.5 kg.

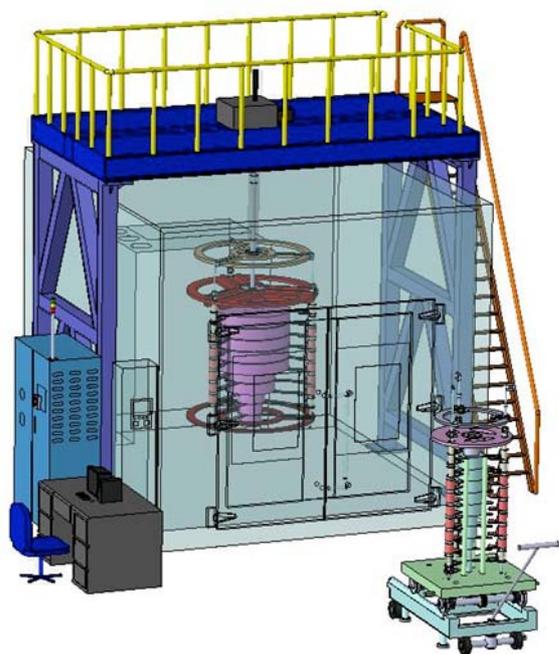


Figure 1 The structure of automatic measurement system on weighing instruments

The frame of nonstandard-shape weights is moved into the center of temperature and humidity controlled cabinet by the automatic handcart and connected with automatic loading and unloading device before the test. After that, 10 test loads placed

the automatic handcart from small weight to big weight are selected according to the parameters of weighing instruments under test. Then the 10 test loads are moved the center of temperature and humidity controlled cabinet by the automatic handcart and lifted to the specified high by servo-driven device and the frame. Finally, the weighing instruments under test is moved the center of temperature and humidity controlled cabinet for performing type evaluation tests. The pictures of automatic measurement system on weighing instruments, 3000 kg nonstandard-shape weights and combined 10 test loads are shown in figure 2, figure3 and figure 4 respectively. One test load is down 5 mm~10 mm in order to loading in the test process. On the contrary, the operation of unloading is accomplished. The data of test are recorded after 5~8 second of loading or unloading function. The whole process with load and unload needs approximately 12 minute.



Figure 2 Automatic measurement system on weighing instruments



Figure 3 3000 kg nonstandard-shape weights



Figure 4 Combined 10 test loads

The whole test process is controlled by computer inside control cabinet. The test data are recorded by camera device inside the temperature and humidity controlled cabinet. The test data are converted into the test sheet by terminal software automatically. Automatic loading and unloading function without impact and adhesion is achieved by the accurate control. The interfaces of terminal software are shown in figure 5 and figure 6 respectively.

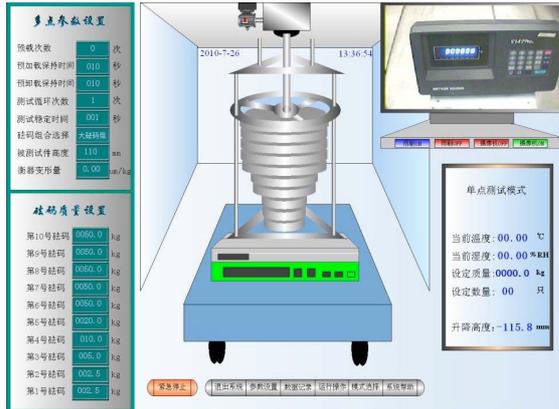


Figure 5 General interface of terminal software



Figure 6 Parameter setup interface of terminal software

### 3 The experiment and analysis of automatic measurement system

According to the test technical requirements of international recommendation OIML R76, the weighing instruments with the maximum capacity of 3000 kg is performed static temperature test and damp heat test in the temperature and humidity controlled cabinet. Table 1, 2 and 3 are weighing performance test data at 40 °C、-10 °C and 40 °C/85%RH respectively.

Table 1 weighing performance test data at 40 °C

Load L (kg)	Indication I (kg)		Add. load ΔL		Error E (kg)		Corrected error E <sub>C</sub> (kg)		mpe (±kg)
	↓	↑	↓	↑	↓	↑	↓	↑	
50	50.0	49.6			0.0	-0.4		-0.4	0.5
100	100.0	99.8			0.0	-0.2	0.0	-0.2	0.5
200	200.0	199.5			0.0	-0.5	0.0	-0.5	0.5
300	299.8	299.5			-0.2	-0.5	-0.2	-0.5	0.5
500	499.8	499.7			-0.2	-0.3	-0.2	-0.3	0.5
1000	999.8	999.8			-0.2	-0.2	-0.2	-0.2	1.0
1500	1499.8	1499.4			-0.2	-0.6	-0.2	-0.6	1.0
2000	1999.8	1999.8			-0.2	-0.2	-0.2	-0.2	1.0
2500	2499.9	2499.8			-0.1	-0.2	-0.1	-0.2	1.5
3000	3000.0				0.0		0.0		1.5

Table 2 weighing performance test data at -10 °C

Load L (kg)	Indication I (kg)		Add. load ΔL (kg)		Error E (kg)		Corrected error E <sub>C</sub> (kg)		mpe (±kg)
	↓	↑	↓	↑	↓	↑	↓	↑	
50	50.0	50.1			0.0	0.1		0.1	0.5
100	100.0	100.0			0.0	0.0	0.0	0.0	0.5
200	199.6	199.6			-0.4	-0.4	-0.4	-0.4	0.5
300	299.7	299.7			-0.3	-0.3	-0.3	-0.3	0.5
500	499.6	499.5			-0.4	-0.5	-0.4	-0.5	0.5
1000	999.3	999.3			-0.7	-0.7	-0.7	-0.7	1.0
1500	1499.9	1499.5			-0.1	-0.5	-0.1	-0.5	1.0
2000	1999.6	1999.4			-0.4	-0.6	-0.4	-0.6	1.0
2500	2499.4	2499.3			-0.6	-0.7	-0.6	-0.7	1.5
3000	2999.3				-0.7		-0.7		1.5

Table 3 weighing performance test data at 40 °C/85%RH

Load L (kg)	Indication I (kg)		Add. load ΔL (kg)		Error E (kg)		Corrected error E <sub>C</sub> (kg)		mpe (±kg)
	↓	↑	↓	↑	↓	↑	↓	↑	
50	50.0	50.0			0.0	0.0		0.0	0.5
100	100.0	99.9			0.0	-0.1	0.0	-0.1	0.5
200	200.1	200.3			0.1	0.3	0.1	0.3	0.5
300	300.1	300.3			0.1	0.3	0.1	0.3	0.5
500	500.2	500.4			0.2	0.4	0.2	0.4	0.5
1000	1000.2	1000.1			0.2	0.1	0.2	0.1	1.0
1500	1500.1	1500.2			0.1	0.2	0.1	0.2	1.0
2000	2000.3	2000.3			0.3	0.3	0.3	0.3	1.0
2500	2500.5	2500.4			0.5	0.4	0.5	0.4	1.5
3000	3000.7				0.7		0.7		1.5

Table 1, 2 and 3 are convert to data sheets by the terminal software. Experimental data of table 1, 2 and 3 show the automatic measurement system on weighing instrument is stable, and there is no adhesion in the process of loading and unloading. So the system can accomplish all test according to the test requirements of international recommendation OIML R76, R50, R61, R107 and R134.

### 4 Conclusions

The test device conforming to test technical requirements of international recommendation is updated step by step to improve the test capacity of type evaluation. Automatic measurement system can accomplish automatic loading and unloading function without impact and adhesion. The system may achieve repeatability test, weighing performance test, tare test, temperature test, damp

heat test and so on for weighing instruments with the maximum capacity below 3000 kg. The system can solve the problem that type evaluation test of weighing instruments with the maximum capacity above 50 kg is not performed by means of personnel. The experimental results show the performance of system is steady. The system can avoid the disturbance of personnel factor and provide the insurance of personnel safety in the measurement.

#### References

- [1] International Recommendation OIML R76-1 Edition 2006(E), “Non-automatic weighing instruments”, pp: 85-100, 2006.
- [2] International Recommendation OIML R50-1 Edition 1997(E), “Continuous totalizing automatic weighing instruments”, pp: 33-34, 1997.
- [3] International Recommendation OIML R61-1 Edition 2004(E), “Automatic gravimetric filling instruments”, pp: 31-32, 2004.
- [4] International Recommendation OIML R107-1 Edition 2007(E), “Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers)”, pp: 48-51, 2007.
- [5] International Recommendation OIML R134-1 Edition 2006(E), “Automatic instruments for weighing road vehicles in motion and measuring axle loads”, pp: 49-52, 2006.