ITTC Quality System Manual

Sample Work Instructions

Work Instructions

Calibration of Weights

7.6	Control of Inspection, Measuring and Test Equipment
7.6-02	Sample Work Instructions
7.6-02-08	Calibration of Weights

Prepared by	Approved
Quality Systems Group of 28th ITTC	28th ITTC 2017
Date 02/2017	Date 09/2017

Table of Contents

Calibration of Weights

1. PURPOSE OF INSTRUCTION

This work instruction shall be applied to new weights and calibration of weights in service and after repair. All weights shall be certified by a laboratory with traceability to the National Metrology Institute (NMI) within each country.

2. SCOPE

The instruction defines the weight calibration requirements in naval hydrodynamic testing for ITTC. Typically, weights are used in calibration stands for the calibration of force dynamometers in towing tank tests for resistance and calibration of torque transducers for propulsion tests. Additional information on calibration requirements for force and torque is located in ITTC procedure 7.5-01-03-01 (2017). Precision weights are also needed in surface ship model incline measurements in the determination metacentric height and center of gravity. Weights also certify and check electronic scales.

3. WORK INSTRUCTION

3.1 Technical Requirements

3.1.1 Classification of Weights

The international standard for the classification of weights is OIML R111-1 (2004). Per OIML (2004), the weight classes are E_1, E_2, F_1, F_2, M_1, $M_{1\text{-}2}$, M_2, $M_{2\text{-}3}$, and M_3. In the USA, the standards are ASTM E617-13 (2013) and NIST Handbook 105-1 (1990). The maximum recommended tolerance is ±0.010 %. The recommended classes for ITTC applications are OIML Class M_2 (±0.0050 %), ASTM Class 6 (±0.010 %), and NIST Class F (±0.010 %). The maximum tolerances δm in mg are summarized in Table 1.

3.1.2 Adjustment

A weight of given nominal value shall be adjusted in such a way that the conventional mass of the result of weighing this weight in air is equal to the given nominal value, within the limits of the maximum permissible errors fixed for the accuracy class to which the weight belongs.

3.1.3 Marking

Weights shall be marked with the nominal value. Weights shall also be marked by the user so that the weight may be linked to its calibration certificate.

3.1.4 Certificates

Weights or weight sets shall be calibrated and verified per the requirements by the country of each laboratory per paragraph 15.2 of OIML (2004) with traceability to the country's NMI. The calibration certificate should be similar to the example in OIML (1991). The certificate shall contain the following minimum information:

- Nominal weight and units
- User identifier
- Conventional mass of the weight
- Indication of whether the weigh has been adjusted prior to calibration
- The expanded uncertainty, *U*

- Value of the coverage factor, k
- Reference standard for the calibration and its calibration date.

4. UNCERTAINTY

For each weight, the expanded uncertainty, U, for k = 2, of the conventional mass, shall be less than or equal to one-third of the maximum permissible error in Table 1.

$$U \leq \delta m / 3 \tag{1}$$

Weights not within the uncertainty of Equation (1) shall be adjusted.

In applications with certified weights, the tolerance δm in Table 1 shall be applied as the estimated expanded uncertainty, U. Since the weight set is calibrated at a single calibration laboratory, the uncertainty in the weight calibration is assumed as correlated. Consequently, the combined and expanded uncertainty of the total load is

$$U_c = \sum_{i=1}^{n} U_i = \sum_{i=1}^{n} \delta m_i \tag{2}$$

Nominal mass (kg)	OIML	ASTM	NIST
	Class M_1	Class 6	Class F
5000	250000	500000	
2000	100000	200000	
1000	50000	100000	
500	25000	50000	50000
200	10000	20000	20000
100	5000	10000	10000
50	2500	5000	5000
20	1000	2000	2000
10	500	1000	1000
5	250	500	500
2	100	200	200
1	50	100	100
0.5	25	50	50
0.2	10	20	20
0.1	5.0	10	10

Table 1: Maximum tolerances of δm in mg for various weight standards.

5. SUMMARY

This procedure outlines the requirements for calibration weights employed in the calibrations at naval hydrodynamics laboratories. These calibrations include force and torque transducers and incline tests. In general, ITTC laboratories do not have traceability for the calibration of weights, and the weights need to be calibrated by a laboratory with NMI traceability. The detailed requirements for the certification of weights are described in OIML R111-1 (2004).

This document is a major revision of the previous version. The previous version contained information similar to that of OIML R111-1 (2004). The information is only necessary for laboratories that calibrate weights with NMI traceability. This procedure outlines weight calibration information necessary for naval hydrodynamics testing relevant to ITTC.

REFERENCES

ITTC, 2017, "Uncertainty Analysis: Instrument Calibration," ITTC Procedure 7.5-01-03-01, Revision 02, 28th International Towing Tank Conference.

ASTM E617-13, 2013, "Standard Specification for Laboratory Weights and Precision Mass Standards," American Society for Testing and Materials, West Conshohocken, Pennsylvania, USA.

NIST Handbook 105-1, 1990, "Specifications and Tolerances for Reference Standards and Field Standards and Measures, 1. Specifications and Tolerances for Field Standard Weights (Class F)," National Institute of Standards and Technology, Gaithersburg, Maryland, USA.

OIML, 1991, "OIML Certificate System for Measuring Instruments," Organisation Internationale de Métrologie Légale, Paris, France.

OIML R 111-1, 2004, "Weights of Classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3}, and M_3, Part 1: Metrological and technical requirements," Organisation Internationale de Métrologie Légale, Paris, France.