Krylov State Research Center

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APPROVED BY

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_____ " ___", 2014

Soft containers

Topple, righting, tear and stacking tests of container MK-14-10

Methodology

IMAN 31-406-14 MI

Agreed by
Chief Metrologist

Dr. V.D. Morozov

" ___ " _____ 2014

Methodology attestation
certificate No. 406/3-14

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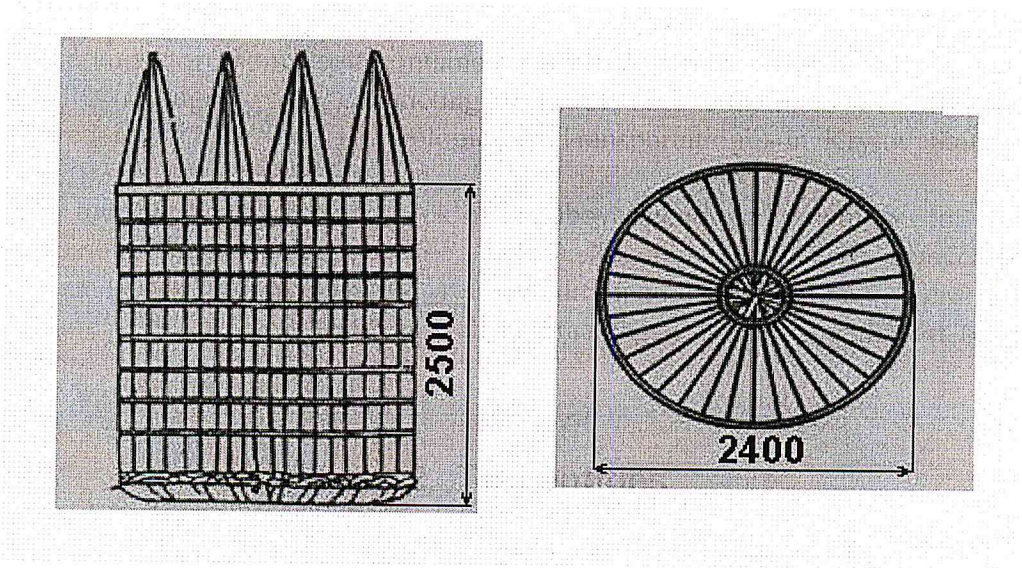
1. Application area and test goal

This Methodology for testing soft containers (hereinafter referred to as MI) is a governing document for arranging and conducting tests of soft containers of MK-14-10 type (manufactured in CJSC "New Technologies in Transportation") in Krylov State Research Center.

The goal of this testing is strength check of the above mentioned containers for compliance with requirements given in Section 6.8.5 "U.N.O. Recommendations for Dangerous Goods Transportation (Model Regulations, 17th revised edition and later editions) in terms of Topple tests, Righting tests and Tear tests, as well as Stacking tests, along with Part 6.9.1 IMDG Code (edition of 2012).

2. Test entities



Lateral view Bottom view

Fig.1. Characteristics of tested container

The test entity is a soft container of MK-14-10 type, the appearance of which is shown in Fig.1. It represents a load-carrying grid with lifting eyes, upper and lower fastening frameworks.

Two containers were tested. The first one was tested under stacking and tear. The second was tested under topple and lifting from the horizontal position to the vertical position (righting tests). The containers loaded not lesser than by 95% of their capacity and up to the maximally allowable gross mass (14 t) are supplied to KSRC by the Customer. Their acceptance is drawn up by a bilateral act.

Information on all detected defects in the container shell and lifting devices is recorded in a special incoming inspection act. It shall contain an unambiguous opinion on containers acceptance for the tests.

Provided the detected defects are essential, a container is not admitted for the testing with the concurrence of Customer.

3. Evaluated characteristics

All characteristics to be defined and measured during the container testing are divided into two main groups.
Characteristics providing procedures, which ensure preparation and conducting the tests in compliance with the existing conditions and requirements, are rated among the first group. This group includes external forces applied to container structural elements under its loading.
The second group incorporates entity characteristics subject to definition and monitoring during this testing. First of all, visual inspection of the container during the tests could be rated in this group. The list of these characteristics depending on test types is given in Section 4 of this Methodology.
The extended uncertainty of measuring forces (loads) (at sweep efficiency 2) shall be not greater than ±3% relatively a measured magnitude.
The extended uncertainty of weighing the loaded container and pressure disk (at sweep efficiency 2) shall be not greater than ±3% relatively a measured magnitude.
The extended uncertainty of measuring the dropping height during the Topple tests (at sweep efficiency 2) shall be not greater than ±20 mm.
The extended uncertainty of measuring the cut length during the Tear tests (at sweep efficiency 2) shall be not greater than ±5 mm.
The extended uncertainty of measuring the container holding time under load during the Stacking tests (at sweep efficiency 2) shall be not greater than ± 15 minutes.
The extended uncertainty of measuring the container holding time under load during the Tear tests (at sweep efficiency 2) shall be not greater than ± 60 seconds.

4. Safety and environmental protection requirements

Testing of containers by this Methodology does not require any special conditions. Therefore, there is no necessity to develop special requirements to provide personnel safety during the testing. It is enough to be guided by existing safety instructions for operating personnel.
The mentioned testing is not related with use or application of any materials and means that pollute the environment. In this connection there is no necessity to formulate any ecological requirements, observation of which shall be obligatory during preparation and conduction of these tests.

5. Test conditions

According to this Methodology, during the tests it is required that the ambient temperature is in the range from +15 to + 25 ^{0}C, besides the site for the testing shall comply with the following requirements:

- it shall be integral and sufficiently massive to remain motionless;
- it shall be flat with the surface free from local defects capable to affect the test results;
- it shall be sufficiently stiff to remain unstrained;
- it shall be sufficiently strong to remain undamaged during the tests;
- it shall be sufficiently large to provide a place for whole container fall

6. Test facilities

6.1. The container was loaded with four force sensing channels that consisted of "ViCont" system and force-measuring transducers of DSTU type. The extended uncertainty of measuring the force (at sweep efficiency 2) shall be not greater than ± 3% relatively a measured magnitude.

6.2. Weighing of the loaded container, as well as weighing the pressure disk is performed with the force sensing channels consisting of "ViCont" system and force-measuring transducers of DSTU type of an appropriate rating. The extended uncertainty of measuring the force (at sweep efficiency 2) shall be not greater than ± 3% relatively a measured magnitude.

6.3. Measuring the dropping height during the Topple tests, as well as measuring the container cut length during the Tear tests is performed with a metallic measuring tape having the measurement range from 0 to 10,000 mm and division value 1 mm.

6.4. Measuring the container holding time under load during the Tear tests is performed with a stopwatch of Сопр type. For this type the maximum error in the interval 0 – 60 min is not greater than ±1.5 s.

6.5. Measuring the container holding time under load during the Stacking tests is performed with mechanical clock - alarm clock "Slava" having the mechanism 5671.H.1 ТУ 25-1619.0023-91. Error of the clock daily rate at temperature (20±5) ^{0}C is not greater than ± 120 s.

6.6 The measuring instrumentation used for the tests shall have valid certificates (documents) on calibration.

6.7. Other measuring instrumentation, metrological characteristics of which are not worse than the above mentioned ones could be used as well.

7. Test procedure. Criteria of test results evaluation

Description of container loading schemes and procedures when conducting various test types, as well as test success criteria are given in this section.

7.1 Container preparation for testing

In compliance with it.2 of the MI, the Customer supplies 2 containers for testing, which are filled with a cargo simulator by not lesser than 95% of its capacity and up to it maximally allowable gross mass $M_к$ equal to 14 t.

Container preparation for testing in the laboratory consists in its control weighing with a special force sensing channel (see it.6.2 of MI). At that the container gross mass $M_к$ is related with the force sensing channel reading G as follows:

$$G = M_k g,$$

where g = gravity acceleration.

The cargo simulator mass shall be corrected if necessary.

7.2 Stacking tests

7.2.1. Install the container prepared according to it. 7.1 of MI vertically on the test site.

7.2.2. Assemble the pressure mechanism according to the diagram given in Fig.2.

7.2.3. Install the pressure disk inside the container with the help of a crane.

7.2.4. Apply a distributed load to the container top; the load is four times as large as the container maximally allowable gross mass $M_к$ ($4M_к$ = 56 t). The total force P_1 produced by hydraulic cylinders is defined as follows:

$$P_1 = g(4M_K - M_{Д.А}),$$

where $M_{НД}$ = pressure disk mass evaluated by weighing the disk with the help of a force sensing channel.

7.2.5. Hold the container under load (see it. 7.4.5) for 24 hours. Monitor each hour the value of the force produced by the hydraulic cylinders.

7.2.6. Unload and examine the container after that.

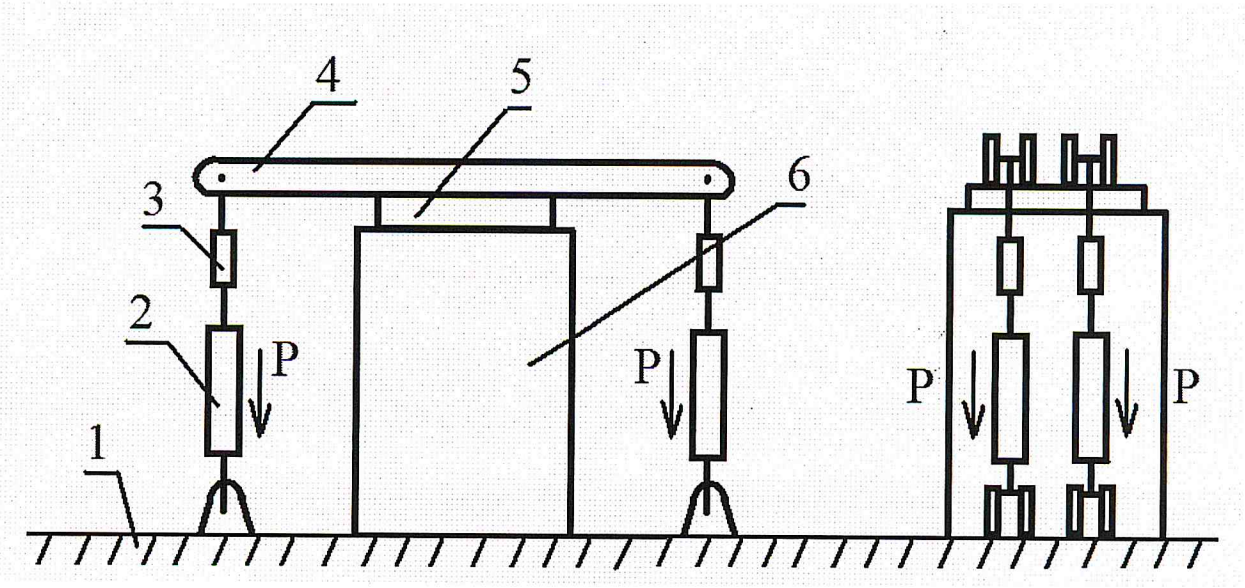


Fig. 2- Container loading scheme under stacking and tear tests

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A through cut of (300±5) mm length is made in the container middle part at the angle 45^0 to its main axis under tear tests.

1 – test site
2 – hydraulic cylinder
3 – dynamometer
4 – crossbar
5 – pressure disk
6 – container

7.2.7. Test success criterion:

- no loss of container contents during the tests or after unloading.

7.3. Tear tests

7.3.1. Tear tests are conducted for the container tested before under stacking or for a new container prepared in compliance with it.7.1 of MI.

7.3.2. In case of a new container, install it vertically on the test site and install a pressure disk in it.

7.3.3. Make a cut on the tested container side surface at an equal distance from the bottom and the upper level of the cargo simulator at the angle 45^0 to its main axis; the cut shall penetrate completely through all layers. The cut length shall be equal to (300±5) mm.

7.3.4. Load the container from above by a uniformly distributed load equal to doubled container maximally allowable gross mass ($2M_к$ = 28 t). The total force P_2 produced by hydraulic cylinders is defined as follows:

$$P_2 = g(2M_K - M_{НД}),$$

where $M_{НД}$ = pressure disk mass evaluated by weighing the disk with the help of a force sensing channel.

7.3.5. Hold the container under load for 15 min and unload.

7.3.6. Lift the container with a crane by raising it above the floor and leave it in this position for 15 min. Then unload, put the container on the floor and examine.

7.3.7. Test success criterion:
- the initial cut length shall not be increased by more than 25 %.

7.4 Topple tests

7.4.1. After the control weighing the cargo simulator is covered with a special rubber diaphragm available in the container. The rubber diaphragm is pressed to the cargo simulator through cross connection of four lifting eyes.

7.4.2. Install the container prepared for the tests on an edge of a turning plate located on a special foundation as it is shown in Fig.3. The height of the turning plate upper surface relatively the floor shall be equal to (0.8±0.02) m, and the plate itself shall have a threshold.

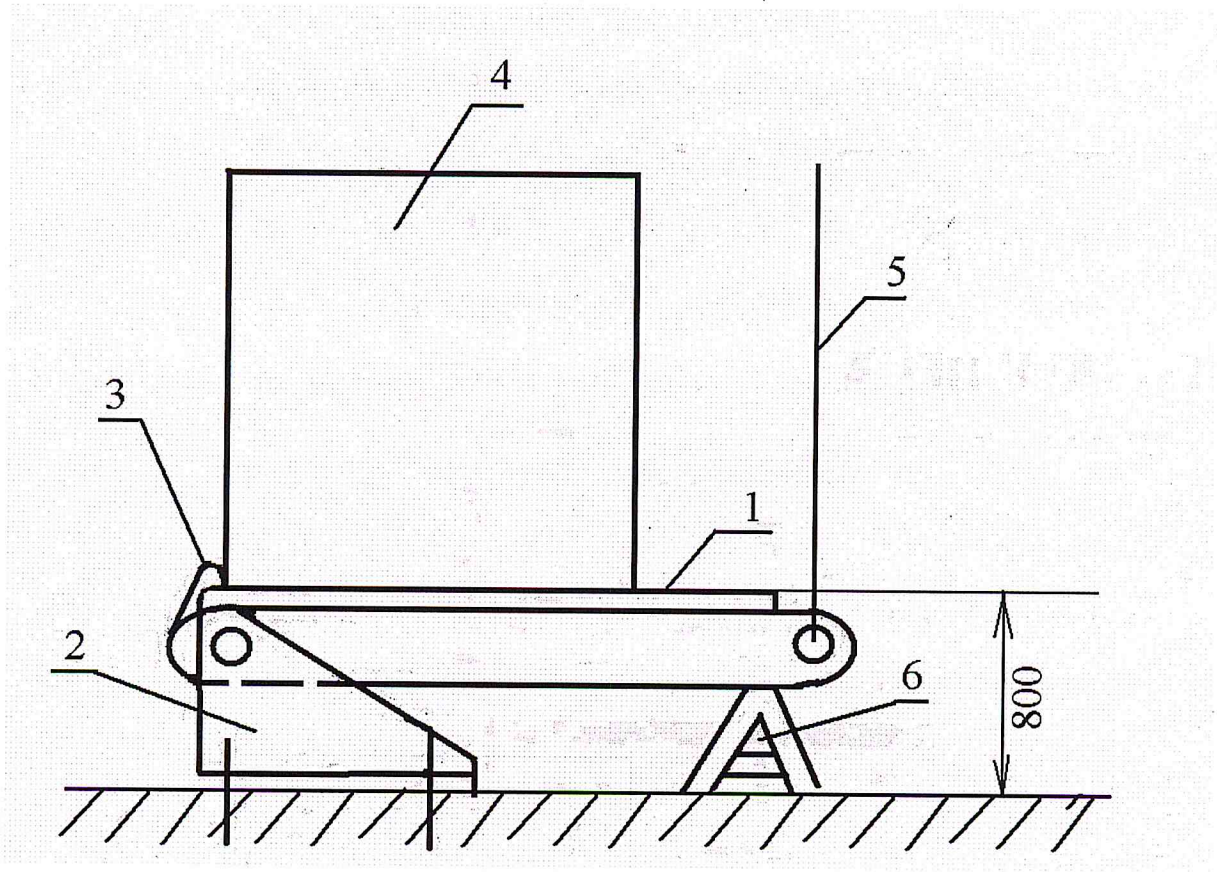

Fig.3 – Container loading scheme under topple tests

1 – turning plate
2 – foundation relatively with the turning plate turns
3 – threshold
4 – container
5 – crane strap
6 – technical support

7.4.3. Put a metallic plate to the foundation side where the container will be toppled.

7.4.4. Lift the turning plate edge (see Fig.3) with the crane by having provided container toppling on the metallic plate.

7.4.5. Shift aside the metallic plate with the container.

7.4.6. Put two container lifting eyes on the crane hook by an instruction of the Test Manager agreed with Customer representatives and a supervising body.

7.4.7. Lift the container with the help of the crane without separating the container from the metallic plate and install it vertically.

7.4.8. Test success criterion:
- no loss of the contents; insufficient ejection under an impact, for example, through locks or openings of weld broaching shall not be considered as a container disadvantage provided leakage is not continued.

7.5. Righting tests

7.5.1. Put the container prepared in compliance with it.7.1 of MI on the test site with a side surface.

7.5.2. Put two container lifting eyes on the crane hook by an instruction of the Test Manager agreed with Customer representatives and a supervising body.

7.5.3. Lift the container up to the vertical position above the floor. The container lifting speed shall not be lesser than 0.1 m/s.

7.5.4. Test success criterion:

- no damage of the container or its lifting devices, which could make the soft container unsafe for transportation and cargo operations.

8. Evaluation of test results

A test report is prepared by the Executor based on the test results in compliance with corresponding clauses from CTP IMAN 083-2013 "Quality Management System. Metrological Work Support. Test Methodology."

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Appendix A

(for reference)

Justification of errors in measured specified parameters

The following parameters are listed among the main ones, measurement accuracy of which could essentially affect the soft container testing results:
- weight of the loaded container and pressure disk;
- values of test loads;
- dropping height under topple tests;
- length of the cut on the container side surface before and after tear tests ;
- holding time under loading;
- load lifting speed.

1 Weight of the loaded container, as well as weight of the pressure disk is evaluated with the force sensing channels consisting of "ViCont" system and force-measuring transducers of DSTU type of an appropriate rating. To conduct the tests, channels are calibrated in the force measurement required range according to the Methodology IMAN 307-80-07 MI. The channel, the limits of relative force measurement error of which do not exceed ± 2.5% at confidence probability equal to 0.95, are admitted for the testing. Therefore, the Methodology requirement on the loaded container and pressure disk weighing metering error (± 3 %) is satisfied.

2. The test load applied to the container is a sum of the pressure disk weight and forces produced by hydraulic cylinders. These forces are measured with special force sensing channels consisting of "ViCont" system and force-measuring transducers of DSTU type. Prior to the tests, the channels are calibrated (see it.1 of this Appendix); requirements to the measurement error imposed to them are similar to those given in it.1
It was said in it.1 that the relative error of weighing the pressure disk does not exceed ± 2.5%. The measuring error for forces produced by the hydraulic cylinders does not exceed ± 2.5% as well. Therefore, the relative error of measuring the test load could not be greater than ± 2.5%.
Therefore, the Methodology requirement on the test load measuring error (± 2.5 %) is satisfied.

3 Linear dimensions (the dropping height during the Topple tests and the container cut length during the Tear tests) are measured with a metallic measuring tape having the measurement range from 0 to 10,000 mm. The measuring tape No.AR/1 was calibrated in the calibrating center of Krylov State Research Center (certificate No. № 2014409 valid up to March 25, 2015) and was recognized fit for use.
In accordance with GOST 7502-98, the measurement error for distances up to 1 m for such a measuring tape shall not exceed ±0.3 mm. Therefore, the Methodology requirement on the dropping height and cut length measuring error (±20 and ±5 mm) is satisfied.

4. Measuring the container holding time under load during the Stacking tests is performed with mechanical clock - alarm clock "Slava" having the mechanism 5671.H.1 ТУ 25-1619.0023-91. Error of the clock daily rate at temperature (20±5) ^{0}C is not greater than ± 120 s.
Measuring the container holding time under load during the Tear tests is performed with a stopwatch of Сопр type. For this type the maximum error in the interval 0 – 60 min is not greater than ±1.5 s.
Therefore, the Methodology requirement on the time interval measuring error (±15 min and ±1min) is satisfied.

Chief metrologist V.D. Morozov

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