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STUDY OF THE FIRE-RESISTANCE PROPERTIES OF FABRICS FOR COMPLIANCE WITH THE REQUIREMENTS OF UZDST 3191:2017 "FIREFIGHTING EQUIPMENT. SPECIAL PROTECTIVE CLOTHING FOR FIREFIGHTERS. GENERAL TECHNICAL REQUIREMENTS AND TEST METHODS"

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Abstract. This article presents the results of a study of fire-resistant fabrics to assess their compliance with the requirements of the national standard of the Republic of Uzbekistan, UzDSt 3191:2017, "Firefighting equipment. Special protective clothing for firefighters. General technical requirements and test methods."

Keywords:fire-resistant fabrics, fire-protective properties, standard, requirements.

Within the broad range of textile products, a special category comprises woven and nonwoven materials used to manufacture clothing for professionals whose occupations involve potential fire hazards. The primary function of fire-resistant fabrics is to protect human health and safety from high temperatures, flammable substances, and open flames. Fire-resistant fabrics are imported into the Republic of Uzbekistan from the Russian Federation and the People's Republic of China. The surfaces of these fabrics are chemically treated with finishes to impart fire-protective properties; as a result, the hygienic and physicomechanical properties of the materials deteriorate. It is noted that the use of special clothing made from these fabrics adversely affects the mobility of firefighters. In addition, imported fabrics have low air-permeability values, which causes discomfort when firefighters wear protective clothing. Consequently, cases of skin disorders have been observed among firefighters.

One of the major challenges facing the textile industry of the Republic of Uzbekistan is the production of high-quality yarn and fabric that meet the requirements imposed on special protective clothing for firefighters and possess improved fire-protective properties [1].

By Order No. 05-861 of the Uzbek Agency for Standardization, Metrology and Certification "Uzstandart," dated 14 July 2017, the UzDSt 3191:2017 standard, "Firefighting equipment. Special protective clothing for firefighters. General technical requirements and test methods," was approved and entered into force; its requirements are mandatory for application [2]. Experimental and testing work was carried out under laboratory conditions at the Testing Center of the Research Institute of Fire Safety and Emergency Situations of the Ministry of Emergency Situations of the Republic of Uzbekistan (NIIFSES of the MES of the Republic of Uzbekistan) to determine the fire-protective properties of fabrics and assess their compliance with the requirements of UzDSt 3191:2017.

The following terms are regulated by this standard:

1. Residual burning time – the period during which the material continues to burn after the flame source has been extinguished.

2. Deep burning – burning of the fabric for more than 5 s.

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3. Continued burning after extinguishing the ignition source – the continued presence of burning of the material after the ignition source has been extinguished.

4. Complete burning – flame covering the surface of the specimen and burning the entirety of the base fabric.

The fire-protective properties of the fabrics were tested using equipment for determining fabric fire resistance, the schematic diagram of which is shown in Figure 1. The dimensions of the equipment shown in Figure 1 correspond to the original.

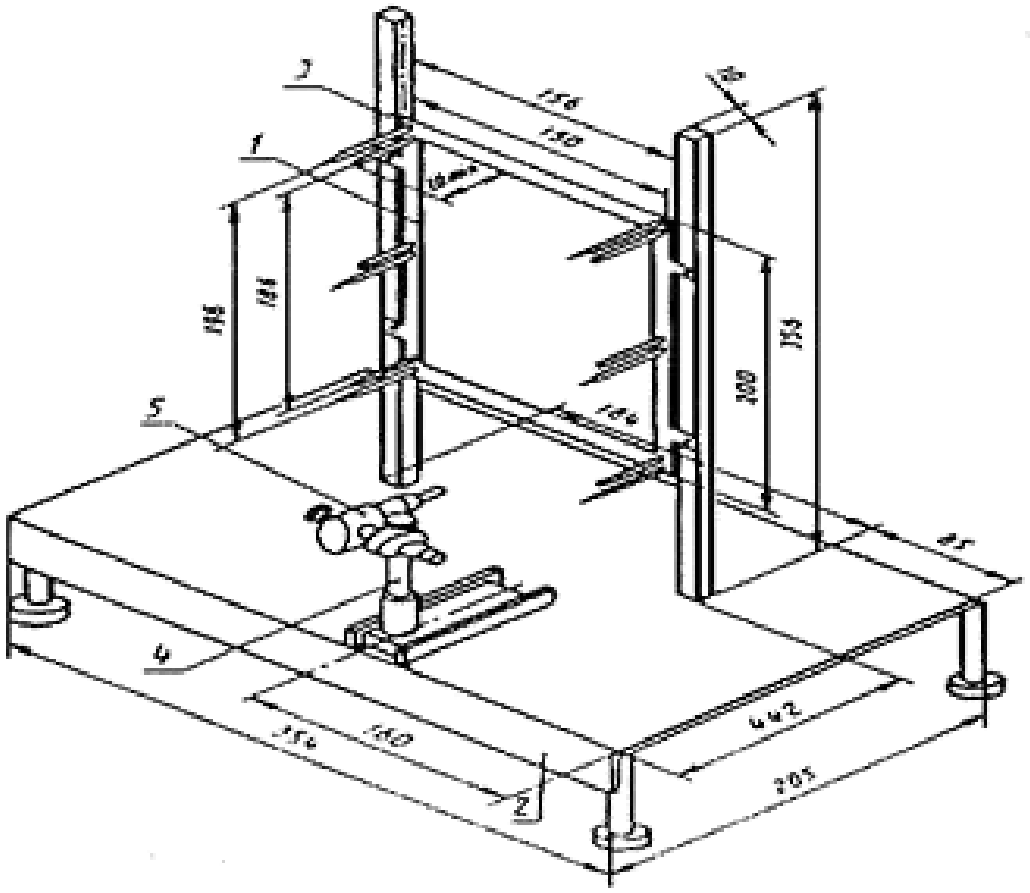


Figure 1 – Equipment for determining the fire resistance of fabrics

The frame is made of stainless steel and has dimensions of 100 × 200 mm. The material specimen is attached to it using studs. During testing, the equipment is installed in a chamber measuring 700 × 325 × 750 mm. The chamber roof has symmetrically arranged openings. Ventilation openings with a total area of not less than 32 mm are installed in the lower part of each vertical wall of the chamber. One chamber wall, measuring 700 × 750 mm, is designed as a closable glass door. The chamber walls are covered with non-combustible insulating material [3]. Figure 2 shows the test procedure. The results of the fabric study are presented in Table 1.

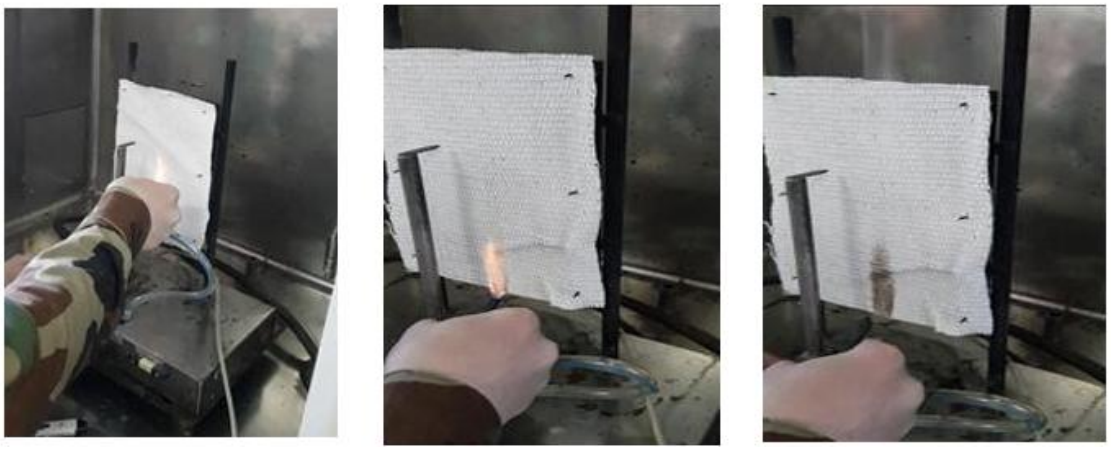


Figure 2 – Images of the fabric fire-resistance testing procedure

Analysis of the test results indicates that it is more appropriate to produce fire-resistant fabrics from natural fibers, specifically from a blend of chrysotile and cotton fibers, thereby improving the protective properties of the fabrics. At present, imports of fire-resistant fabrics from the Russian Federation, the People's Republic of China, and the Republic of Kazakhstan amount to USD 4.5–4.7 million. The cost of a set of special clothing for each firefighter is USD 450. Domestic production of fire-resistant fabrics would reduce imports and the Republic of Uzbekistan's demand for foreign currency.

Table 1 – Experimental data from fabric fire-resistance tests

Number of experiments	Burning time, s		Length of removed field, mm		Self-burning time, s	Final result
	Warp	Weft	Warp	Weft		
1	5	5	85	75	5–7–15	Does not burn
2	7	7	90	80	5–7–15	Does not burn
3	15	15	95	85	5–7–15	Does not burn

The recommended fire-resistant fabric complies with all requirements of UzDSt 3191:2017 concerning the fire-protective properties of materials.

The studied fabric also has a longer service life; no release of toxic substances was observed, and the occurrence of allergic reactions during wear by firefighters is excluded. The annual economic effect from the production and use of fire-resistant fabric in special protective clothing for firefighters amounted to at least UZS 420,700 thousand.

The studied fire-resistant fabric containing natural cotton and chrysotile fiber is recommended as a fire-protective fabric for manufacturing special protective clothing for firefighters.

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