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ASSESSMENT OF THE RISK OF A CHEMICAL ACCIDENT AND ITS CONSEQUENCES

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Abstract: In this article chemical accident risk assessment at the Vostochny cosmodrome was presented. The degree of damage, number of affected population and the area of infection with different initial data were established. The probability of the chemical accident risk when spreading heptyl is 0, 1%, when spreading kerosene is 0,9%.

Keywords: Heptyl, kerosene, chemical accident, risk assessment

In the Far East in the Amur Region Vostochny space center is being built. There rocket launchers of the Union 2.1.A will be launched. The first launch from Vostochny took place on April 28, 2016., Kerosene and heptyl as fuel are used. The volume of kerosene is about 80-95 tons, heptyl is 3.5 tons when the rocket is flying about 200 kilometers. Thus, the "Vostochny" cosmodrome is a chemically dangerous object in the Amur region. In our country the classification of chemically hazardous objects is adopted based on an estimation of the number of accidentally hazardous chemicals at the site, as well as the number of people who can be exposed to it in an emergency situation. These data are the starting point for assessing the scale of possible chemical disasters (taking into account possible sanitary losses), planning of health care in the event of emergency response, and, therefore, to justify the necessary amount of antidotes reserve for liquidating the health consequences of the peacetime and wartime emergency situations [3]. 1,1-Dimethylhydrazine is the standard fuel of liquid rocket fuels, the trade name is heptyl. It is readily soluble in water and mixed with it in any concentration, has a high volatility [4]. Kerosene is a mixture of the ultimate aromatic hydrocarbons, olefins and naphthenes. The explosive concentration of kerosene vapor in a mixture with air is 2-3%. The maximum allowable concentration of kerosene vapor is 0.3 mg / l. Heptyl and kerosene belong to accidentally hazardous chemicals [4].

The aim of the work is to assess the risk of a chemical accident, the amount of affected population and the area of infection, in the event of an accident with bottling of heptyl or kerosene, a comparative characteristic.

To assess the risk of a chemical accident and its consequences, the RD52 - 40 methodology was used. If an accident at the cosmodrome with the ejection of heptyl or kerosene into the atmosphere occurred in the morning from 7.00 to 11.00 or from 7.00 to 8.00, about 20% of people are at home, 48% people are in industrial buildings, about 26% peaople are in public and personal transport, as well as 6%people are in open spaces, streets [2]. Heptil and kerosene are transported immediately before launching the missile in road and railway tanks with a capacity of 40-60 m3 (heptyl) under excess nitrogen pressure of 100-150 kPa. The number of emitted into the atmosphere is about 3 tons, with damage to all heptyl tanks and 80 tons for kerosene. As the meteorological conditions, the speed of the wind, the state of the atmosphere are taken. The greatest probability is associated with the occurrence of forest fires in the Amur Region, and the risk of anthropogenic accidents is not ruled out. The frequency of forest fires was 70% (in relation to earthquakes, terrorist acts, floods, forest fires, hurricanes and squalls).It was considered that [5].

We calculate by the formulas: Total depth of infection:

$$Г_{зар} = Г_1 + 0,5Г_2, \quad (10)$$

where, $Г_1$ - the depth of infection with the primary cloud, km; $Г_2$ - secondary cloud, km.

The maximum possible depth of air mass transfer:

$$Г_{пред} = u\tau, \quad (11)$$

$Г_{пред}$ – the limiting depth of infection, u - the rate of transport of the front of contaminated air, km; τ (tau) - the time from the beginning of the accident, h.

The true depth is taken as:

$$Г = \min \{Г_{зар}, Г_{пред}\}, \quad (12)$$

Area of infection of Emergency chemically hazardous substance:

$$S_{зар} = k_в Г^2 \tau^{0,2} \quad (13)$$

k_8 - coefficient that takes into account the effect of the degree of vertical stability of air on the width of the zone of infection; τ - time from the beginning of the accident, h.

Expected losses:

$$P_{пор} = N_{пор/} N = \sum q_i (1 – k_{защ\,i}), \quad (14)$$

$N_{пор}$ - number of affected population, persons; N - total population, people.; q_i - share of the population protected from Emergency chemically hazardous substance i-м way; $k_{защ\,i}$ - protection factor (type i). [2].

Results and discussion. In Table. 1 shows the number of affected population (damage assessment) and the area of in-

fection 4 and 1 hour after the accident, as well as for different atmospheric conditions (inversion, isothermy, convection) calculated by the method of RD52-40 [6-7]. The degree of population damage (light, severe, average, threshold, fatal outcome) for different atmospheric conditions is presented in Table. 2 [6-7]. The risk of a chemical accident at the Vostochny cosmodrome is established with bottling of heptyl, kerosene. The probability of the risk of a chemical accident with bottling of heptyl is 0, 1%, with the filling of kerosene 0, 9%.

Table. 1 The area of infection and the expected damage under different conditions of the atmosphere at different times from the beginning of the accident.

	Heptyl		Kerosene	
Atmospheric conditions	$S_{зар}$, area of infection, km2	$P_{пор}$, expected damage, h	$S_{зар}$, area of infection, km2	$P_{пор}$, expected damage, h
Inversion:				
4 h:	27, 2	2693	170	4543
1h:	10, 5	2095	50	2958
Isotherm:				
4 h:	35, 8	3058	195	5740
1h:	18, 3	2548	70	3347
Convection:				
4 h:	47, 5	3603	218	6295
1h:	28, 5	2728	95	3998

Table. 2 Degree of damage at different states of the atmosphere at different times from the beginning of the accident.

HEPTILE	Inversion		Isothermy		Convection	
Degree of defeat	4 h	1 h	4 h	1 h	4 h	1 h
Lightweight (20%)	539	419	611	510	720	546
Heavy, medium (15%)	403	314	459	382	541	410
Heavy, medium (55%)	1481	1153	1682	1402	1982	1500
Lethal outcome (10%)	270	209	306	254	360	272
KEROSENE	Inversion		Isothermy		Convection	
Degree of defeat	4 h	1 h	4 h	1 h	4 h	1 h
Lightweight (20%)	909	592	1148	669	1259	799
Heavy, medium (15%)	681	443	861	502	944	600
Threshold (55%)	2499	1627	3157	1841	3462	2199
Lethal outcome (10%)	454	296	574	335	630	400

Conclusions: The “Vostochny” spaceport is undoubtedly an emergency hazardous chemical facility on which a chemical accident with an Emergency chemically hazardous substance release into the environment is possible. The established level of risk for the population of the Amur region is ten times lower than the average for the Russian Federation.

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