On making amendments to the safety data sheet for territories

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Abstract. The article shows the importance of developing a safety data sheet for the territories of subjects and municipalities of the Russian Federation, argues the need for risk and threat analysis of various nature and the use of information technologies in the light of general and regional informatization. An innovative approach is described, with which you can automate some stages of the development of a safety data sheet, store the characteristics of potentially dangerous technical objects, analyze the results in accordance with documents adopted by the Government of the Russian Federation. An innovative approach is described, which can be used to automate some stages of the development of a safety data sheet, store the characteristics of potentially dangerous technical objects, and analyze the results in accordance with the documents adopted by the government of the Russian Federation.

1. Introduction
The ongoing development of the technosphere is increasingly evolving the contradiction of our civilization - for many centuries people have perfected technology to protect themselves from natural hazards, and as a result they have come to the highest technological risks associated with the production and use of hazardous equipment and technologies. Man-made hazards of the XXI century continue to increase steadily, while the "price" of human error in the design, production and maintenance of technical systems, incorrect implementation of management procedures or improper organization of the workplace, etc. also increases.

2. The relevance of the topic and the current state of the problem
A striking example of a high level of risk of a man-made emergency, as a result of the notorious human factor, can be the incident of August 7, 2018. When in a suburb of the city of Bologna (Italy) on a highway overpass in the settlement there was a traffic accident involving a fuel tanker truck as a result of which there was an accidental spill of gasoline with subsequent ignition and explosion. The fire was so strong that it spread to cars that were located in dealerships at a considerable distance from the road. They also began to explode, and the overpass partially collapsed. As a result of the incident, 2 people were killed and more than 70 were injured. The cause of the accident was a gross violation of traffic rules.
An analysis of media reports about incidents involving vehicles carrying dangerous goods (only fuels and lubricants!) showed that in January - February 2020 there were 17 similar incidents on Russian roads in which 14 people died, 4 were injured and in 8 cases cargo was lost.

In other words, despite all the rules (ADR) for the transport of dangerous goods, there is a high risk of its loss, since the vehicle carrying the dangerous goods may be subjected to mechanical impact (collision) from another vehicle. It is also reasonable to assume that the probability of a road accident with a vehicle involved in the transportation of dangerous goods is identical to the probability of a man-made emergency [1].

All this allows us to conclude that the topic of assessing the accident rate of a road network section, as well as the choice of a rational route for the movement of automobile transport during the transportation of dangerous goods, is relevant today.

3. Information and methods
In accordance with the main documents of the strategic development planning system of the Russian Federation, which determine the directions and expected results of socio-economic development of the country in the long term, a change of priorities is envisaged in the state policy to ensure the safety of the population and territories from various dangers and threats [2,3]. The main vector of the proposed changes is the thesis that instead of a "culture of response" to emergency situations, the "warning culture" should come first. Some conditions that ensure the implementation of the stated task are measures aimed at introducing risk management technologies into all parts of the socio-economic development of society, creating an appropriate regulatory framework, introducing a risk-based approach in planning disaster risk reduction measures, including when preparation of the “ACTION PLAN” for the protection of the population and territories from emergency situations and liquidation of their consequences [4].

The action plan determines the scope, organization, order, methods and timing of measures to reduce the risk of an emergency, to prevent and (or) reduce the negative consequences of emergencies, as well as to protect the population, territories, material assets and emergency rescue and other urgent work during emergencies and the forces and means involved for this [5-7]. The development of an action plan is carried out by the relevant local government on the basis of forecasting the consequences of possible emergencies contained in the safety data sheets of the territories of municipalities, critical and potential facilities [8,9].

According to the Order of the Ministry of Emergencies of the Russian Federation of October 25, 2004 No. 484 “On the Approval of a Standard Safety Data Sheet for the Territories of the Subjects of the Russian Federation and Municipalities”, safety data sheets are developed for:

- determination of indicators of the degree of emergency risk;
- assessment of possible consequences of emergency situations;
- assessment of the state of work of territorial bodies on prevention emergency situation;
- development of measures to reduce the risk and mitigate the consequences of emergencies on the territory.

Also, in accordance with the requirements of this order, maps and plans with the zones of consequences of possible emergencies, as well as zones of individual (potential) risk, are attached to the safety passport of the municipality. In addition, dangerous goods transport routes are plotted on the territory map.

A prerequisite for solving these tasks is the need to predict the consequences of possible accidents that may occur at the studied objects and routes of dangerous cargo transportation and determine whether these accidents are capable of being sources of man-made emergencies in accordance with the order of the [10].

For reference, here is a definition of actions related to forecasting used in the practice of the Russian Ministry of Emergency Situations. Predicting an emergency situation is a forward assumption about the probability of occurrence and development of an emergency situation based on the analysis
of the causes of its (emergency situation) occurrence and its (emergency situation) sources in the past and present, forecasting its (emergency situation) consequences [11].

Given the above definition and information about 17 accidents involving vehicles carrying dangerous goods in just two months, it becomes obvious that the wording-requirement for “plotting dangerous goods transportation routes on the map” clearly does not meet the expected requirements. Since this interpretation simply does not provide an estimate of the number of victims and the frequency of an emergency on the route. As a consequence, event trees are not built and the most likely emergency scenarios are not determined. Despite the fact that the routes pass through bridges, overpasses and other critical facilities, estimates of the possibility of an emergency due to an accident at a neighboring dangerous facility and / or an initiation of emergency at neighboring dangerous facilities are not taken into account. The possible situation when new fires, explosions and emissions of toxic substances are initiated during the development of an emergency is also ignored, in other words, if the so-called "Domino effect" occurs during the development of an emergency, a stable combination becomes the first episode of the event tree. Subsequent episodes, which also play the role of stable combinations of typed fragments of events, are determined by the type of dangerous object that falls into the affected area, and their appearance and the point of connection with the first episode — the formalized conditions under which new fires, explosions and emissions of toxic substances are initiated.

These circumstances are due to the fact that the implementation of measures in relation to the route of transportation of dangerous goods, as well as the assessment of the frequency of an emergency with a vehicle involved in the transportation of dangerous goods, are not regulated by anything. The need for revising the “Safety Data Sheet” form has been obvious for a long time, however, as part of the article, we dwell on the issue of taking into account the dangers of hazardous goods transportation routes.

The transportation of dangerous goods by road is a complex technological process that is strictly regulated by law, including due to the environmental aspect. The damage from the consequences of accidents of this type, due to the characteristics and physicochemical properties of the dangerous cargo, is greatly amplified, presenting a real danger to human life and health, being the reason for the destruction of material assets, as well as a source of environmental damage to the environment. The current legislation defines the requirements for the carrier, for the cargo owner, for container manufacturers, for rolling stock, as well as for traffic control authorities, however, there are no requirements for the route of transportation of dangerous goods [12, 13].

The key idea is to develop a comprehensive safety indicator for a section of the road network, depending on the factors under study. However, this problem is complex and to solve it, it is necessary to make a decomposition for particular purposes. System analysis offers a convenient tool for solving and visualizing this problem - building a tree of goals [14]. The root of the tree is the main task, which is then sequentially divided into subtasks. At the first stage, the main goal is divided into three groups of events:

- increasing the stability of dangerous goods to external influences;
- minimization of the risk of man-made emergencies on the route of transportation of dangerous goods by road;
- improving the effectiveness of measures to eliminate the consequences of man-made emergencies involving dangerous goods.

All three groups of activities are important for ensuring the safety of the population, infrastructure and the environment. However, in the framework of this issue, it is necessary to study only the second group.

In accordance with the traffic Rules, a route can be defined as a set of special road sections: a stage, an intersection, an adjacent territory, a locality, a pedestrian crossing, a railway crossing, or a motorway. Also, the route of the vehicle can be characterized by the travel time, the probability of an accident on it, as well as the degree of damage if the accident still occurs.
To solve this sub-task, it is necessary to analyze data on the state of road safety indicators for possible routes, which implies identifying these indicators (factors), obtaining data on their quantitative characteristics and evaluating their significance [13].

The indicated factors for the occurrence of an accident can be divided into 5 main groups:

A. Factors affecting driving patterns
   a1 - Intersections: several traffic flows intersect at an intersection, which enhances the interaction between vehicles and increases the risk of traffic accidents. In addition, the driver is forced to process a large amount of information than on a straight stretch of road, so the likelihood that he will make a mistake increases.
   a2 - Number of adjacent roads: a factor similar in meaning to a1, but taking into account the number of exits to secondary roads.
   a3 - Number of lanes: affects the number of vehicles on the route, the density of traffic, and therefore the intensity of interaction between vehicles.
   a4 - Availability and number of pedestrian crossings: interaction with pedestrians can increase the risk of accidents, including situations when one vehicle collides with another when avoiding a collision with a pedestrian.
   a5 - Parkings (and their number) along the route: similarly, a1 and a2 increase the risk of a collision with a vehicle leaving the parking lot.
   a6 - Road network items that regulate traffic: car signs, traffic lights, artificial bumps. All these factors directly regulate the traffic flow, so their presence or absence affects the risk of accidents.
   a7 - Accident concentration points: accident concentration area: a road section that does not exceed 1000 m outside a settlement, 200 m in a settlement, or a road intersection where three or more accidents of the same type or 5 or more accidents, regardless of their type, have occurred in the past 12 months, resulting in death or injury [5,6]. Although such a formulation does not allow us to understand the mechanism of the occurrence of accidents in this area, this factor can be taken into account to predict the risk of accidents in it.
   a8, a9 - Partial blocking of the road and previous accidents on the route: can limit the effective number of lanes by changing the density of the traffic flow and the intensity of interaction between vehicles.

B. Features of the road structure
   b1 - The width of the road affects the ability of the vehicle to maneuver.
   b2 - The curvature of the road affects the probability of going beyond the lane, as well as the driver's view.
   b3 - The slope of the road affects the visibility of the driver.
   b4 - The type of road surface affects the adhesion on the road and the length of the braking distance.
   b5 - The type of dividing lane affects the ability to enter the oncoming lane.

C. Non-human factors
   C1 - High or low temperature affects the condition of vehicles and drivers, temperature differences can change the quality of the vehicle’s adhesion (icing, slush).
   c2 - Fog impairs road visibility.
   c3 - Precipitation reduces the visibility of the road, changes the quality of adhesion of the vehicle to the road.
   c4 - Strong winds can cause the vehicles to overturn, and also cause trees or billboards to fall onto vehicles or the road.
   c5 - Seasonality and special dates affect the number of vehicles on the road, the number of pedestrians, and traffic capacity.
   c6 - Day of the week affects the number of vehicles on the road, the number of pedestrians.
   c7 - The time of day affects the number of vehicles on the road, the number of pedestrians and visibility of the road.

D. Factors related to pedestrian activity
d1 - The type of district affects the total number of pedestrians and their behavior. For example, it was noted that in the areas where shopping centers are located, the risk of accidents increases significantly.

d2 - Public transport and its stops: numerous pedestrians cross the road near public transport. In addition, the exit of public transport from a stop can cause accidents similar to the exit of vehicles from parking lots.

d3 - The population density near the route directly affects the number of pedestrians crossing the road.

d4 - Places of concentration of accidents involving pedestrians can be taken into account to assess the risk of accidents involving pedestrians.

E. Factors related to the vehicle or driver

e1 - The type of vehicle affects its maneuverability.

e2 - The time spent by the driver on the route affects his fatigue (intermediate points are required for his rest), and in addition, on the long route, refueling of the vehicle may be required, which narrows the range of acceptable driving routes.

e3 - The route length, similar to travel time, affects driver fatigue and the need to refuel the vehicle.

e4 - The need for refueling on the route requires the availability of places on the route suitable for refueling vehicles.

All of these factors can be represented as a diagram of Ishikawa's cause-and-effect relationships (figure 1).

Figure 1. Cause-and-effect diagram (Ishikawa).

It is worth noting that not all the above factors can be used in the final model. This may be due to one of the following reasons:
1. First, it is often quite difficult to find data for a particular factor. If this data can be found, it may turn out that its accuracy is very low. For example, one of the most important data for predicting the number of accidents is the geographical coordinates recorded in the accident card. However, even they often contain omissions, inaccuracies (sometimes latitude and longitude are rounded to whole degrees, i.e. they contain errors up to 100 km), or they are filled in a different standard format and require additional pre-processing.

2. Different factors can have a significant correlation, i.e. taking into account several factors from a group will not carry additional information in comparison with taking into account one factor, and may even lead to a drop in the quality of predictions due to the so-called retraining problem.

3. It may also turn out that a factor that at the stage of initial analysis was considered important and significantly contributes to the danger of the site, will be much less significant, i.e. its consideration will not add to the quality of the predictive model.

4. Conclusion

Further development and implementation of the presented development in the activities of local authorities will significantly reduce the manifestation of subjectivity in the preparation of "Safety Data Sheets", which will allow them to organize effective monitoring of indicators and indicators of hazards during the transportation of dangerous goods and threats by road on the territory of the municipality. In addition, this development is a key element of the scientific and methodological apparatus for justifying the rational route of road transport for the transportation of dangerous goods, taking into account the physical and geometric properties of the road, the mode of movement of traffic flows and dynamically changing factors contributing to the emergence of man-made emergencies, the urgency of which is formed as it develops at all levels of government the system of decision support centers is only increasing.

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