ABSTRACT

Analysis of the street-road network in the city of Volzhsky, a tense security situation with embarkation and disembarkation of public transport passengers is provided. The discrepancy between the lengths of stopping points and the incoming traffic of buses is determined. Proposals are made to improve the quality of passenger transportation, taking into account safety intervals at bus stops and optimizing the routes of urban public transport, private buses and fixed-route taxis.

Keywords: urban public transport, bus, stopping point, safety interval, route network, route optimization.

Background. The uncontrolled introduction of private carriers led to a rapid increase in the number of buses and, as a result, to overloading the street-road network. The absence in the traffic rules of the requirements for stop of public transport at the stopping point only in the extreme right lane led to the fact that the buses began to stop without taking into account the safety interval, in two lanes and on the carriageway, thus not providing the proper conditions for carriage of passengers.

With the established transport infrastructure of cities, it was established that the stopping points were designed for the use of large and medium capacity buses on routes, and therefore their throughput was ensured taking into account a safe stop of transport in accordance with the requirements of normative documents [1]. The length of stopping points provided for a safe stop of public transport in one right-hand lane, taking into account the safety interval defined by the standards [3].

Objective. The objective of the authors is to consider «safety intervals» at the bus stops of the city of Volzhsky.

Methods. The authors use general scientific methods, comparative analysis, evaluation approach.

Results.

1. On the city routes in the city of Volzhsky there are 107 large and medium buses of the municipal passenger motorcade and 512 small buses. Due to their growing incoming traffic at the stops, there was a problem with ensuring safe transportation of passengers.

The length of a stopping point should correspond to intensity of the incoming traffic of buses, so that there are no congestion, waiting and stop of passenger cars in two lanes.

The layout of the city is rectangular, and stretched along the Akhtub river, and therefore routes are mostly focused on longitudinal streets Mira, Druzhby, Karbysheva, prospect Lenina (Pic. 2).

The public transport system of Volzhsky consists of bus and tram sectors.

All bus lines are located in an area which is limited from the side of Volgograd by the streets Loginova, Naborzhzhnaya, Kirova, Sverdlova, Karbysheva, Engelsa, Pushkina, Volzhsky Voennoi Flotili, 87 Gvardieiskoi Divizii, prospect Lenina. In total, there are 55 city routes and 47 suburban destinations. The length of the street-road network is 97, 114 km, the length of the routes is 85, 581 km.

The most loaded with public transport are the streets Mira and Kommunisticheskaya, Boulevards Profsoyuzov, prospect Lenina, along which from 1100 to 3500 buses a day run. Basically all city municipal routes are duplicated by routes of private carriers. In addition, all suburban routes that depart from the city bus station, Lenin Square, the 18th and 32nd microdistricts, also pass through the city center – prospect Lenina and Mira street.

The route scheme with the number of routes on the streets of the city is shown in Pic. 3.

The largest number of buses a day passes along Mira street from Olomutsky street to Truda square and prospect Lenina from Malodogvardeitsev street to Stroitelei square (2000–3000 buses per day), along Kommunisticheskaya street (1100–2000 buses a day), so almost all the stops do not have enough length to accommodate concurrently arrived buses. Less loaded (1100–2000 buses per day) are the streets Khimiko, Engelsa, a section of the Druzhby street from 40 let Pobedy street to Olomutskaya street, section of Mira street to Olomutskaya street, Karbysheva street from the Profsoyuzov Boulevard to Karbysheva square.

The flow of buses at rush hour at the stopping points in the forward and reverse directions is: prospect Lenina – 226 and 294, Mira street – 281 and 280, Profsoyuzov Boulevard – 240 and 240, Druzhby street – 183 and 141, Karbysheva street – 129 and 120, Olomutskaya street – 139 and 139, Engelsa street – 150 and 150.

2. In this situation, there are two ways to solve the problem. The first is to increase the length of the stopping points for the existing flow of buses; the second is to reduce the incoming traffic of buses at the stopping points.

The main factor in determining the length of stopping points is the safe placement of buses at...
The main factor in determining the length of stopping points is the safe placement of buses at stops and an obligatory condition – the safety distance between standing vehicles (according to VSN 23-75 it is taken to be 3 m) [1].

In accordance with these requirements and application of the queuing theory, the nomograms were developed [11] and used to determine the correspondence of the length of the stop points to the incoming flow of buses for the mixed flow and the flow of buses «GAZelle». The required length is refined based on the results obtained for the mixed bus flow. A nomogram concerning the number of parking spaces at stop points, depending on the intensity of the mixed incoming traffic of buses, is shown in Pic. 4.

Pic. 4. Nomogram for determining the number of parking spaces at the stopping points, depending on the intensity of the mixed incoming traffic of buses.

To assess the provision of a safe bus stop at the Volzhsky stop points before and after the optimization of the route network, an inventory was made based on the route passports, which include the names of the points and the distance between them. The register of stopping points is made up, the following data are included:

- street,
- name of the stopping point,
- length of the stopping point,
- maximum incoming traffic of buses,
- required length of the stopping point.

The correspondence of the length of the stop points to the incoming traffic of buses was determined on the basis of a survey of the loading of the stopping points.
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The correspondence of the length of the stopping points to the incoming traffic of buses was determined on the basis of a survey of the loading of the stopping points in the direction from the new part of the city and the number of buses stopping in the hour-peak was counted from 7 to 8 hours.

Table 1 shows the indicators of stopping points based on the results of a survey of their load: length and incoming traffic of buses. According to the nomogram (Pic. 4), the required length of the stopping points is determined.

Of the 54 surveyed 22 stopping points with the existing organization of transportation, passengers do not provide a simultaneous safe stop of buses. Therefore, the city was faced with the issue of measures to ensure the safe stay of people and buses at stops.

3. Based on the planning document (in accordance with Federal Law No. 220 dated July 13, 2015) in Volzhsky, optimization of the route network was carried out, consisting in the abolition of routes duplicating the social routes of convoy No. 1732, and in bringing the number of buses on the routes in line with passenger traffic. As a result of optimization, the number of routes for private carriers decreases from 25 to 14, and the number of especially small capacity stops decreases from 12 to 6.

Table 1

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of the stopping point</th>
<th>Indicators of the stopping point</th>
<th>Indicators of the stopping point</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>At present</td>
<td>After optimization</td>
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<td>Length, m</td>
<td>required length, m</td>
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<td>Incoming traffic of buses, units/h</td>
<td>required length, m</td>
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<td>urb/suburb</td>
<td>urb/suburb</td>
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<td>required length, m</td>
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<td>144/30</td>
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<td>114/30</td>
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<td>118/49</td>
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<td>46/49</td>
<td>40–60</td>
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<td>46/49</td>
<td>40–60</td>
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<td>5</td>
<td>Dom Torgovli</td>
<td>86</td>
<td>263/71</td>
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<td></td>
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<td>78/71</td>
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<td>6</td>
<td>Aleksandrova</td>
<td>45</td>
<td>263/71</td>
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<td>78/71</td>
<td>50–70</td>
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<td>Universam</td>
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<td>234/74</td>
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<td>62/74</td>
<td>50–70</td>
</tr>
<tr>
<td>8</td>
<td>Narimanova</td>
<td>30</td>
<td>234/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>62/75</td>
<td>50–70</td>
</tr>
<tr>
<td>9</td>
<td>Mira–Iskra</td>
<td>37</td>
<td>254/74</td>
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<td></td>
<td>56/74</td>
<td>50–70</td>
</tr>
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<td>10</td>
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<td>37</td>
<td>232/62</td>
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<td>75/62</td>
<td>50–70</td>
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<td>11</td>
<td>Stimul</td>
<td>75</td>
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<td>75/62</td>
<td>50–70</td>
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</table>
buses is reduced by 193 units (there were 512 as of January 1, 2016).
The calculation of the number of buses that will pass through the stopping points as a result of optimization of the route network on the basis of [10] and a reduction in the number of fixed-route taxis has been carried out. The correspondence of the lengths of the stopping points for the new bus flow is determined on the basis of the nomogram (Pic. 3).

The resulting flow of buses (units per hour) to the stopping points and the corresponding length of the safe stop are given in Table 1.
Since the optimization of the route network does not ensure safe stopping of buses at all stopping points, measures are needed to improve the quality of passenger service.
In connection with the high intensity of the bus flows approaching the stopping points, the following solutions are possible:
1. To increase the length of the stopping points.
2. To construct new stopping points for buses of especially small capacity.
3. To bring the number of buses on the routes to the optimal value corresponding to the maximum passenger traffic.
4. At stopping points with a length corresponding to the intensity of the incoming traffic of buses, to allocate individual parking spaces for buses of large and extra-large capacity.
5. To redistribute suburban buses to TIH (transport-interchange hubs) located on the outskirts of the city.

Table 2 shows the loading of 22 stops, which do not provide a safe bus stop, even as a result of the closure of 14 routes of private carriers, and network optimization measures.

### Khimikov street

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<tbody>
<tr>
<td>1</td>
<td>Idea</td>
<td>52</td>
<td>104/50</td>
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<tr>
<td>2</td>
<td>10 microdistrict</td>
<td>64</td>
<td>89/50</td>
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<tr>
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<td>10 microdistrict-2</td>
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<td>15/–</td>
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<tr>
<td>4</td>
<td>VPZ</td>
<td>56</td>
<td>93/50</td>
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### Engelsa street

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<tbody>
<tr>
<td>1</td>
<td>8 microdistrict</td>
<td>40</td>
<td>99/21</td>
</tr>
<tr>
<td>2</td>
<td>Pl. Karbysheva</td>
<td>46</td>
<td>121/21</td>
</tr>
<tr>
<td>3</td>
<td>Sovetskaya street</td>
<td>37</td>
<td>121/21</td>
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### Boulevard Prosoyuzov

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<tbody>
<tr>
<td>1</td>
<td>K-n Yunost’</td>
<td>60</td>
<td>190/16</td>
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<tr>
<td>2</td>
<td>12 microdistrict</td>
<td>47</td>
<td>190/16</td>
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### Karbysheva street

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</thead>
<tbody>
<tr>
<td>1</td>
<td>Koroleva</td>
<td>25,6</td>
<td>64/–</td>
</tr>
<tr>
<td>2</td>
<td>Energotekhmash</td>
<td>17</td>
<td>64/–</td>
</tr>
<tr>
<td>3</td>
<td>Pl. Karbysheva</td>
<td>45,8</td>
<td>49/–</td>
</tr>
<tr>
<td>4</td>
<td>Molodezhnaya</td>
<td>80</td>
<td>49/–</td>
</tr>
<tr>
<td>5</td>
<td>Pushchina</td>
<td>80</td>
<td>33/–</td>
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### Aleksandrova street

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<tr>
<td>1</td>
<td>Volgamonoll</td>
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<td>33/44</td>
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<tr>
<td>2</td>
<td>Lenta</td>
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### Prospect Lenina

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<tr>
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<td>Man (pos. Rabochiy)</td>
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<td>Policlinic</td>
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<td>Koroleva street</td>
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<td>164/67</td>
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<td>5</td>
<td>Central park</td>
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<td>171/69</td>
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<tr>
<td>6</td>
<td>Tovary dlya shkolnikov</td>
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<td>171/69</td>
</tr>
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<td>7</td>
<td>Pl. Lenina</td>
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<td>291/95</td>
</tr>
<tr>
<td>8</td>
<td>Kosmonavtov street</td>
<td>35</td>
<td>291/95</td>
</tr>
<tr>
<td>9</td>
<td>Bolnichniy gorodok</td>
<td>40</td>
<td>140/49</td>
</tr>
<tr>
<td>10</td>
<td>Pl. Sverdlova</td>
<td>80</td>
<td>175/64</td>
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<td>11</td>
<td>DK VGS</td>
<td>80</td>
<td>175/61</td>
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<tr>
<td>12</td>
<td>Pl. Stroitelei</td>
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<td>201/71</td>
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### Kommunisticheskaya street

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</thead>
<tbody>
<tr>
<td>1</td>
<td>Gorkogo street</td>
<td>34</td>
<td>140/49</td>
</tr>
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</table>

4. During the events held:
1. On Olomutskaya street a safe bus stop at the stopping point (SP) «Pharmacy «Vitapharm» is not provided. It is necessary to increase the length from 21,7 to 50–70 meters.
2. On Mira street there is no safe stop of buses at the stopping points «Aleksandrova street», «Universam», «Narimanova street», «Mira street. Iskra shop», «Mira street. Pionerskaya». Redistribution of suburban routes to TIH in the south direction is required.

3. On Prospect Lenina at the SP Policlinic, special parking areas for cars should be allocated. Buses stop in the second lane. In case of redistribution of suburban routes to TIH, the solution of the problem is ensured.

4. At the ST «Kosmonavtov street» the length of 35 meters does not provide a safe bus stop, a length

<table>
<thead>
<tr>
<th>No.</th>
<th>Stopping point</th>
<th>Length of SP, m</th>
<th>Incoming traffic of buses, units/h</th>
<th>Required length of SP, m</th>
<th>Provision of a safe stop of buses at SP as a result of optimization</th>
<th>Measures</th>
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<tbody>
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<td>85/24</td>
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</table>

**Table 2**

The results of decreasing the number of buses at stopping points during the optimization process

<table>
<thead>
<tr>
<th>No.</th>
<th>Stopping point</th>
<th>Length of SP, m</th>
<th>Incoming traffic of buses, units/h</th>
<th>Required length of SP, m</th>
<th>Provision of a safe stop of buses at SP as a result of optimization</th>
<th>Measures</th>
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<tr>
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</table>

2. On Mira street there is no safe stop of buses at the stopping points «Aleksandrova street», «Universam», «Narimanova street», «Mira street. Iskra shop», «Mira street. Pionerskaya». Redistribution of suburban routes to TIH in the south direction is required.

3. On Prospect Lenina at the SP Policlinic, special parking areas for cars should be allocated. Buses stop in the second lane. In case of redistribution of suburban routes to TIH, the solution of the problem is ensured.

4. At the ST «Kosmonavtov street» the length of 35 meters does not provide a safe bus stop, a length
of 50–70 meters is required. The length of the SP cannot be increased due to insufficient space. Redistribution of suburban routes to TIH will not help.

5. On Stroitelei square, due to the lack of coordination of the work of carriers, there are occasional situations when buses stop in two lanes. It is necessary to coordinate the timetable for movement of municipal and private buses.

6. There are no stopping points on 40 let Pobedy street, therefore it is required to change the routes of the routes leaving from the 27 microdistrict to 87 Gvardeiskaya street with a turn to Druzhby street. Pedestrian accessibility of stopping points for residents living and working in the area of 40 let Pobedy street is provided to the stops located on the streets of Karbysheva, 87 Gvardeiskaya, and is about 250–300 meters at a standard of 500 meters.

As a result, at ten stops in the streets Mira, Olomutskaya, prospect Lenina, even after reducing the number of buses, a safe bus stop is not ensured (Table 2).

**Conclusion.** The main disadvantages of organizing passenger transportation by public transport are:

1. The lack of co-ordination of the bus exit from the initial stopping point of municipal and private buses, which can lead to a simultaneous approach of several buses to stopping points.

2. The passage of suburban routes through the city, which gives an additional load of the street-road network.

There are proposals to improve the situation:

1. To ensure a coordinated exit of buses from the initial stopping points.

2. If it is not possible to ensure a safe bus stop, to organize new stopping points.

3. To plan the construction of transport-interchange hubs on the outskirts of the city for suburban routes, thereby excluding the passage of suburban buses through the city.

4. To continue the optimization of the route network, to streamline the use of fixed-route taxis, to exclude the dubbing of urban public transport routes by them.

**REFERENCES**

1. VSN23–75 «Instructions for marking of highways». [VSN23–75 «Ukazaniya po razmetke avtomobil'nых dorog»].

2. GOST 25869–90. Distinctive signs and information support for rolling stock of passenger ground transport, stopping points and passenger stations. General technical requirements [GOST 25869–90. Otlichitel'nye znaki i informatsionnoe obspechenie podvychizhnogo sostava passazhirskogo nazemnogo transporta, ostanovonchikh punktov i passazhirskikh stancii. Obshhie tehnikheskie trebovanija].

3. SNIP 2.05.02–85 «Roads» (approved by the decision of the USSR Gosstroy dated 17.12.1985 No. 223, as amended on 30.06.2003) [SNIP 2.05.02–85 «Avtomobil'nые dorogi» (utv. postanovleniem Gosstroi SSSR ot 17.12.1985 № 223, v red. ot 30.06.2003 г.)].


8. Charter of road transport. FZ No. 259 dated 08.11.2007, as amended on 03.02.2014 [Ustat avtomobil'nogo transporta. FZ № 259 ot 08.11.2007 г., v red. от 03.02.2014 г.].


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Article received 17.05.2017, accepted 24.08.2017.