AJSIHD
GLOBAL RESEARCH NETWORK

**AMERICAN Journal of Science on Integration and Human Development**
*Volume 2, Issue 6, 2024 ISSN (E): 2993-2750*

# Justification of the Efficiency of 3vl80s Electric Locomotives on the Markand – Navoi Section of the Uzbek Railway

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**Abstract:** The results of substantiating the parameters of the transportation operation of three-section mainline (train) freight electric locomotives 3VL80S on a real hilly-mountainous section of the railway when moving freight trains with stops at intermediate separate points, as well as assessing the traction quality of the track profile of the hauls of this section are presented. The criterion for the mentioned assessment is the given values of the total and specific consumption of electrical energy for traction of trains in quantitative and monetary terms, taking into account the values of the reduced running time of the train in traction mode and the specific consumption of electrical energy per trip that accompany the transportation process. The research results were obtained using methods and techniques of the theory of locomotive traction, taking into account the average values of the main indicators of traction and energy efficiency of using the studied 3VL80S electric locomotives in the form of tabular data and graphical dependencies, as well as practical conclusions and recommendations.

**Keywords:** investigation, result, freight train, movement, electric locomotive, railway track, methodology, condition, direction, the stage, the speed, calculation, rolling – stock, analyses, hilly - mountainous, average, railway.

Employees of the Department of «Locomotives and Locomotive Facilities» of TSTU, together with specialists from linear enterprises of the locomotive complex of the railway network and other structural divisions of the railway industry of Uzbekistan, conduct theoretical and experimental research, which consists of developing promising resource-saving technologies for the economical use of fuel and energy resources for traction of trains. Such developments, first of all, should be related to the substantiation of the parameters of the main indicators of the

energy intensity of transportation work and the efficiency of using electric traction rolling stock in various operating conditions.

This is confirmed by the fact that, indeed [1], approximately 59.2 percent of the total actual total volume of railway transportation on sections of the Uzbek railways of varying degrees of difficulty is carried by mainline (train) freight electric locomotives VL80$^S$ in various sectional designs.

The purpose of this study is to substantiate the parameters of the main indicators of the efficiency of using mainline (train) freight electric locomotives of the VL80$^S$ series on one of the real sections of the railway of «Uzbekistan Temir Yollari» JSC and, in addition, it is associated with an assessment of the traction quality of the track profile of each of the hauls of the specified section. The basic component of the technological process of the movement of freight trains and freight rail transportation of goods of various views and types are the real material and technological conditions for organizing the operational activities of the mentioned hilly-mountainous section of the railway.

The algorithm developed by the authors for implementing the research problem formulated above is based on the methods and methods of the theory of locomotive traction [2] and the conditions for organizing the transportation work of locomotives with freight trains of a unified mass of trains on a straightened track profile of the railway section under study, the object and subject of research [3, 4].

The object of the study is three-section mainline (train) freight electric locomotives 3VL80$^S$ and a straightened track profile, a real, hilly-mountainous section of Marokand - Navoi JSC "Uzbekistan Railways" with seven railway stages - these are the stages Marokand - Juma, Juma - Nurbulak, Nurbulak - Kattakurgan, Kattakurgan - Passage No. 28, Passage No. 28 - Zirabulak, Zirabulak - Ziyovuddin, and Ziyovuddin - Navoi.

The subject of the study is the main indicators of transportation work and the parameters of traction and energy efficiency of using the studied electric locomotives 3VL80$^S$, taking into account the reduced costs of electrical energy for traction of trains in quantitative and monetary terms on a given, real, hilly-mountainous section of the railway.

Similarly to [5, 6], the given values of the total and specific consumption of electrical energy for traction of trains, numerically equal to the quotient of dividing the number of mentioned expenses per kilometer of railway track length, are taken as a criterion (indicator) of the difficulty of the route profile. And additionally, the following are used: t* - the reduced running time of the train in traction mode, as well as the values of $c_e$ and $a$ - respectively, specific monetary costs and electrical energy consumption for traction of trains.

As a result of a series of traction calculations for the studied 3VL80$^S$ electric locomotives were determined, the kinematic parameters of the movement of freight trains and the energy parameters of the main indicators of the transportation work of three-section mainline (train) electric locomotives 3VL80$^S$ on the hilly - mountainous section of Marokand - Navoi of the Uzbek railway. The movement of freight trains with a unified train mass Q = 3000 tons and a constant number of axles consisting of m = 200 axles was carried out with stops at intermediate stations and sidings, taking into account the maximum use of the power of power energy systems and the traction qualities of the locomotive, as well as the kinetic energy of the train at each, specific, path profile element.

In table 1 shows the values of some kinematic parameters of the movement of freight trains along the hilly-mountainous section of Marokand - Navoi JSC "Uzbekistan Railways" with stops at intermediate stations and sidings.

**Table 1. Travel time of a freight train on the hilly-mountainous railway section of Marokand-Navoi when moving with stops, electric locomotives 3VL80$^S$**

| No. in order | Stages | Train running time, min | | |
|---|---|---|---|---|
| | | along the hauls | in mode | |
| | | | traction | traction |
| 1 | Marokand - Juma | 8,80 | 2,10 | 6,70 |
| 2 | Juma - Nurbulak | 24,80 | 4,15 | 20,65 |
| 3 | Nurbulak - Kattakurgan | 19,50 | 3,80 | 15,70 |
| 4 | Kattakurgan – Passage No. 28 | 10,80 | 3,55 | 7,25 |
| 5 | Passage No. 28 - Zirabulak | 15,20 | 5,80 | 9,40 |
| 6 | Zirabulak - Ziyovuddin | 20,90 | 5,10 | 15,80 |
| 7 | Ziyovuddin - Navoi | 18,95 | 6,00 | 12,95 |
| 8 | Marokand - Navoi | 118,95 | 30,50 | 88,45 |

Values of the total (total) and specific consumption of electrical energy, which is expended by each studied electric locomotive 3VL80$^S$ in the process of implementing the movement of a specific, only its own, freight train with a unified mass of trains on the hilly-mountainous section of Marokand - Navoi of the Uzbek Railway, taking into account [7] in in quantitative and monetary terms are given in table. 2.

Next, we present the results of substantiating the traction quality (properties) of the track profile of the hauls of the studied hilly-mountainous section of Marokand - Navoi of the Uzbek railway.

In fig. 1 presents graphical dependencies of the energy efficiency indicators of 3VL80$^S$ electric locomotives for each haul of the mentioned section of the railway and some other parameters accompanying the railway transportation of goods by three-section mainline (train) freight electric locomotives 3VL80$^S$, which were determined based on data from the first stage of research

**Table 2. Electrical energy consumption and cash costs of 3VL80$^S$ electric locomotives when moving freight trains with stops on the hilly-mountainous section of Marokand – Navoi**

| No. in order | Stages | Total and specific consumption of electrical energy | | |
|---|---|---|---|---|
| | | general per trip $A$, kW-h | specific per trip $a$, W-h/tkm gross | specific monetary expenses $c_э$, thousand soums /km |
| 1 | 2 | 3 | 4 | 5 |
| 1 | Marokand - Juma | 372,04 | 14,22 | 3,713 |
| 2 | Juma - Nurbulak | 798,18 | 9,33 | 2,436 |
| 3 | Nurbulak - Kattakurgan | 654,31 | 9,05 | 2,363 |
| 4 | Kattakurgan – Passage No. 28 | 566,82 | 17,30 | 4,518 |
| 5 | Passage No. 28 - Zirabulak | 908,04 | 21,30 | 5,563 |
| 6 | Zirabulak - Ziyovuddin | 792,43 | 9,74 | 2,542 |
| 7 | Ziyovuddin - Navoi | 1003,30 | 14,11 | 3,686 |
| 8 | Marokand - Navoi | 5095,12 | 12,35 | 3,232 |

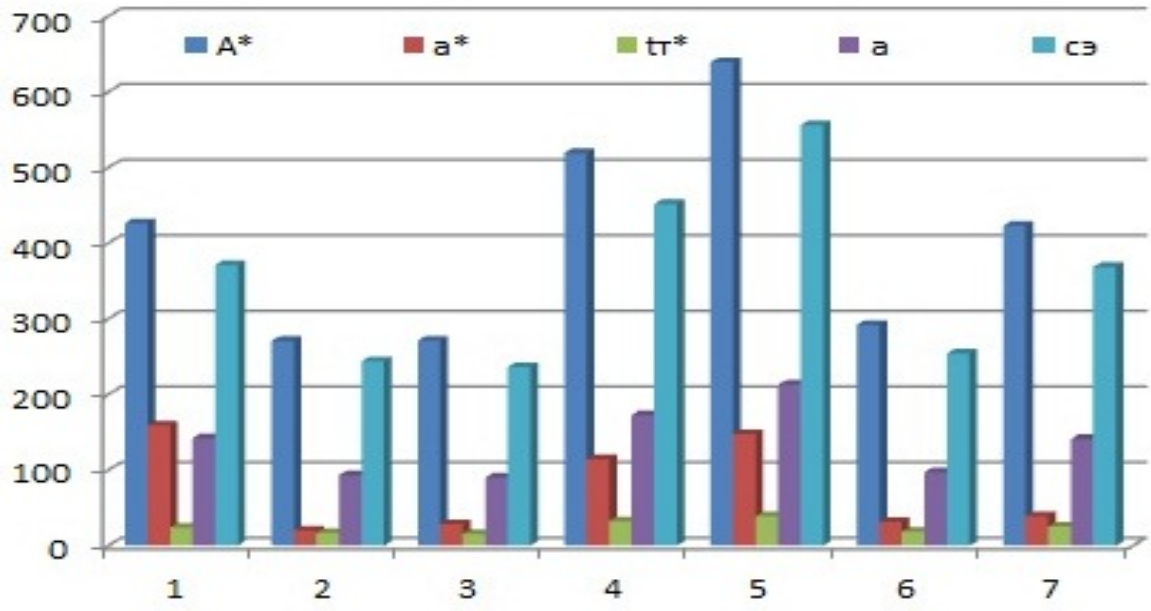


**Figure 1. Energy efficiency indicators of 3VL80$^S$ electric locomotives on the Marokand – Navoi section, movement with stops**

Along the x-axis, each section under study has the following symbol: 1 - Marokand - Juma, 2 - Juma - Nurbulak, 3 - Nurbulak - Kattakurgan, 4 - Kattakurgan - Passage No. 28, 5 - Passage No. 28 - Zirabulak, 6 - Zirabulak - Ziyovuddin , 7 - Ziyovuddin – Navoi. The ordinate axis indicates: electrical energy consumption per trip, respectively, reduced total (full) A*, reduced specific *a** and specific *a*, as well as the reduced running time of the train in traction mode $t_{tr}$* and specific monetary costs $c_e$.

In order to more clearly illustrate the graphical dependencies presented in Fig. 2, the given values of the parameters of the main indicators of energy efficiency of the transportation work of the studied 3VL80$^S$ electric locomotives on the hilly-mountainous section of Marokand - Navoi of «Uzbekistan Temir Yollari» JSC were increased ten times for indicators A* and *a*, and hundred times for indicators *a**, $t_{tr}$*, $c_e$.

The value of the reduced total electrical energy consumption (A*, kW-h/km) / specific (a*, Wh/tkm gross: km) for each section of the hilly-mountainous section of Marokand-Navoi is:

- on the stretches Marokand - Juma and Razezd No. 28 - Zirabulak 42.66/1.63 and 63.91/1.499 units;
- on the haul Kattakurgan - Razezd No. 28 - this is 51.91/1.584 units;
- on the remaining four hauls (Juma - Nurbulak, Nurbulak - Kattakurgan, Zirabulak - Ziyovuddin and Ziyovuddin - Navoi) there is a fluctuation from 27.15/0.327 to 42.34/0.595 units.

Consequently, the hauls Marokand - Juma and Razezd No. 28 - Zirabulak are the most difficult, the haul Kattakurgan - Razezd No. 28 is average in difficulty, the relatively easy hauls are Zirabulak - Ziyovuddin and Ziyovuddin - Navoi, and the hauls Juma - Nurbulak and Nurbulak - Kattakurgan are the most lungs.

Thus, as a result of the research, the authors established the values of the kinematic parameters of the movement of freight trains with a unified mass of trains and the parameters of the main indicators of energy efficiency of electric locomotives of the 3VL80$^S$ series under various conditions for organizing freight traffic on the hilly and mountainous section of Marokand - Navoi of the Uzbek railway. Also, the values of the criterion for traction quality of the track profile were determined for each of the stretches (hauls) of a real hilly-mountainous section.

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