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# REGULATION OF THE SUPPLY OF TRANSIT AND DECONSTRUCTION OF FREIGHT TRAINS TO THE TECHNICAL STATIONS

The article presents the results of the application analysis of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" dispatching technique.

**Aim:** To substantiate the effectiveness of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" dispatching technique.

**Method:** Simulation using the "Simulation of transport systems" (AvroraW) software package.

**Results:** The study revealed that the use of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" dispatching technique results in cutting idle time between operations, saving operating costs and in more uniform loading of station devices.

**Conclusion:** The results of the study will contribute to improving the efficiency of dispatching control of operational work.

***Keywords:*** dispatching/supervisory control, efficiency, simulation modeling.

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# РЕГУЛИРОВАНИЕ ПОДВОДА ТРАНЗИТНЫХ И РАЗБОРОЧНЫХ ГРУЗОВЫХ ПОЕЗДОВ К ТЕХНИЧЕСКИМ СТАНЦИЯМ

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Представлены результаты исследования применения диспетчерского приема «Регулирование (чередование) подвода транзитных и перерабатываемых поездов к станции с учетом положения в ее парках».

**Цель:** Обосновать эффективность реализации диспетчерского приема «Регулирование (чередование) подвода транзитных и перерабатываемых поездов к станции с учетом положения в ее парках».

**Метод:** Использовано имитационное моделирование с применением программного комплекса «Моделирование работы транспортных систем» (AvroraW).

**Результаты:** В ходе исследования установлено, что применение диспетчерского приема «Регулирование (чередование) подвода транзитных и перерабатываемых поездов к сортировочной станции с учетом положения в ее парках» ведет к снижению межоперационных простоев, экономии эксплуатационных расходов и более равномерной загрузке устройств станции.

**Выводы:** результаты исследования будут способствовать повышению эффективности диспетчерского регулирования эксплуатационной работы.

***Ключевые слова:*** диспетчерское регулирование, эффективность, имитационное моделирование.

## Introduction

During the last years increased train traffic bound to ports of the Northwestern Federal District resulted in major increase of railroad sections, train yards and port stations of Oktyabrskaya Railway (October Railway), which in its turn triggered delays in train traffic and increased cars downtime.

Multiple dispatcher techniques were developed over the years of existence of the railway transport dispatcher system [1].

Several methods and techniques targeted at train yards efficiency enhancement were used over the years of dispatching practice [2–4].

Special methods and complexes of analytic expression were developed as part of the study of workflow arrangement and information technologies at the St. Petersburg Moskovsky Marshalling Yard used in operational and economic feasibility calculations and in evaluation of multiple dispatching methods and techniques application efficiency.

This article presents the following technique: regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks.

## Short profile of St. Petersburg Moskovsky Marshalling Yard

The St. Petersburg Moskovsky Marshalling Yard is a basic non-class railway marshalling yard of the St. Petersburg railway junction, and appears as a bidirectional station with in-line arrangement or receiving yards, gravity hump yard, sorting yard and departure yard in each classification system.

Classification systems are arranged parallel to each other, see fig. 1. The “Uneven” system works deals with car traffic arriving from train stations of the

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St. Petersburg railway junction, from Vyborg and Kouznechny stations and from Finland, Estonia, Lithuania, Latvia and Belarus. The "Even" system is used for car traffic coming from Mga (Sonkovo, Boudgoshsh, Kirishi, Volkhovstroy, Petrozavodsk, Babevo) and Moscow (Bologoe, Malaya Vishera, Tchudovo, Novgorod, Kolpino).

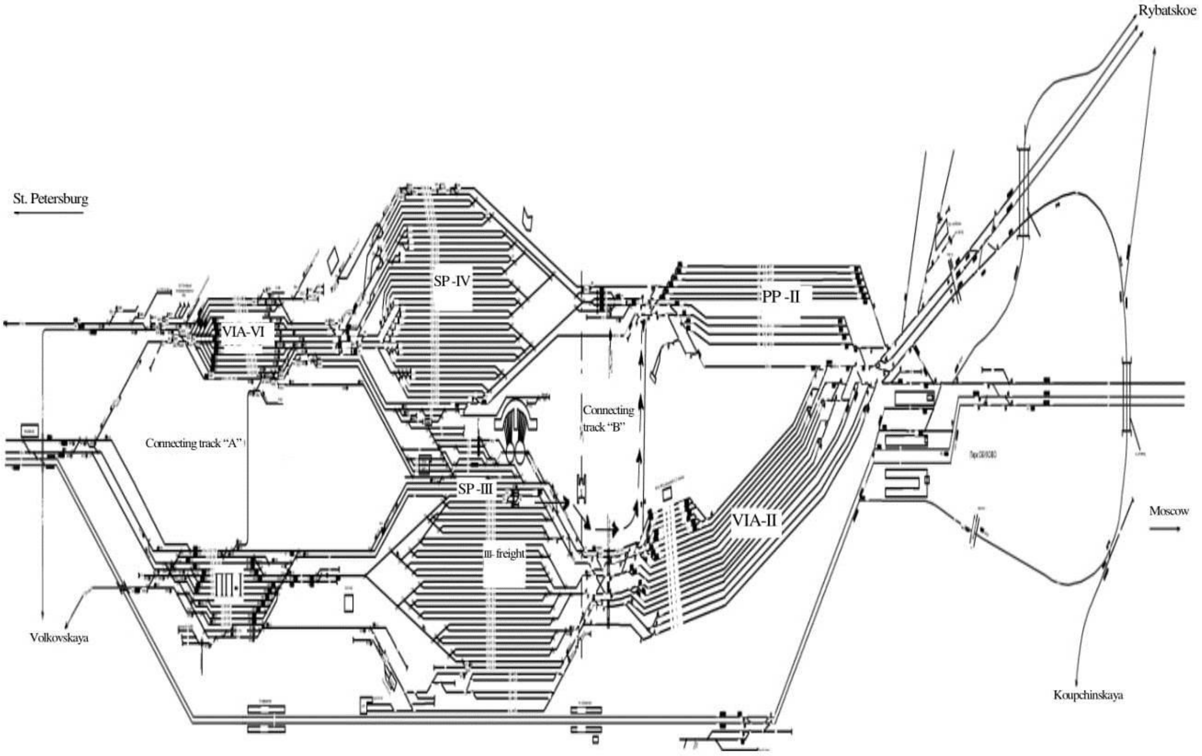


Fig. 1. St. Petersburg Moskovsky MarshallingYard

## Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks

In order to arrange the station dispatcher shift paced operation in coordination with the Railroad Operational Control Center rational alteration approach of transit and remarshalling trains to the station shall be arranged in conformity with the marshalling devices and receiving and departure tracks rhythm of work. This results in enhancement of unhampered train admission at the station [5–7].

In order to arrange such efficient operation within the St. Petersburg Moskovsky Marshalling Yard, experiments were performed with the use of simulation modelling at different percentage ratios of transit and remarshalling trains arriving at the station during the design day.

To evaluate the efficiency of the train dispatching method the analysis was performed and informational implementation technologies were developed, as well as graphical characterization and algorithms were established in order to introduce this dispatching method in the simulation model.

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Simulation modelling was performed throughout the year (365 days) with plotting comparable diagrams of basic transport system elements involvement for each day with application of the dispatching technique under study and without application of this technique.

Schematically the “Regulation (alternate arrangement) of transit and re-marshalling trains approach to the station, with account for the situation in team tracks” technique is presented in fig. 2.

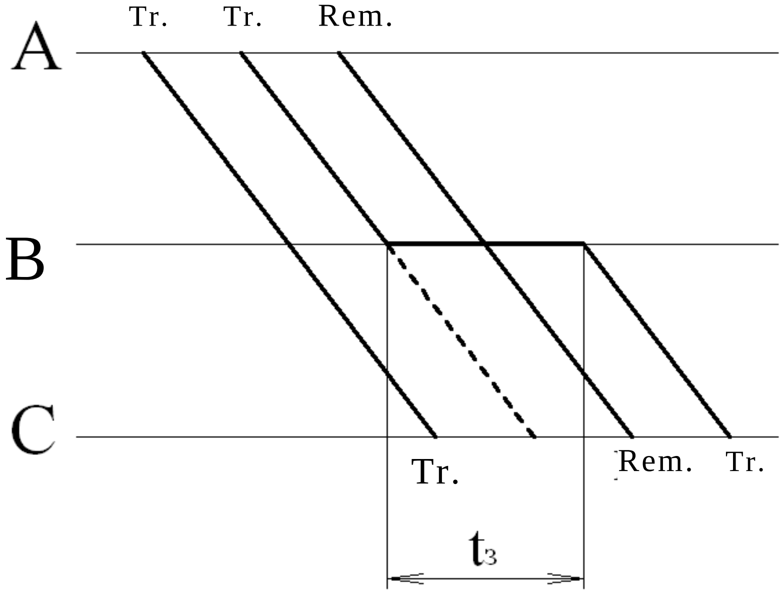


Fig. 2. Schematic presentation of the “Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks” technique

This fragment of the train schedule diagram shows two transit trains (Tr.) and one remarshalling train (Rem.) moving one after another from station A in the direction of marshalling station C with train-to-train interval (assumed equal to 10 minutes for calculation purposes). In order the trains reach station C on alternate basis, the second transit train shall be set for overtaking by the remarshalling train.

Irregularity of trains arrivals shall be accounted for in simulation modelling through the use of probability theory methods.

Formalized presentation of simulation model implementation for dispatching regulatory impact is shown in fig. 3.

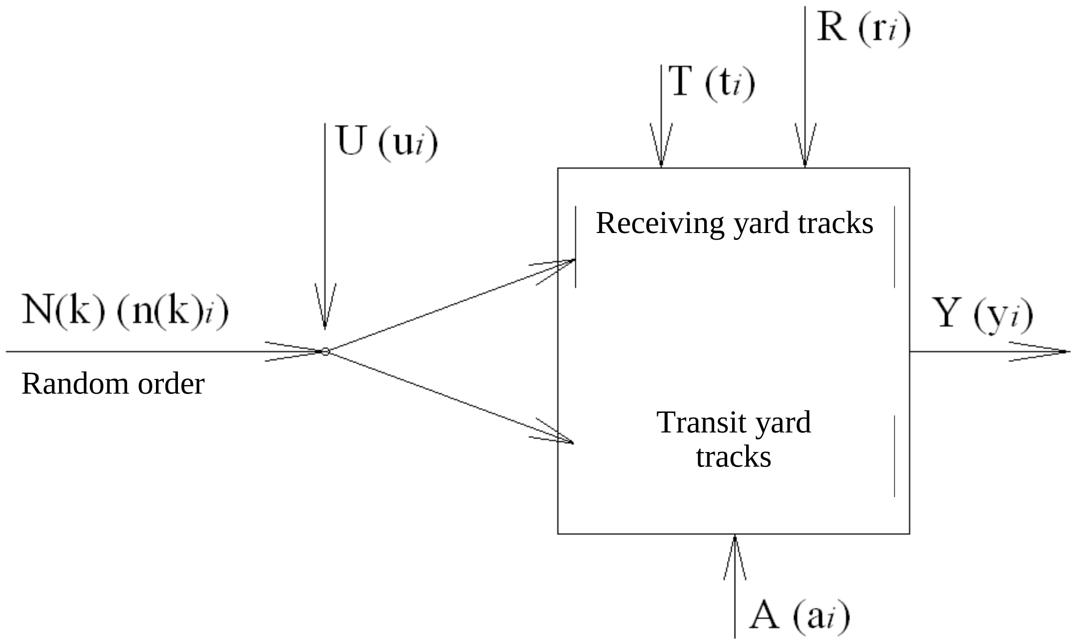


Fig. 3. Formalized presentation of implementation of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" dispatching technique within the simulation model framework

Fig. 3 shows all impacts and responses in vector form: *N*(*k*) (*n*(*k*)*i*) – incoming freight trains traffic flow, comprised of *k* categories (transit trains and remarshalling trains) and characterized by non-uniformity throughout the year, month, week and day; *T*(*ti*) – duration of activities related to incoming trains traffic flow; *R*(*ri*) – resources of the station; *Y*(*yi*) – simulation model responses; *A*(*ai*) – random component of the station operation process; *U*(*ui*) –control impact.

Simulation modelling of processes implemented at the station makes possible to compare values of in-process downtimes for the following options: with and without application of the dispatching technique [8].

The fig. 4 shows the diagrams presenting the relationship between average in-process downtimes characteristic curves without application of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" technique and with application of this technique as function of remarshalling trains percentage.

In case the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the train station, with account for the situation in team tracks" technique is not used, downtimes resulting from waiting for operations implementation shall be significantly higher than the ones in the case when such dispatching techniques are used.

Comparison of total downtimes caused by waiting for operations implementation showed that maximum effect due to application of the technique is reached when transit trains constitute 50 % of total trains traffic.

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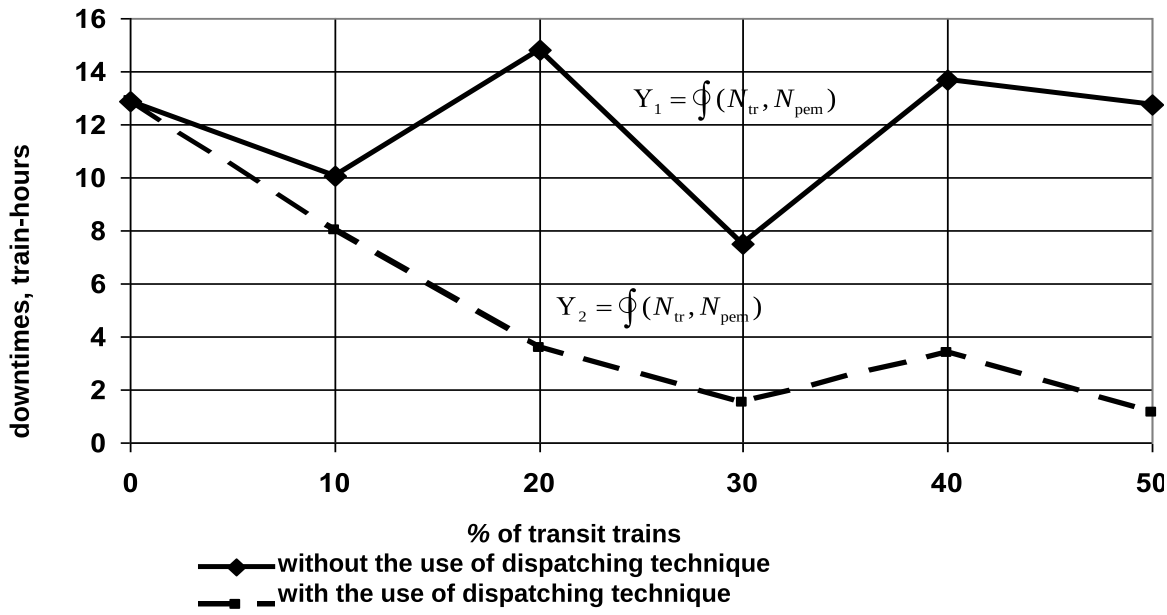


Fig. 4. Diagrams presenting relationship between average in-process downtimes and remarshalling trains percentage without application of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" technique and with application of this technique

The diagram shows that pronounced effect is observed when transit trains constitute 20 % of total trains traffic.

Model experiments were performed as part of the study and dispatching technique application efficiency was analyzed on the day-to-day basis throughout the year. Fig. 5 shows changes of total and average "waiting for service" delays during the first month without the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" technique and with application of this technique (transit trains constitute 50 % of total trains traffic).

Fig. 5. Diagrams of total and average "waiting for service" delays during the first month without application of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" technique and with application of this technique (transit trains constitute 50 % of total trains traffic)

Fig. 5 shows that in-process downtimes are subject to sizeable fluctuations during the month, while average delays caused by waiting for service with application of the dispatching technique (1,14 train-hours) are lower than average delays without application of this technique (12,76 train-hours).

Schedules of main transport system elements employment (standard day) without application of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in

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team tracks" technique and with application of this technique are presented in fig. 6 respectively (50 % of transit trains).

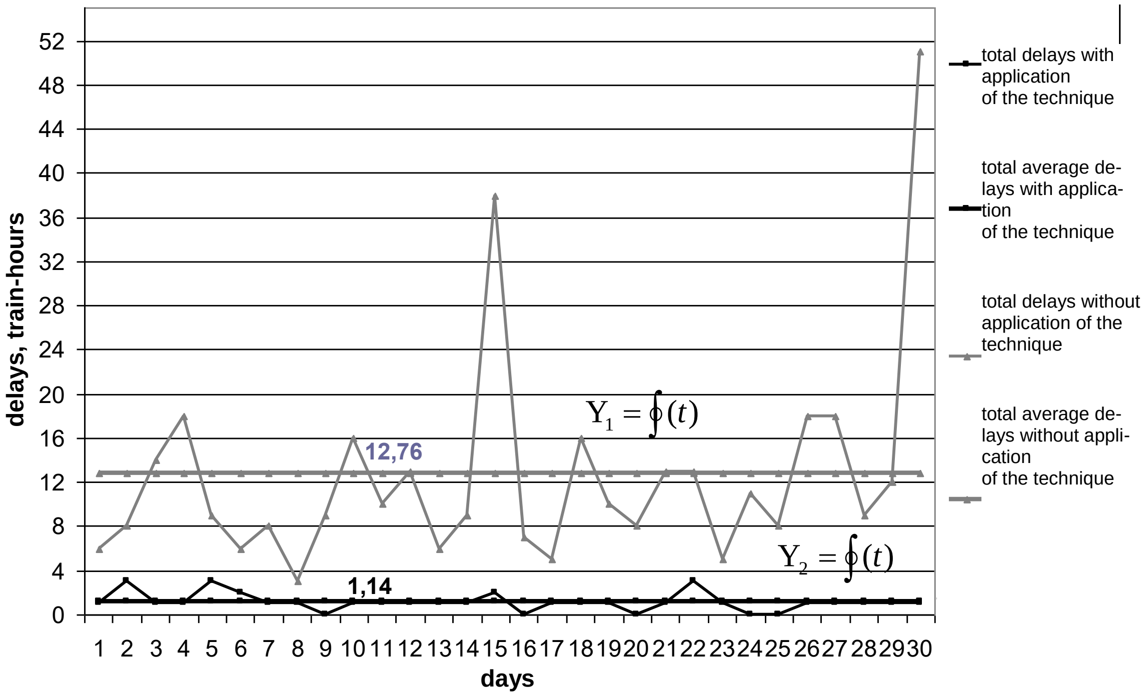


Fig. 5. Diagrams of total and average "waiting for service" delays during the first month without application of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" technique and with application of this technique (transit trains constitute 50 % of total trains traffic)

Calculations were performed aimed at evaluation cost savings based on application of this dispatching technique both for electric and diesel propulsion [9–11].

Results of operational cost savings calculations due to alternation of approach of freight trains in the ratio of 20% of transit trains and 80% of remarshalling trains can be presented by way of example.

RUR 14,7 th. per day with electric propulsion

RUR 13,5 th. per day with diesel propulsion

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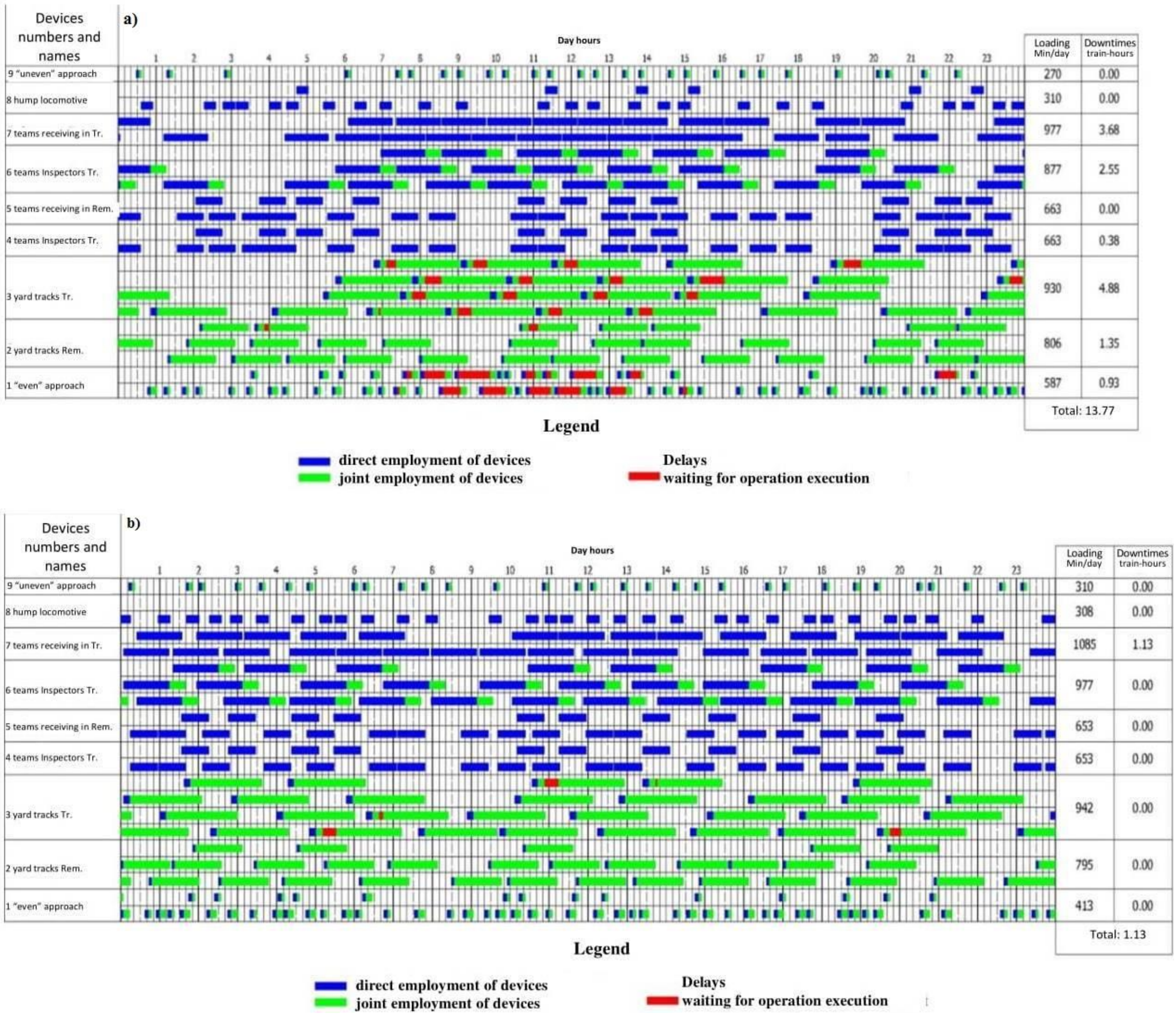


Fig. 6. Schedule of main transport system elements employment (standard day) without application of the "Regulation (alternate arrangement) of transit and remarshaling trains approach to the station, with account for the situation in team tracks" dispatching technique (a) and with application of the dispatching technique (b) (50 % of transit trains)

The study showed that application of the "Regulation (alternate arrangement) of transit and remarshalling trains approach to the station, with account for the situation in team tracks" dispatching technique results in cutting downtimes between operations, in saving operating costs and in more uniform loading of station devices.

## Conclusion

Development of information technologies and implementation of state-of-the-art dispatching methods and techniques at freight stations, as well as algorithms of making economically viable operative decisions with respect to application of these techniques, promote trains operation according to set time schedules on railways of the country [12–14].

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