



MODERNIZATION OF RAILWAY VEHICLE MAINTENANCE WORKSHOPS AT ŽRS A.D. DOBOJ

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Abstract: *The capacities for maintenance of railway vehicles for freight traffic include the Doboj maintenance workshop, the Banja Luka maintenance workshop and the Prijedor maintenance workshop. These workshops can provide maintenance services for various types of locomotives and wagons such as diesel locomotives, electric locomotives and freight wagons. The workshop at the Zvornik border station (which belongs to the Doboj maintenance workshop) and the workshop at the Omarska station (which belongs to the Prijedor maintenance workshop) are also included in the maintenance for the purpose of emergency and ongoing maintenance. Based on the field inspection of the condition of the existing railway vehicle maintenance workshops, it was concluded that they can meet the maintenance needs of the existing locomotives and vehicles. ŽRS still has a large number of railway vehicles out of exploitation, and the capacities were able to meet the maintenance needs of all railway vehicles (operational and non-operational) many years ago. The buildings, facilities and equipment in these workshops are deteriorating, and the working environment is poor, and they need to be renovated or modernized. In addition, newly purchased rail vehicles should also be equipped with appropriate buildings, facilities and maintenance equipment and devices.*

Keywords: *maintenance workshops, railway vehicles for freight traffic, workshop.*

1. INTRODUCTION

Currently, ŽRS has various types of rolling stock, including diesel locomotives 661, electric locomotives 441 and freight cars of various models, all of which are manufactured in European countries. The average lifespan of the existing rolling stock is close to 30 years. Most of the rolling stock is not in operational condition. The number of available rolling stock is small, and the demand for freight traffic is mostly defined by permanent contracts for the transport of bulk goods according to the requirements of the economy. In order to extend the lifespan of locomotives and vehicles, it is necessary to comply with all prescribed maintenance deadlines, and the various levels of work are limited, in addition to the lack of financial resources, by the fact that the existing rolling stock models have not been produced for a long time, and it is not possible to purchase the necessary equipment and devices.

2. CAPACITIES FOR MAINTENANCE OF FREIGHT VEHICLES

The maintenance capacities for railway vehicles for freight traffic include the Doboj maintenance workshop, the Banja Luka maintenance workshop and the Prijedor maintenance workshop. These workshops can provide maintenance services for various types of locomotives and wagons such as diesel locomotives, electric locomotives and freight wagons. The workshop at the Zvornik border station (which belongs to the Doboj maintenance workshop) and the workshop at the Omarska station (which belongs to the Prijedor maintenance workshop) are also included in the maintenance for the purpose of emergency and ongoing maintenance.

➤ Doboj railway vehicle maintenance workshop;

The Doboj maintenance workshop is the most important maintenance workshop of the ŽRS, which is responsible for the ongoing and investment maintenance of all traction and hauled railway vehicles (locomotives, diesel-motor trains and freight

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wagons), as well as vehicles for railway purposes (track maintenance vehicles and contact network). The Doboj maintenance workshop is located on the eastern side of the Doboj station. The maintenance workshop and the station are arranged in parallel, and both ends of the workshops are connected to the station. In addition to the current and investment maintenance of the above types of railway vehicles for the needs of ŽRS, the workshop also provides inspection services, as well as repairs (overhauls) of locomotives, cars and individual assemblies, equipment and devices from them, for the needs of third parties. The workshop also contains modernized machine equipment for processing all types of wheel profiles of railway vehicles. Since May 2009, the workshop has received an ISO standard certificate for maintenance and overhaul of rolling stock, which allows it to participate equally in international tenders for the maintenance of railway vehicles in the region. Overall, the Doboj railway vehicle maintenance workshop is divided into two parts: the locomotive maintenance area and the freight car maintenance area. The Zvornik maintenance workshop belongs to the Doboj maintenance workshop and performs current maintenance and temporary repairs of freight cars at the border station.

➤ **Banja Luka railway vehicle maintenance workshop;**

The Banja Luka railway vehicle maintenance workshop performs bodywork and painting work on diesel and electric locomotives. The workshop also includes a modern painting workshop for the protection and painting of all ŽRS rolling stock.

➤ **Prijedor Rail Vehicle Maintenance Workshop;**

The Prijedor Workshop performs current and investment maintenance of freight wagons of all types and series. The workshop's annual capacity is 100 regular and several hundred current repairs. The Prijedor Workshop has modernized equipment for testing the buffer-traction device and brake system elements. The workshop contains mechanical equipment for pressing axle assemblies. The technological process of investment maintenance in this workshop is carried out according to the highest standards of TSI norms as well as internal instructions and regulations of ŽRS. The Prijedor Workshop is ISO 9001: 2000 certified. A department of the Prijedor Wagon Maintenance Section has been established at Omarska station and a workshop has been formed for emergency current repairs of freight E wagons for all damages caused by manipulation during loading or unloading, where most of the smaller-scale emergency works are carried out on the track itself.

3. MODERNIZATION OF RAIL VEHICLE MAINTENANCE WORKSHOPS

In Based on the field inspection of the existing rail vehicle maintenance workshops, it was concluded that they can meet the maintenance needs of existing locomotives and vehicles. ŽRS still has a large number of rail vehicles out of operation, and the capacities were able to meet the maintenance needs of all rail vehicles (operational and non-operational) many years ago. The buildings, facilities and equipment in these workshops are deteriorating, and the working environment is poor, and they need to be renovated or modernized. In addition, newly purchased rail vehicles should also be equipped with appropriate buildings, facilities and equipment and maintenance devices. Given the existing problems, it is planned to modernize the maintenance workshops in Doboj, Banja Luka and Prijedor. Taking into account the volume of passenger and freight transport, the organization of train traffic and the locations of existing maintenance workshops in the railway network, the functional positioning of the three workshops was carried out as follows:

- ✓ The Doboj Maintenance Workshop is the most important maintenance workshop owned by the Railways of the Republic of Srpska, which is responsible for the maintenance of all locomotives and electric trains, part of freight cars, as well as for the maintenance of infrastructure maintenance machinery.
- ✓ The Banja Luka Maintenance Workshop performs maintenance work on passenger cars of all series, part of freight cars, passenger cars for narrow-gauge traffic and vehicles for railway purposes. This workshop performs painting work on rail vehicles.
- ✓ The Prijedor Maintenance Workshop performs maintenance on freight cars of all types and series. The Omarska Freight Car Maintenance Workshop specializes in ongoing maintenance work on freight cars that are mainly used for ore transport.
- ✓ It is recommended that the Doboj Maintenance Workshop be modernized in the first phase and the Banja Luka Maintenance Workshop and Prijedor Maintenance Workshop in the second phase.

➤ **Doboj Maintenance Workshop;**

Locomotive maintenance facilities at the Doboj Workshop mainly include a workshop for current and capital maintenance of electric locomotives, a workshop for current maintenance and capital maintenance of diesel locomotives and DMV trains, a specialized workshop for maintenance of brake equipment and other special-purpose facilities. The field inspection determined that the entrance doors, windows, roofs, walls and floors of each maintenance

workshop have varying degrees of damage, and the working environment in the workshop halls is poor, so the aforementioned facilities need to be urgently renovated. It was also determined that the Dobož Workshop lacks specialized facilities for painting locomotives, as the Banja Luka Workshop is currently the only one responsible for painting locomotives. Given that the process of painting locomotives produces harmful gases due to paint evaporation, and that there are certain risks to the health of workers and the environment, it is necessary to build a new paint shop. Given that the purchase of new electric locomotives is planned, it will also be necessary to adapt the maintenance of new types of locomotives to the requirements prescribed by the manufacturer. In order to meet the maintenance requirements of electric motor trains and improve the working environment in workshop halls, it is proposed to build a new facility for testing electric motor trains and equip it with appropriate equipment for control, testing and maintenance. At the same time, for maintenance and parking of electric trains, it is necessary to have four tracks, and it is necessary to build two additional tracks intended for this purpose. The truck maintenance facilities at the Dobož Workshop mainly include a truck maintenance workshop, a sandblasting room, a brake maintenance room, a wheel lathe workshop and a press workshop. On site inspection, it was determined that the buildings, facilities and equipment of the truck maintenance workshop are very old and in poor condition, and it is proposed to demolish the existing truck maintenance workshop and rebuild it at the same location. It is also proposed to reconstruct the room for sandblasting freight cars and equip it with complete electrical and pneumatic plants and the necessary equipment for sandblasting. Description of planned works:

1. New EMU maintenance hall;
2. New painting hall;
3. Removal of existing and construction of new facilities for maintenance of freight cars and sandblasting;
4. Equipping the halls with devices and equipment for maintenance of new locomotives and new EMUs and replacing existing equipment;
5. Adaptation of all other maintenance halls;
6. Adaptation of existing facilities for accommodation of administrative and other staff;
7. Other unspecified works.

➤ **Maintenance Workshop Banja Luka;**

The Maintenance Workshop Banja Luka performs current and investment maintenance of passenger cars of all series, individual freight cars and vehicles for railway purposes of ŽRS, and is also responsible for the external painting of locomotives. It consists of a workshop for maintenance of passenger and freight

cars, a hall for maintenance of rotary stands, a paint shop, an electrical testing room, a washing hall, a hall for wheel processing and maintenance of axle assemblies for railway vehicles, two transmissions, a hall for controlling axle pressure on railway vehicles, administration buildings and more. According to the field inspection, the main problem of the Banja Luka Maintenance Workshop is that the workshop halls are old and urgently need renovation, and the equipment in them is outdated and there is a need for urgent renovation. For example, the roofs and systems for collecting and draining atmospheric precipitation on some facilities have serious damage, some hydraulic cranes and other lifting devices have exceeded all periods for performing regular repairs and now require urgent investment, some metalworking machines do not fully meet functional needs and must be reconstructed, and in general there is a lack of various maintenance equipment. Description of planned works:

1. Replacement and overhaul of maintenance equipment;
2. Adaptation of all other maintenance halls;
3. Adaptation of existing facilities to accommodate administrative and other staff;
4. Other unspecified works.

➤ **Prijedor Maintenance Workshop;**

The Prijedor Maintenance Workshop has a workshop for periodic repairs of wagons, a workshop for current repairs of wagons, a workshop for axle assemblies, a workshop for rafamet, a blacksmith shop, a carpentry workshop, a warehouse for spare parts and technical gases, a warehouse for flammable liquids, an administrative building with a restaurant and a boiler room with a compressor station, etc. The workshop halls and facilities in the Prijedor Maintenance Workshop are old, the equipment in them is outdated and there is a lack of an appropriate sandblasting facility and a painting facility. Due to the aforementioned problems in the current work of the Prijedor Maintenance Workshop, it is planned to renovate the existing halls and facilities in the coming period and to overhaul or purchase part of the equipment for maintaining rail vehicles. In addition, adaptation or construction of sandblasting and painting facilities will be required. Description of the planned works:

1. Replacement and overhaul of maintenance equipment;
2. Adaptation of all other maintenance halls;
3. Adaptation of existing facilities to accommodate administrative and other staff;
4. Other unspecified works. [3].

4. FINANCIAL ANALYSIS

The financial analysis was performed using

standard dynamic indicators of investment justification: Net present value; Internal rate of return. Net present value is an indicator that takes into account time values and represents the sum of net income over the economic life of the project discounted to the present moment, i.e. at the beginning of the investment. The net present value method is based on the assumption of discounting all future income and expenses at the beginning of the project implementation, with a specific discount rate determined in advance. The project is acceptable if the net present value is greater than zero. Internal rate of return is the discount rate that reduces the present value of the project to 0. This rate reflects the market-financial efficiency of the project. The eligibility criterion is that it be greater than the discount rate. A prerequisite for a dynamic assessment of profitability is the determination of an appropriate discount rate, which in this research was taken in accordance with the data specified in the document "*Guide to Cost-Benefit Analysis of Investment Projects*" (European Commission, 2014), where the financial discount rate of 4% is specified. Overview of project feasibility indicators:

- ✓ Financial net present value (FNPV) 12,242,869 EUR.
- ✓ Financial internal rate of return (FIRR) 4.94%.
- ✓ The financial net present value (FNPV) of this project is positive in the amount of 12,242,869 EUR, which means that if the company expects a return of 4%, it will be in profit by the amount of the net present value.
- ✓ The financial internal rate of return (FIRR) of this project is 4.94%, which can be considered a favorable internal rate if we consider that a project is acceptable if it has an IRR of at least 4%.

5. SENSITIVITY ANALYSIS

Sensitivity analysis is an analysis that considers the elasticity of an investment project. The goal of sensitivity analysis is to assess the acceptability of an investment project if critical investment parameters change. Critical investment project parameters are those parameters that, by their occurrence, have the greatest impact on the efficiency of the investment project and are at the same time highly uncertain. Sensitivity analysis is used to predict the impact of changes in the input variables in the model on the model results. Project sensitivity analysis:

- ✓ Base case 4.94% 12,242,869 EUR.
- ✓ Increase in regular current maintenance

costs by 10% 4.98% EUR 12,849,430.

- ✓ Reduction of regular current maintenance costs by 10% 4.89% EUR 11,636,308.

As can be seen, the project showed resistance to all realistic types of changes in input parameters. In all cases, there is a return on investment solution.

6. CONCLUSION

During the crisis period of 1992-1995, the railway infrastructure and rolling stock on the territory of the Republika Srpska suffered serious losses. The lack of adequate maintenance, primarily of the rolling stock, electric traction facilities and the catenary network, further increased the overall damage rate in the railway sector in the post-crisis period. Railway vehicle maintenance facilities mainly include workshops for current and investment maintenance of electric locomotives, workshops for current maintenance of passenger and freight wagons, workshops for investment maintenance of diesel locomotives and DMV trains, as well as specialized workshops for maintenance of brake equipment and other special-purpose facilities. The field inspection determined that in many facilities, the entrance doors, windows, roofs, walls and floors of the maintenance workshops have varying degrees of damage, and the working environment is poor, so some of them need urgent renovation. It was also determined that some workshops lack specialized facilities for painting, sandblasting, turning and other types of craft work or control of equipment and devices with special tools and devices. In accordance with the plans for the procurement of new railway vehicles, the construction of new halls and/or the renovation of existing facilities will be required to meet the specific maintenance requirements of specific types of railway vehicles in accordance with the technology applied to them. For now, the recommended urgent procurements are the replacement and overhaul of maintenance equipment, the adaptation of existing halls for vehicle maintenance, the adaptation of existing facilities for the accommodation of administrative and other staff, as well as other necessary minor works not listed.

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