ORIGINAL ARTICLE
DOI: https://doi.org/10.30932/1992-3252-2023-21-4-6

World of Transport and Transportation, 2023,
Vol. 21, Iss. 4 (107), pp. 199–206

Technical Preparation for Scheduled Preventive Maintenance of Double-Decker Rolling Stock

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ABSTRACT

The article is devoted to the study of the process of technical preparation preceding scheduled preventive maintenance of newly commissioned double-deck passenger coaches. The paper considers the main tasks and goals of technical preparation, including the step-by-step process of car repair, as well as repair planning, formation of a range of applied materials, tools, and step-by-step control of work performed during repair and maintenance. Upon identifying features and inconsistencies that arise during technical preparation for repair of double-deck coaches of a new model range, ways to solve them are proposed.

The paper considers the main directions in organisation of preventive maintenance in terms of implementation of measures to integrate into the process the features associated with the specifics of the assemblies, parts and materials used in those coaches; main tasks of preparing for scheduled preventive maintenance with regard to provision of workshops, of developing forms, methods and adjusting production processes, as well as of employing small-scale mechanisation tools, and manufacturing devices to speed up the repair process. The processes of carrying out scheduled preventive maintenance are structured allowing development of a process model for repair of a double-decker coaches when they are delivered at maintenance and repair facilities.

The study allows regulating and improving the efficiency of technical preparation for repair of double-deck coaches, ensuring higher quality and speed of repair work, as well as effectively assessing the real need for spare parts and materials used during the repair process, since the operation of these coaches provides for a new set of spare parts, materials and elements in comparison with single-deck analogues already manufactured.

Keywords: railways, double-deck coach, passenger car, personnel, costs, unification, model, design.

For citation: Shinkaruk, A. S. Technical Preparation for Scheduled Preventive Maintenance of Double-Decker Rolling Stock. World of Transport and Transportation, 2023, Vol. 21, Iss. 4 (107), pp. 199–206. DOI: https://doi.org/10.30932/1992-3252-2023-21-4-6.

The text of the article originally written in Russian is published in the first part of the issue.
Текст статьи на русском языке публикуется в первой части данного выпуска.

INTRODUCTION

Railway transport plays a key role in the economics of the Russian Federation. Railways are the main medium for transporting goods over long distances, which is useful, first, for development and maintenance of the industries ensuring economic growth and prosperity. Most cargo, especially food products, is shipped by rail, which is also important for ensuring food provision of the population. Due to implementation of various projects, for example, construction and modernisation of railway lines, the number of deliveries and speed of cargo transportation, as well as rail transportation process are significantly increasing and improving.

Railway transport is also important for passenger transportation, especially when transporting passengers over long distances, which provides an opportunity to travel around Russia and get acquainted with its beauty and culture. It also connects different regions and cities, providing access to labour and natural resources.

The Decree of the Government of the Russian Federation of May 18, 2001 No. 384 approved the «Program for the Structural Reform of Railway Transport»[1] which sets out the concept of reforming the railway transport and its passenger complex, in particular it provided for subsequent differentiation of certain areas for development of passenger transportation that englobe long-distance, suburban and high-speed traffic.

On March 27, 2007, JSC Russian Railways approved Regulation No. 405 «On the Federal Passenger Directorate – a branch of JSC Russian Railways»,[2] within the framework of which the transition and structuring of long-distance passenger transportation as a separate business structure began. This process resulted in its complete transformation based on the principles of territorial-administrative management.

In 2009, the Board of Directors of JSC Russian Railways approved the creation of Federal Passenger Company Open Joint Stock Company (hereinafter JSC FPC) as an independent structural entity and, since 2010, this company began its production and financial activities. JSC FPC's assets include locomotive-hauled passenger coaches, passenger car depots and territorial sections, luggage facilities and rail ticketing agencies.

In accordance with the Long-Term Development Program of JSC Russian Railways until 2025, approved by Decree of the Government of the Russian Federation No. 466-r on March 19, 2019,[3] and to implement it, it was established that to achieve an increase in passenger turnover, an average purchase of 600 cars is required annually. The implementation of these requirements will make it possible to maintain the share of long-distance passenger traffic at the level of 26–28 percent, achieving 116,7 billion passenger-kilometres in long-distance traffic by 2025[3].

The world leader in the number of passengers travelling with all types of traffic is China [1], where 3 billion people were carried in 2021, followed by India (1,25 billion), and Germany ranked the third (1,2 billion). In Russia, this figure is 1,06 billion departure passengers and corresponds to the 5th place in the world ranking.[4]

When transforming this indicator into billion pass.-km, it was found that Russian railways in this segment are inferior to Chinese carriers with a volume of 946 billion pass.-km and Indian railway transportation with 201 billion pass.-km. In Russia, the indicator of railway passenger transportation in all segments for 2021 amounted to 104,2 billion passenger-km.[5] The difference in indicators refers, among other things, to the fact that residents of Europe and Asia use high-speed rail services as a priority.

When considering the mobility of passengers and their preferences in using different modes of transport, it was found that 54 % of passengers use air transport services [2], 23 % travel with railway transport, 15 % with road transport, 8 % with metro, and less than 1 % use water transport[5].

[1] Decree of the Government of the Russian Federation of May 18, 2001 r. No. 384 «On the Program for the Structural Reform of Railway Transport». [Electronic resource in Russian]: https://base.garant.ru/183354/. Last accessed 02.03.2023.

[2] Regulation No. 405 «On the Federal Passenger Directorate – a branch of JSC Russian Railways». [Electronic resource in Russian]: https://docs.cntd.ru/document/901989485. Last accessed 02.03.2023.

[3] Decree of the Government of the Russian Federation dated March 19, 2019 No. 466-r «On approval of the long-term development program of JSC Russian Railways until 2025». [Electronic resource in Russian]: http://government.ru/docs/36094/. Last accessed 15.01.2023.

[4] Based on: [Electronic resource]: https://uic-stats.uic.org/list/. Last accessed 20.05.2023.

[5] Transport in Russia. 2022: Statistics collection. Rosstat, Moscow, 2022, 101 p. [Electronic resource in Russian]: https://rosstat.gov.ru/storage/mediabank/Transport_2022.pdf. Last accessed 25.02.2023.

To increase volumes of transportation in long-distance passenger traffic, it is necessary to develop both convenient transport logistics and connectivity between transportation areas, using various modes of transport (multimodality) [3], and improve the quality of service, as well as the comfort of offered rolling stock [4].

The age of rolling stock has a primary influence on improvement of passenger travel conditions. Thus, in the Russian Federation over the past decade, implementation of the investment program for purchase of rolling stock has made it possible to reduce the average age of a passenger coach from 19,2 to 17,5 years, and to reduce its wear and tear from 66,4 % to 54,4 %,[6] which had a positive effect on both the quality of services, and on attracting passengers to travel in the long-distance segment of transportation [5].

However, despite a significant increase in purchase of rolling stock in recent years, the available number of passenger coaches is still not enough to meet all the needs for passenger transportation during peak periods. To meet them on a systematic basis, opportunities are being sought and prospects are being considered for increasing the use of rolling stock in operation through introduction of promising diagnostic tools [6], which reduce the risk of significant damage or wear of car components [7–9], as well as the use of elements with increased operational reliability and service life [10]. Technological processes for organising maintenance and scheduled preventive maintenance are also being improved.

Along with improving the technical features of rolling stock, the carrier is also interested in increasing the capacity of the passenger car [11]. So, from November 1, 2013, a train has been launched, formed with double-decker domestic-made coaches on Adler–Moscow route. This type of rolling stock has become in great demand for passengers, and at present, more than 850 cars are already running on the railway network, connecting regional centres, as well as resorts on the Black Sea coast.

Thus, the role of preparing production facilities for organising preventive maintenance to ensure efficient maintenance and scheduled preventive repairs during the entire operational stage of the life cycle grows taking into account the constant increase in the fleet of double-deck passenger coaches, results of the analysis of organisation of work on preparation for production, development and operation of rolling stock in foreign companies [12–14].

The *objective* of the study is to analyse technical preparation for scheduled preventive maintenance of double-deck coaches of a new model range at the production facilities of passenger car depots. The study used the *methods* of engineering modelling, regulatory analysis, as well as a comparative study.

RESULTS

Carrying out scheduled preventive maintenance of passenger rolling stock includes equipping sections and workshops of the relevant enterprises with appropriate equipment, measuring tools and fixtures,[7] as well as implementation of other measures to integrate design features of various models of cars into the technological process. The process of mastering a new production process for repair of double-deck rolling stock is systematised in accordance with the requirements of the Single Design Documentation System, in accordance with which the developed manual for depot and overhaul (KR-1) repairs of passenger double-deck cars (LV1.0058 RK)[8] was extended to repair of a new prototype. Based on the results of the pilot repair and testing, the existing manual will be amended with assignment of the letter «RO», a set of coaches will be repaired according to the revised manual, acceptance tests will be carried out and the letter «RA» will be assigned to repair documentation, allowing extending repairs to cars of these models on an ongoing basis. Due to the unity of forms and rules of general requirements in accordance with requirements of GOST [State Standard] 2.602–2013,[9] formation of a standard manual for repair of rolling stock is greatly simplified.

Structural enterprises are developing their own technological processes interconnected with both repair and operational documentation for the corresponding car models.

[6] Annual report of JSC FPC. 2021. Key figures [Electronic resource in Russian]: https://ar2021.fpc.ru/ru/company/results. Last accessed 25.02.2023.

[7] Decree of JSC FPC dated 2.12.2020, No. 1072r «On Approval of the Regulations on Technological Equipment for Maintenance and Repair of Passenger Cars». Moscow, JSC FPC, 2020, 63 p.

[8] Guidelines for depot and overhaul (KR-1) repairs of passenger double-deck coaches LV1.0058 RK. Moscow, JSC Russian Railways, 2021, 294 p.

[9] GOST 2.602-2013. Single Design Documentation System. Repair documents. Moscow, Standartinform publ., 2014, 20 p. [Electronic resource]: https://docs.cntd.ru/document/1200106870. Last accessed 25.02.2023.

However, to increase the efficiency of formation of local technological processes at the structural enterprises of the passenger complex, it is necessary to create a regulatory document regulating the procedure for sending newly commissioned models of passenger coaches and their components for scheduled preventive maintenance, as well as technical preparation of production facilities for repair and procedure assessment of quality of the repaired car with its acceptance control for compliance with quality of repair and maintenance of relevant components and parts.

To implement the process of technical preparation of the repair facility and interconnection of governing documents, JSC FPC developed the Procedure for preparation, coordination and approval of technological processes in the structural divisions of JSC FPC branches, approved by Order of JSC FPC dated August 26, 2021 No. 893r.[10] It contains the requirements for preparation, coordination and approval of technological processes.

This procedure regulates the requirements for development of technological processes, considering local conditions, capacities of workshops and sites, normative control, labour protection requirements, fire and industrial safety, and also establishes the procedures for updating, adjusting and revising the frequency of technological processes and linear schedules.

However, this Procedure does not reflect the process of preparing production for repair of passenger coaches of a new model range, taking into account their design features and new elements.

Organisation Process at Production Facilities for Repair of Double-Deck Rolling Stock: Prospective Requirements

To form a single approach to organising the preparation of production facilities for repair of new models of double-deck passenger rolling stock, it is required to ensure the implementation of the following main stages, this is formation of a linear schedule, conduct of standard control, assessment, and confirmation of quantitative characteristics of the equipment used for maintenance and repair, identification of the staff and their qualifications[10].

[10] Decree of JSC FPC dated 26.08.2021 No. 893r «On approval of the Procedure for preparation, coordination and pproval of technological processes in the structural divisions of JSC FPC branches». Moscow, JSC FPC, 2021, 33 p.

Upon the results of development of a single technological process for implementation of the procedure for technical preparation of production facilities, it is necessary to include the following areas: development of a project for re-equipping the structural unit with necessary equipment, fixtures and measuring tools; reprofiling or mastering repair of new units and parts (backlash-free coupling units (BCU), converters, etc.); training and staffing; identification, formation and maintenance of a working stock of spare parts and materials[10].

The task of re-equipping the structural unit with necessary equipment, fixtures and measuring instruments is to fulfil one of the stages of preparation for production facilities to ensure high-quality and timely repair of purchased new models of double-deck rolling stock in compliance with all the requirements laid down by the manufacturers of both the rolling stock itself and its elements.

The task of re-profiling production facilities or individual production sites (workshops) for repair of newly commissioned models of double-deck rolling stock is to reduce the cost of repairs, optimise downtime in repairs, reduce the financial burden in terms of additional purchase of parts to form a working stock or use rolling stock repair services from third party contractors.

The task of staffing and training personnel is to make them acquire the skills to master repair of new components and parts of the rolling stock introduced by the manufacturer in new coaches.

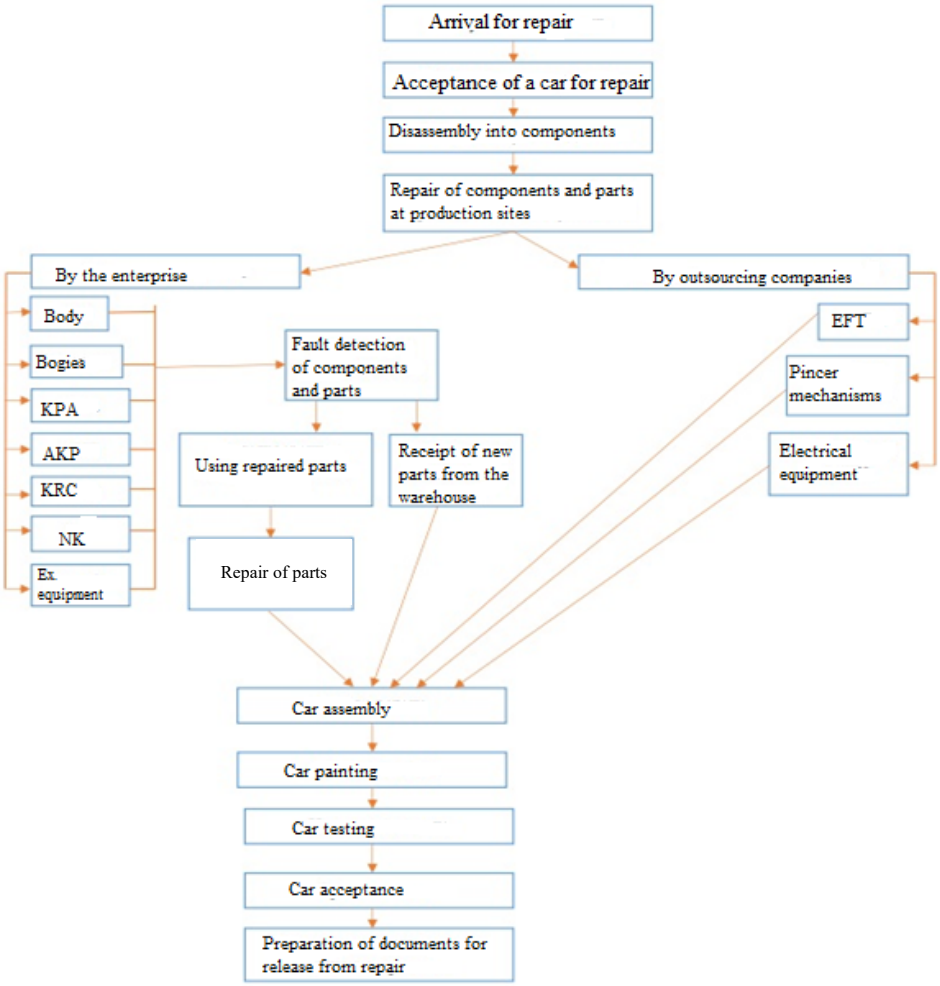
In general, the scheme for carrying out scheduled preventive maintenance is structured in Pic. 1.

The general goal of preparing production facilities for scheduled preventive maintenance of double-deck passenger coaches of a new model range is development of optimal technological processes (both for general KR-1 depot and overhaul maintenance and repair of the coach, as well as regarding its components and parts) that would ensure repair of products of a given quality with minimal time, production, and financial costs.

The main objectives of scheduled preventive maintenance are:

• Development and implementation of technological processes (both for workshops and sites incorporated in the structural unit, and for outsourcing companies).

• Providing workshops and sites with measuring tools.



Pic. 1. Step-by-step scheme for repair of a double-deck passenger coach [performed by the author].

• Implementation of re-profiling of sites and workshops for mastering repair of new equipment.

• If necessary, a certification procedure or expansion of the range of the activity of repurposed workshops (sections).

• Development of forms and methods for organising production processes.

• Providing the enterprise with means of small-scale mechanisation for transportation and warehousing.

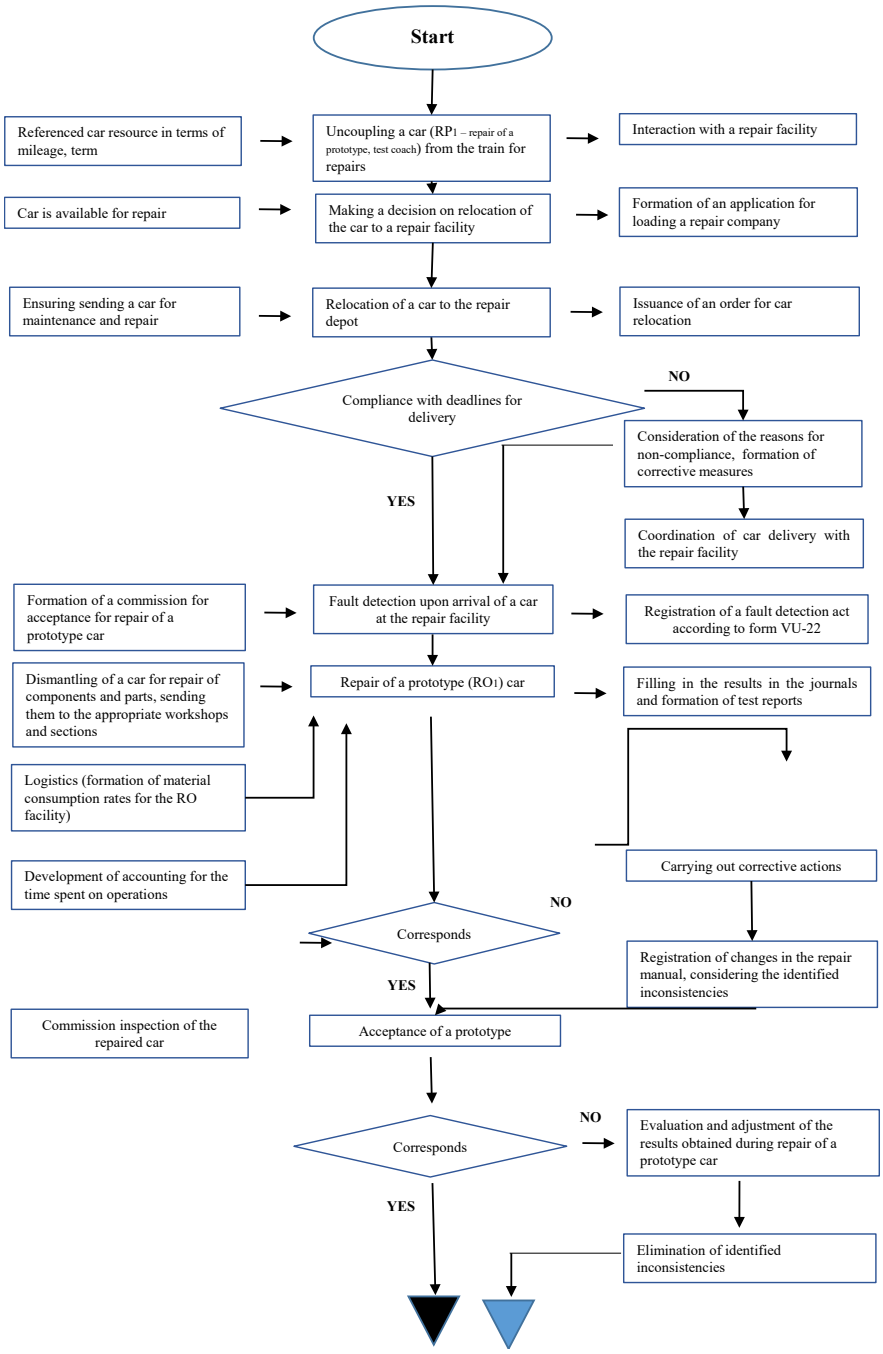
• Development of technologies and means of technical control of production processes.

• The use of small-scale mechanisation, measuring tools and equipment in the technological process during repair of car components and parts.

• Repair of a prototype with subsequent commission acceptance.

• Adjustment of technological processes, their components and parts, revision of the program for retrofitting the enterprise for technical preparation of production.

The continuity of the transportation process, the demand for double-deck rolling stock requires production facilities to master maintenance and/or preventive maintenance as soon as possible and with minimisation of losses during performance of basic technological operations and of costs. At the same time, for formation of technological operations for repair and restoration of components and parts, this primarily concerns electrical, electronic equipment, as well as systems to ensure comfortable travel for the passenger (environmentally friendly toilet complexes (EFT), air conditioning units, etc.), it is necessary to promptly update changes, additions and innovations with relevant changes in the design documentation. As a rule, these changes are sent to the structural subdivisions with a significant delay and it is not possible to organise repairs in

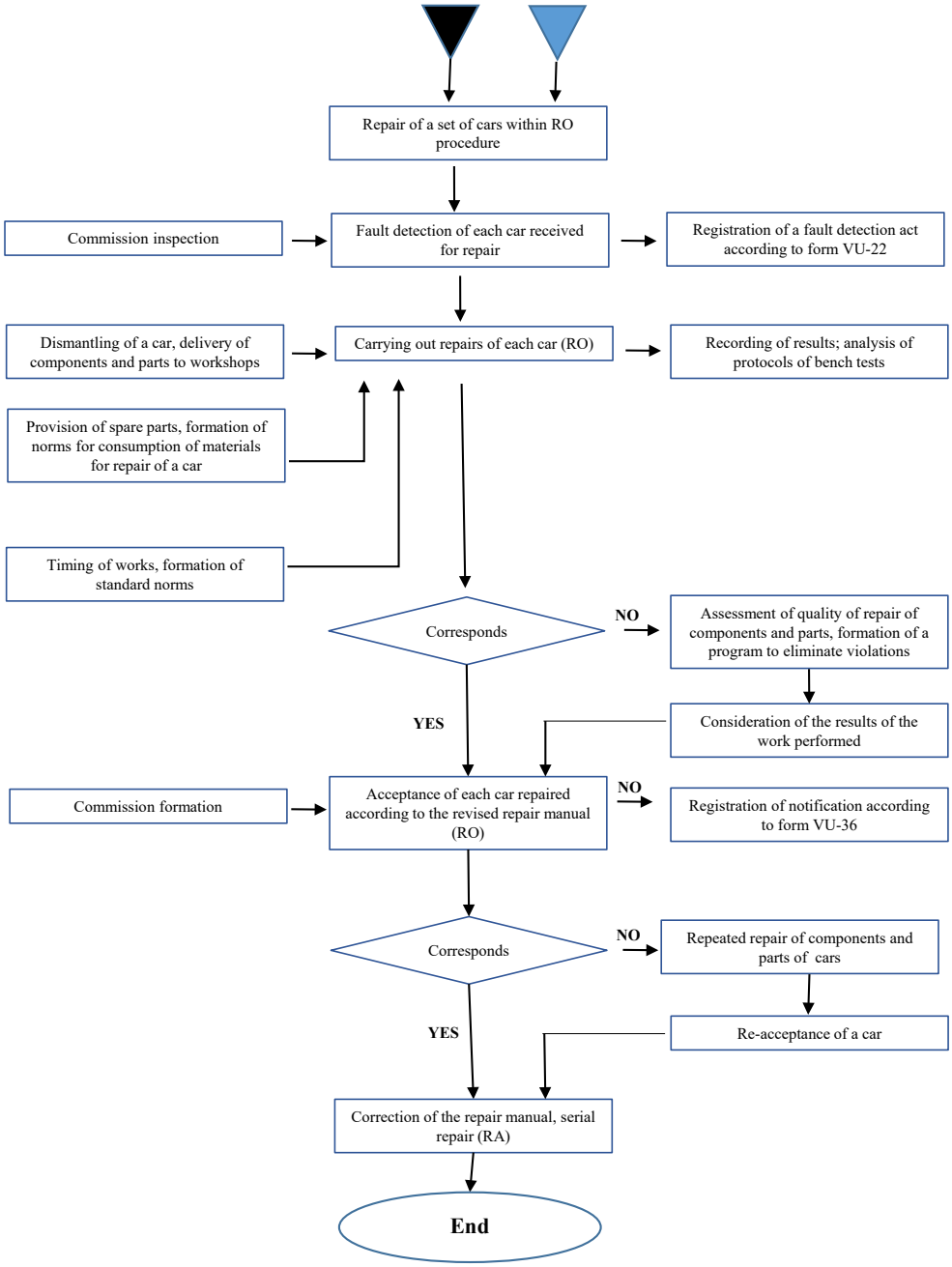


Pic. 2. A process model for repair of a double-deck passenger coach when it enters maintenance facility [performed by the author].

full accordance with the requirements of design or operational documentation due to the technical complexity of a number of components and parts that require additional preparation of production facilities, personnel or the need to purchase bench equipment within the framework of investment program, which is a lengthy procedure.

So, on a systematic basis, additions are made to systematise organisation of repair of electrical converters located in the under-roof space of the car, backlash-free coupling devices.

The process algorithm for solving the problem of mastering production with engineering modelling of the processes of repairing a passenger double-deck coach is shown in Pic. 2.



Pic. 2. A process model for repair of a double-deck passenger coach when it enters maintenance facility [performed by the author] (end of the chart).

This approach allows us to consider in detail all the aspects that arise during repair, and during implementation of the stages of this engineering model, it is possible to consider any stage that the car passes when it is delivered at maintenance and repair facility, including setting standard spending of material resources, labour costs, wording and updating of the specifications, regulatory and technological documentation, as well as qualifications and training of personnel. Those specific practices are the most effective and allow us to adjust the process, considering the conditions of the existing production facilities, to quickly build optimal technological operations with preparation of necessary text and graphic documents, technical charts used in repair and

maintenance, tools and fixtures. In addition, one of the key stages of implementation as part of technical preparation of production facilities is development of a manual for serial repair of new models of double-deck rolling stock that makes it possible to assess the real need, first, for material, time and human resources, determine the layout and, if necessary, redevelop individual workshops or sections, as well as determine the capacity of each of them. Even taking into account significant financial investments in technical preparation of production facilities, the results are always justified and the economic effect of increasing productivity significantly exceeds their share in the total costs of the structural unit.

CONCLUSIONS

The process model for maintenance and repair of double-deck passenger rolling stock is aimed at a qualified organisation and technical preparation of production facilities for scheduled preventive maintenance of newly commissioned cars. Considering the need for maintaining continuous and uninterrupted transportation process, it was determined that the process of mastering maintenance and repair of a new model range rolling stock requires the soonest implementation with minimal losses to perform the main technological process of an enterprise.

In particular, the relevance of technical preparation of production facilities has been confirmed to master maintenance and repair of a new model range of rolling stock introduced as part of the reform of the long-range passenger complex.

Based on the results of considering the structure of organising the launch of maintenance and repair of a new model range of passenger rolling stock, the main goals and objectives were formulated (updating technological processes, re-profiling sections and workshops, equipping production with the necessary equipment, etc.).

Based on the results of preparation of production facilities for maintenance and repair of serially produced rolling stock, the main production processes were identified that require adaptation (list and rate of replacement of spare parts, personnel qualifications, labour costs).

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Article received 23.05.2023, approved 13.10.2023, accepted 16.10.2023.