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THE DEVELOPMENT AND CONSTRUCTION OF NARROW-GAUGE LOCOMOTIVES AT THE DNIPROPETROVSK ELECTRIC LOCOMOTIVE PLANT (1969–1991)

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Abstract. The article attempts to investigate the historical circumstances of the development and serial construction of narrow-gauge electric locomotives at the Dnepropetrovsk Electric Locomotive Plant based on a comprehensive analysis of sources and scientific literature. It is determined that during the 1960s and 1990s the staff of the Special Design and Technology Bureau of the Dnipropetrovsk Plant, having a strong research and production potential, developed and created projects of unique narrow-gauge electric locomotives of PEU 1 series (IELNG1 – industrial narrow-gauge electric locomotive type 1) and PEU 2 (IELNG2 – industrial narrow-gauge electric locomotive type 2) to meet the needs of the Soviet mining industry in the complex mining and geological conditions of Central Asia with modern high-tech electric vehicles. The development of the research and production base of the machine-building enterprise is traced, the production nomenclature of which, originally represented exclusively by electric locomotives and traction units for industrial purposes, was expanded to the production of main traction rolling stock and special repair equipment. It was found that due to the economic crisis of the CIS countries in the first half of the 1990s, the rupture of economic ties of the former Soviet republics and the lack of need for such equipment on electrified access roads of narrow-gauge Ukrainian mining enterprises all work on designing promising projects and serial production of narrow-gauge electric locomotives at the Dnipropetrovsk Electric Locomotive Plant were stopped, and the Special Design and Technology Bureau of the enterprise, having received a state order, was reorganized into the Ukrainian Research Design Institute of Electric Locomotive Construction and focused on the development of main wide-gauge locomotive fleet of the railway network of Ukraine. Despite the fact that the Ukrainian Research Design Institute of Electric Locomotive has been liquidated and the Dnipropetrovsk plant is in decline, taking into account the historical experience of electric locomotive building in Ukraine is of fundamental importance in the general perspective of Ukrainian transport engineering and the domestic railway industry in particular. Further study of the history of Dnipropetrovsk Electric Locomotive Plant requires analysis of the historical circumstances of the institutionalization of the Special Design and Technology Bureau of the enterprise from the creation of shunting electric locomotives and traction units for industrial purposes to the development and re-equipment of main traction rolling stock and specialized repair equipment within the state enterprise «Ukrainian Research Design Institute of Electric Locomotive Engineering» under the leadership of Academician Victor Bratash.

Keywords: Dnipropetrvsk electric locomotive plant, transport engineering, narrow-gauge electric locomotives.

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РОЗРОБКА ТА БУДІВНИЦТВО ВУЗЬКОКОЛІЙНИХ ЕЛЕКТРОВОЗІВ НА ДНІПРОПЕТРОВСЬКОМУ ЕЛЕКТРОВОЗОБУДІВНОМУ ЗАВОДІ (1969–1991)

Анотація. Здійснено спробу дослідити історичні обставини розробки та серійного будівництва вузькоколійних електровозів на Дніпропетровському електровозобудівному заводі на підставі комплексного аналізу джерел і наукової літератури. Визначено, що протягом 1960–1990-х рр. колектив Спеціального конструкторсько-технологічного бюро Дніпропетровського заводу, маючи потужний науково-виробничий потенціал, здійснив розробку та створив проекти унікальних вузькоколійних електровозів серій ПЕУ1 (промисловий електровоз вузькоколійний тип 1) та ПЕУ2 (промисловий електровоз вузькоколійний тип 2) для забезпечення радянської гірничовидобувної промисловості в складних гірничо-геологічних умовах країн Центральної Азії сучасним високотехнологічним електротранспортом. Простежено розвиток науково-виробничої бази машинобудівного підприємства, виробнича номенклатура якого, первісно представлена виключно електровозами і тяговими агрегатами промислового призначення, була розширена до виробництва магістрального тягового рухомого складу та спеціальної ремонтної техніки. З'ясовано, що внаслідок економічної кризи країн СНД першої половини 1990-х рр., розриву економічних зв'язків колишніх республік СРСР та відсутності потреби в подібній техніці на електрифікованих під'їзних шляхах вузької колії українських підприємств видобувної промисловості всі роботи з розробки перспективних зразків та серійного виробництва вузькоколійних електровозів на Дніпропетровському електровозобудівному заводі були припинені, а Спеціальне конструкторсько-технологічне бюро підприємства, отримавши державне замовлення, було реорганізоване в Український науково-дослідний проектно-конструкторський інститут електровозобудування та зосередилось на розробці магістральних ширококолійних локомотивів і спеціальної ремонтної техніки з метою оновлення локомотивного парку мережі залізниць України. Попри те, що УНДІ Електровозобудування на сьогодні ліквідований, а Дніпропетровський завод перебуває в занепаді, врахування історичного досвіду становлення електровозобудування в Україні має принципове значення як у загальній перспективі розвитку українського транспортного машинобудування, так і вітчизняної залізничної галузі зокрема. Подальше дослідження історії Дніпропетровського електровозобудівного заводу потребує аналізу історичних обставин інституалізації Спеціального конструкторсько-технологічного бюро підприємства від створення маневрових електровозів і тягових агрегатів промислового призначення до розробки та переобладнання магістрального тягового рухомого складу, а також спеціалізованої ремонтної техніки у рамках державного підприємства «Український науково-дослідний проектно-конструкторський інститут електровозобудування» під керівництвом академіка Віктора Браташа.

Ключові слова: Дніпровський електровозобудівний завод, транспортне машинобудування, вузькоколійні електровози.

Introduction. The branch of transport engineering on the territory of Ukraine has deep historical traditions. The first Ukrainian steam locomotives of the tandem-compound system based on the Odesa railway workshops of the South-Western Railways were built during 1894–1897. At the end of the XIX century leading specialized locomotive centers were formed in Kharkiv and Luhansk. In the postwar period (1947–1961) the staff of the Kharkiv Plant of Transport Engineering began the latest era of locomotive construction in the USSR. Due to the low cost of infrastructure construction and the small radius of the curves of the route on the access tracks of the sugar, logging, mining, as well as military field highways, a narrow track width of 600 to 1200 mm was used. Initially, narrow-gauge traction rolling stock was represented by locomotives. In Ukraine, the beginning of the construction of industrial locomotives of 750 mm gauge with internal combustion engines was associated with the construction of about 1050 locomotives during 1933–1935 at the production facilities of Smila Mechanical Engineering Plant and Odesa Plant of the January Uprising (former railway workshops) [8, p. 48–51, 53; 13, p. 525]. Further experiments with the introduction of alternative types of traction in the Soviet narrow-gauge locomotive industry were implemented in the early 1950s in the development of locomotives at the Kaluga Mechanical Engineering Plant (Kaluga, Russia) and electric locomotives at the Demikhovo Mechanical Engineering Plant (Demikhovo, Russia).

The first known narrow-gauge industrial electric locomotives on the territory of modern Ukraine (manufactured by the German plant Arthur Koppel) came to work on the tracks of the quarry of the factory of refractory materials. Chasiv Yar in Donbas, it is also known for the use of electric traction in the current process at the Mechanical Engineering, Foundry and Cast Iron Melting Plant of the Kramatorsk Metallurgical Society [8, p. 90]. The first known series of Soviet narrow-gauge electric locomotives were built at the Novocherkassk Electric Locomotive Plant (Russia), which at the time was researching the introduction of electric traction on the access tracks of industrial enterprises. Given the expansion of production of main electric locomotives at the Novocherkassk plant since 1958, the profile enterprise for the construction of industrial electric locomotives became the Dnipropetrovsk electric locomotive plant. During 1969–1990, a special design bureau of the Dnipropetrovsk plant developed and built unique narrow-gauge electric locomotives of the PEU 1 (IELNG1) and PEU 2 (IELNG2) series, which were delivered to work on the tracks of Central Asian mining plants. The use of electric traction for ore removal and transportation of waste rock on open pits was due to the presence of large slopes, substations for power mining and loading equipment, which reduced the cost of operation of electrified lines, as well as the relative ease of maintenance of electric rolling stock compared to heat and steam. Quarry electric locomotives and traction units, as a rule, had a high coupling weight and power, a centrally located cab with two control panels, which provided a wide view during operation.

Unfortunately, for a long time the circumstances of the production activities of the Dnipro Electric Locomotive Plant have not found their proper coverage in the domestic historiography, the only exception is the book by O. Shatovskyi and G. Volnianskyi [19]. Some issues of the history of electric locomotive development at the Dnipropetrovsk plant are presented in the engineering and technical surveys of employees of the Special Design and Technology Bureau of the enterprise (later – Ukrainian Research Design Institute of Electric Locomotive) on the pages of magazines «Electric and locomotive traction» and «Railway transport» [1–3; 9, 10], materials of the Encyclopedia of Modern Ukraine [5; 11; 18], monographs by V. Rakov [12–14], P. Kashin [8], academician V. Bratash [4], as well as articles by the author [16; 17]. At the same time, most historical and technical publications do not even mention the Dnipropetrovsk Electric Locomotive Plant [7]. Instead, the analysis of the history of development of transport engineering enterprises of Ukraine acquires its acute relevance against the background of the general reform of the domestic railway industry, the need to update traction rolling stock and take into account the historical experience of solving this issue.

Thus, the subject of the proposed study is the production activity of the Dnipropetrovsk Electric Locomotive Plant. The chronological boundaries of the study cover the period from the time of formation of the construction of industrial narrow-gauge electric locomotives at the Dnipropetrovsk plant to the time of its actual collapse in 1991.

The purpose of the article is to reproduce a holistic picture of the development and construction of industrial main narrow-gauge electric locomotives at the Dnipropetrovsk Electric Locomotive Plant 1969–1991 based on a comprehensive analysis of historical sources, periodicals and scientific literature, which involves solving the following research tasks: first, to find out the historical circumstances of the development of the Dnipropetrovsk Electric Locomotive Plant; secondly, to consider the preconditions of serial construction and technical features of narrow-gauge electric locomotives of the Dnipropetrovsk plant; third, to find out the reasons for the decline of further development and construction of industrial narrow-gauge electric locomotives in Ukraine.

Electric locomotive PEU 1 (IELNG 1 – industrial electric locomotive narrow-gauge type 1)

Resolution of the Council of Ministers of the Ukrainian SSR № 1040 of August 7, 1958 approved the organization of production of industrial electric locomotives at the Dnipropetrovsk Locomotive Repair Plant, and by Order of the Dnipropetrovsk Council of National Economy № 862-R of November 13, 1958 the company was reorganized into «Dnepropetrovsk Electric Locomotives Plant (hereinafter – DELP). According to the order, it was planned to organize, starting from 1959, the production of electric locomotives and spare parts for them with the subsequent increase of capacity by 1965–200 locomotives per year. The nomenclature of production consisted of contact four-axle electric locomotives with a coupling weight of 100 tons and a six-axle – coupling weight of 150 tons [19, p. 88–89]. The plant specialized in the production of electric locomotives for the mining industry and had a powerful special design and technology bureau (hereinafter – SDTB), which was institutionally separated in 1970 [6].

Figure 1. Electric locomotive D 100–001, Dnipropetrovsk Electric Locomotive Plant 1961

In 1959, the Dnipropetrovsk plant began designing and organizing the production of the first industrial electric locomotives of single-phase high-voltage industrial frequency in the USSR. At the end of 1961, the first two experimental electric locomotives were manufactured, which were designated the D 100 series [12, p. 401–402], and at the end of 1964 – the experimental electric locomotive series D 94 [12, p. 407]. At the end of 1967, Dnipropetrovsk SDTB designed the first in the USSR experimental traction unit PE 2, designed to work on open-pit mines with a slope of up to 60 % electrified at DC voltage of 3000 V, which became the basic model for future units of DELP. The unit, which for the first time in the domestic electric locomotive was used magnetic rail brake, could also be used on quarry tracks with a catenary voltage of 1500 V. In total during 1968–1969 were built 20 PE 2 units, which came for operation on the track of the largest in Soviet Union of Sokolov-Sarabai Mining and Processing Plant (Rudnyi, Kazakhstan) [12, p. 425]. In 1972 based on PE 2 the industrial unit of alternating current OPE 2 was developed, and in 1973 – the diesel-electric unit OPE 1A. Small-series experimental diesel-electric units of high power PE 3T and OPE 1B were also created. In 1977, for the creation, development of serial production and operation of traction units in opencast mining Leonid Kuzmenko and Chief Engineer Victor Bratash received the USSR State Prize in Science and Technology, and some electric locomotives received the State Quality Mark [18].

Carrying out work on improving the design of traction units, the staff of SDTB Dnipropetrovsk Electric Locomotive Plant to fulfill the state order began to develop an industrial narrow-gauge electric locomotive to work in difficult mining and geological conditions of Kazakhstan. In 1950, for the needs of the industrial narrow-gauge railway of the Tekeli lead-zinc plant, the Novocherkassk Electric Locomotive Plant produced 6 electric locomotives of series II-KP2A (II–CI2A – the II weight category, «CI» – contact industrial) [8, p. 182], however, increasing the production performance of the enterprise required the use of more modern and powerful locomotives

Figure 2. Traction machine PE 2–001, Dnipropetrovsk Electric Locomotive Plant 1969

In addition, the railway route had an extremely difficult profile (slope up to 45 %). Execution of the order for the development and construction of a new industrial narrow-gauge electric locomotive was entrusted to the Dnipropetrovsk Electric Locomotive Plant. In order to get acquainted with the working conditions for the development of the technical task of the future narrow-gauge electric locomotive in the city of Tekeli on a business trip personally went the head of SDTB Dnipropetrovsk plant Leonid Kuzmenko together with the head of the design and installation department Mikhail Bichuch [19, p. 133]. The design of the electric locomotive of a direct current of the PEU 1 type was completed in 1969. It was intended for work on the industrial railways of 750 mm, electrified on a direct current of 550 V. The locomotive had a car body type and could work reliably at voltage fluctuations in a contact network from 400 to 700 V and temperatures from –50 to +40 degrees. Its design provided for the possibility of working on guide lifts (over 40 ‰), which is primarily characteristic of opencast mining and mountainous terrain. Axial characteristic – 2o-2o. Voltage – 550 V. Coupling weight – 30 t. Hourly power – 252 kW. Design speed – 45 km/h. The first 8 electric locomotives PEU 1 № 001–008 arrived at the Tekeli lead-zinc plant [8, p. 205]. The locomotives were used with double traction to drive trains consisting of 14 wagons with lead-zinc ore. The introduction of electric locomotives PEU 1 allowed increasing the extraction of non-ferrous metal ores by 20 % [19, p. 133].

The electric circuit of the electric locomotive provided four modes of operation: traction with series or series-parallel connection of traction motors and electric rheostat braking with a power supply of auxiliary machines from traction motors or the catenary [4, p. 10]. The drive of wheel pairs is made individually and was carried out through gear transmission by four traction motors with sequential excitation DT-11 with support-axial suspension, developed by the department of electric machines of Dnipropetrovsk SDTB, whose designers took an active part in making prototypes. The design and installation department of SDTB developed the electrical circuit of the electric locomotive, performed the layout of the equipment, the rest of the units developed trolleys, electrical equipment and other components [19, p. 133].

Ventilation of electric motors – forced from the centrifugal fan Ts8–19 № 7,6, with the drive from the DK-258A1 electric motor. The electric locomotive was started by means of starting rheostats with a serial connection of all four electric locomotive engines, which were regrouped on a series-parallel connection by the bridge method. In total, there were 20 regulatory positions, of which 11th and 20th were running. In addition, field attenuation was applied by shunting the excitation windings of traction motors with a resistance factor of 0.54. Electric locomotive control system – short-circuit, with the driver's controller and push-button switches of the control post.

The body of the electric locomotive is an all-metal welded construction, made of rolled bent profiles and sheets of carbon steel. The welded frame of the body, consisting of two sides made of sheet and superimposed channels, served to transmit traction from the driving axles, as well as to accommodate the power and auxiliary equipment. The channels were connected by two buffer and two pivot beams, as well as a number of transverse beams. In the first electric locomotives № 001–008 in buffer bars narrow-gauge auto couplings of the AU-5 type were installed, in the rest – standard shock-traction devices. On the lower sheet of the buffer beam there were height-adjustable track cleaners, the entrance stairs were welded to the sides of the frame, the upper steps of which were mounted directly in the sides of the frame. All high-voltage electrical equipment is concentrated in a high-voltage chamber and assembled into separate blocks and panels. The high-voltage chamber is enclosed by mesh curtains, which are interlocked and prevent personnel from accessing the equipment in the presence of high voltage. Outside the high-voltage chamber, directly in the body of the locomotive are installed: motor-fan Ts8–19 № 7.6 for cooling of traction motors and the block of starting-braking resistors, two compressors BB-0,7/8 and the auxiliary compressor KB-1V for raising the current collector from powered by a rechargeable battery. Above the compressors there is a 38KN-125 battery and an air distributor. On the roof of the electric locomotive are installed: one current collector TL-14M or two semi-pantographs on the first locomotive, an interference suppression choke, a discharge arrester and bushings. There are three mounting hatches on the roof and sockets for the inter-electric connection on the end wall. The body rested on unarticulated carts with two central rigid supports, which simultaneously transmitted traction and braking forces, as well as four lateral spring supports.

The electric locomotive trolley consisted of a frame, wheelsets with traction motors, gears, axle boxes, spring suspension and a brake system. The frame of the trolley consists of two sides connected by a pivot and two end beams. In the upper part of the frame in the middle of the pivot beam there is a plate with a landing hole for mounting the thrust of the central support, and at the ends of the side there are plates for side supports. Brackets for axle guides, suspension of traction motors and brake system were welded to the lower part of the sidewalls and crossbeams. Wheels – steel, all-rolled; axle boxes – jaw, with two roller bearings. The spring suspension on each side of the truck consists of two coil springs and a leaf spring connected by two balancers.

At the ends of the body are the driver's cab, each of which is separated from the engine room by a transverse wall with an entrance door. The location of the equipment is the same in both cabins. On the driver's side there is a control panel, which has built-in pushbutton switches, panels of measuring instruments, signal lamps and toggle switches. Close to the panel the controller of the driver KME-6D is established, on the right on a side wall the brake crane of the driver (conditional number 394), the crane of an auxiliary brake (conditional number 254) and standard signaling devices are located. On the side of the driver's assistant in the cab there is a table-box for food, a fire extinguisher, a register speedometer SL-2M and a household socket. On the rear wall of the cab are graphic images of electrical and pneumatic circuits, handbrake. The pneumatic system consisted of two BB-0.7/8 compressors to maintain the pressure in the pneumatic system 6.5–8 kgf/cm3, the main tank with a capacity of 340 liters, supply and brake lines, typical sound signals. The electric locomotive was equipped with pneumatic locomotive and train, manual and electric rheostatic brakes. The driver's cabins, engine room, and locomotive control panels were equipped with electric lighting. At each end, the electric locomotive was equipped with one upper searchlight, two white and two red buffer lights.

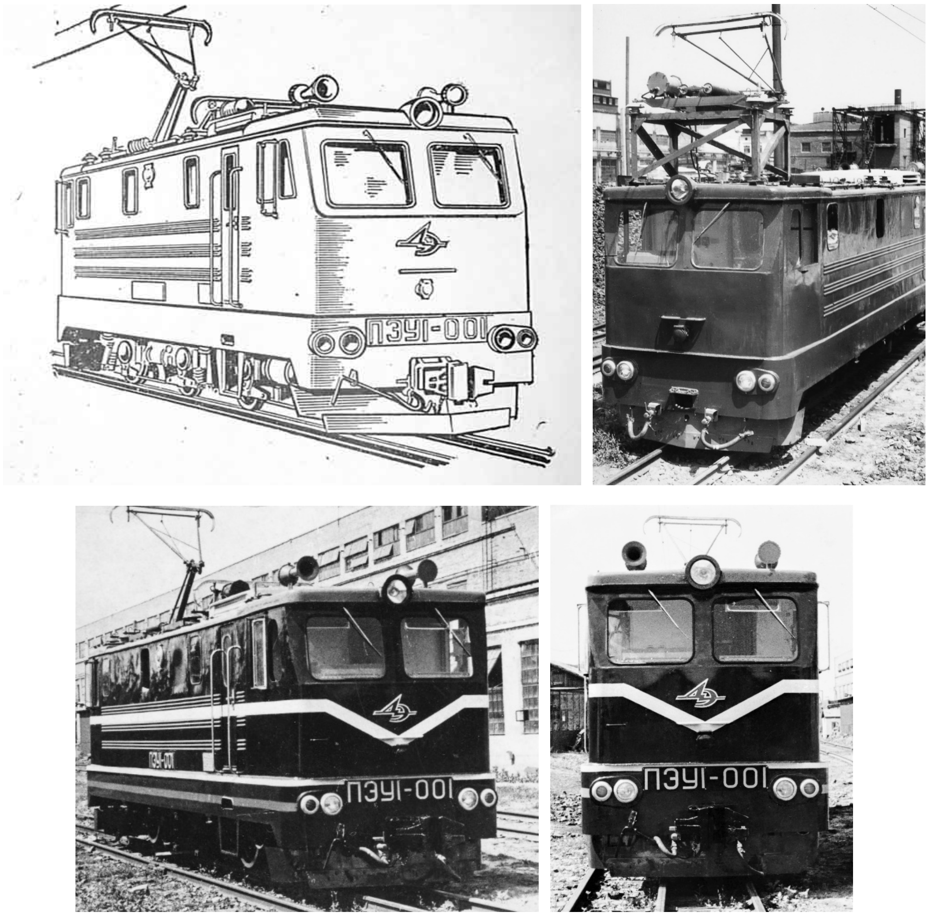

Figure 3. Electric locomotive PEU 1–001, Dnipropetrovsk Electric Locomotive Plant 1970

After assembling the first experimental electric locomotive PEU 1 in order to ensure its tests on the territory of Dnipropetrovsk plant, a third rail was laid on the experimental site where tests of wide-gauge electric locomotives were carried out in order to form a track width of 750 mm. Also, since the electric locomotive had a low height, a special superstructure was built on its roof, on which the current collector was placed. Therefore, there was no need to significantly re-equip the catenary of the enterprise site to carry out running-in factory tests.

During the production of the first batch of electric locomotives, a significant number of design and technological improvements were introduced. In the process of modernization, the electrical circuit was improved, unified boxes for connecting traction motor cables were installed, and the insulation of resistor blocks was improved. Terminal connectors in power circuits and control circuits have been introduced to simplify the installation and dismantling of equipment, to improve the conditions of its maintenance and repair. Two semi-pantographs installed on the first locomotives were later replaced by one pantograph, the main air tank was moved from under the frame to the roof, which increased reliability and maintainability. Operating time between failures increased from 250 000 tkm to 300 000. Resource for small periodic repairs increased from 175 000 to 250 000 tkm, for large periodic repairs from 525 000 to 650 000, for lifting repairs from 3 000 000 to 4 000 000 [8, p. 205]. By the decision of the state attestation commission, the narrow-gauge DC electric locomotive of the PEU 1 type in 1972 was awarded the state Quality Mark.

In the early 1970's it was decided to electrify the narrow-gauge access tracks of the Proletarian loading and transport department «Sredazugol» on the line Proletarsk (Tajikistan) – Tovarnaya (Suliukta, Kyrgyzstan), and in 1973 the first electrified area [8, p. 95]. Electric locomotives PEU 1 № 009–012 were sent to work on the access tracks of the ore management

«Suluktavugol» of the Osh region of Kyrgyzstan, the rest of the electric locomotives № 013–027, manufactured in two batches, were sent to work on the tracks of the Proletarian loading and unloading department. In total, from 1970 to 1984, 27 electric locomotives of this series were built [8, p. 206].

Electric locomotive PEU 2 (IELNG 2 – industrial electric locomotive narrow-gauge type 2)

In 1988 DELP was named Production Association «Dnipropetrovsk Electric Locomotive Plant» [19, p. 220]. In the second half of 1988, a new industry standard for the type of industrial electric locomotives was introduced, which provided for the creation of an eight-axle two-section electric locomotive to operate on railways with a track width of 750 mm at a voltage of 550 V DC. Obviously, in the future it was planned to standardize narrow-gauge electric locomotives in accordance with development plans and needs of various sectors of the economy. Thus, it was planned to develop a new two-section locomotive to replace the locomotive fleets of the Tekeli lead-zinc plant and the Proletarian loading and unloading department of single-section electric locomotives PEU 1, which had low power (252 kW), step-by-step and only voltage-regulated units. A feature of the access tracks of this company was the use of rails not lighter than the R-43, which are heavy for a track of 750 mm. This led to the creation of a locomotive with a body that maximized the size of the TU [3, p. 36].

The design of the new electric locomotive was attended by the head of SDB L. Kuzmenko, chief engineer V. Bratash, heads of design and installation department M. Bichuch, department of electric machines and devices V. Savisko, department of mechanical part E. Moskvichov, department of circuits E. Benenson, A. Gurevich, Department of Cooling and Ventilation Systems, J. Handelman, Department of Traction Calculations. In 1989, the design was completed at the Dnipropetrovsk plant, and in 1990 the first electric locomotive PEU 2–001 was manufactured. Voltage – 550 V. Traction force – 2×61.5 kN (torque 61,500 nm) Power consumption – 2×410 kW. Design speed – 45 km/h. Weight – 2×35 tons. According to experts, the economic effect of the introduction of one electric locomotive PEU 2 to the national economy was 46 600 rubles. in 1990 prices [3, p. 38].

Figure 4. Electric locomotive PEU 2–001 Dnipropetrovsk Electric Locomotive Plant 1990

The sections of the locomotive are completely identical to each other and, if necessary, are able to work as independent traction units. Four DT-11M traction engines with a capacity of 103 kW each are installed on each four-axle section of PEU 2. The body of the section rests on two two-axle carts. Axle drive – individual, each equipped with its traction motor. Gear – cylindrical, one-sided, straight-toothed with a gear ratio of 5.54. Each section is equipped with a thyristor frequency-pulse converter for smooth voltage regulation on traction motors. The abandonment of the contactor circuit and the use of thermistor-pulse control, some elements of which were previously tested on the traction unit PE 3T, allowed to reduce heat loss and increase efficiency, which increased the economic effect of using electric locomotive PEU 2, increased adhesion and smoothness at shear.

The frequency-pulse converter consisted of two six-phase regulators, each of which operated on two traction motors connected in parallel. The phases of the regulators were switched on with a time shift of 1/12 of the period, which reduced the ripple of voltage and current consumed from the catenary to acceptable limits. The voltage on the traction motors was regulated manually, using the driver's controller. The angle of rotation of the main handle of the controller sets the frequency of the thyristors and, accordingly, the voltage on the motors. The converter is made of block-modular design, with cooling of its elements and traction motors from one fan-air cleaner. Each phase of the frequency-pulse generator consisted of two main circuits: switching and loading. Structurally, every two phases consisted of a choke unit, in which two switching chokes are located on the load choke. Switching capacitors were located in the immediate vicinity of this unit, and a panel of two-phase semiconductors was located above the unit.

The body of the sections is of the wagon type, with one end cab of the driver, separated from the engine room by a vestibule. Unlike PEU 1, high-voltage equipment and fan-cleaner are located in the center of the section, which provided ease of maintenance. One pantograph current collector TL-14M was installed on the roof of each section. The control panel and converter control units are installed in the driver's cab. To ensure the microclimate of the locomotive crew when working in Central Asia, air conditioning was provided. According to available information, electric locomotives PEU 2 were equipped with auto-couplings SA-3, which is not typical for narrow-gauge rolling stock. The electric locomotive was provided with electric rheostatic braking, in which the braking force and speed were regulated by a smooth change of the excitation current of traction motors, as well as pneumatic and manual brakes [3, p. 38].

In 1990, an electric locomotive PEU 2–001 was built and the frames of locomotives № 002 and 003 were laid with the plan for 1991, provided, according to the plant, for the locomotive fleet of the Proletarian loading and unloading department «Sredazugol» [8, p. 210]. However, the collapse of the USSR interrupted the serial production of electric locomotives PEU 2, which, according to some researchers, is «*the pinnacle of narrow-gauge locomotive construction in post-Soviet countries*» [8, p. 210]. In January 1991, the Dnipropetrovsk plant was headed by Valerii Chumak, whose name is associated with the era of the formation of the main electric locomotive industry in independent Ukraine. On June 26, 1993, the Cabinet of Ministers of Ukraine adopted Resolution № 480 «*On the development and production of main freight and passenger electric locomotives*» [15]. On October 22, 1992, by the decree of the Ministry of Mechanical Engineering, Military-Industrial Complex and Conversion of Ukraine, the Ukrainian Research, Design and Technological Institute of Electric Locomotive Building was established based on SDTB, which became a part of the newly formed [19, p. 219–220].

Conclusions. Thus, during the 1960s and 1990s, the teams of the Special Design and Technology Bureau and the Dnipropetrovsk Electric Locomotive Plant, having a strong research and production potential, developed and designed unique narrow-gauge electric locomotives of the PEU 1 (IELNG1) and PEU 2 (IELNG2) series to meet the needs of Soviet high-tech mining industry. by electric transport. Unfortunately, due to the economic crisis of the CIS countries in the early 1990s, the rupture of economic ties of the former Soviet republics and the lack of need for such equipment on the electrified access roads of narrow gauge Ukrainian mining enterprises all work on the design and serial production of narrow gauge electric locomotives at the Dnipropetrovsk plant were discontinued, and the company itself focused on the development of main wide-gauge locomotives for the needs of the railway network of Ukraine. However, it is clear that the historical experience of becoming a domestic scientific-production base of the electrical locomotive production needs its proper understanding in the context of current tendencies of import of traction rolling stock with an attempt to localize its production in Ukraine. Finally, taking into account the historical experience of the formation and technological development of electric locomotive construction in Ukraine is of fundamental importance both in the general perspective of the development of Ukrainian transport engineering, and the domestic railway industry in particular.

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АСТРОНОМІЯ В ХАРКОВІ У РОКИ ГРОМАДЯНСЬКОЇ ВІЙНИ ПЕРІОДУ УКРАЇНСЬКОЇ РЕВОЛЮЦІЇ (1917–1921)

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Анотація. Розглянуто науково-дослідну діяльність астрономічної обсерваторії Харківського університету під час Української революції 1917–1921 рр. Проаналізовано публікації харківських астрономів зазначеного періоду, присвячені фотометричним спостереженням зір, поглинанню світла та його відбиття від матових поверхонь, вивченню близькополюсних зір та зір типу бети Цефея, дослідженню Нової Орла 1918 та спостереженням планет. Автором застосовано спеціальні методи, використання яких дозволило виділити основні етапи розвитку астрономії у досліджуваному періоді, розкрити змістовність наукового потенціалу харківських астрономів. З'ясовано біографічні відомості представників харківської астрономії та висвітлено їх участь у подіях громадянської війни. Висвітлено питання трансформації Харківської астрономічної обсерваторії на тлі перетворень Харківського університету у 1920–1921 рр. Передбачається, що матеріали історико-наукового дослідження будуть використані в науково-дослідній роботі з історії астрономії у Харкові першої половини XX ст.

Ключові слова: Харківська астрономічна обсерваторія (ХАО), громадянська війна, Українська революція, кафедра астрономії, астрономічний гурток, Харківський університет

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ASTRONOMY IN KHARKIV DURING THE CIVIL WAR PERIOD OF THE UKRAINIAN REVOLUTION (1917–1921)

Abstract. As a result of the historiographical analysis, it was discovered that no separate publications were devoted to the study of the development of astronomical science in Kharkiv during the Ukrainian Revolution of 1917–1921. Therefore, the general purpose of the work is to study and synthesis facts of the history of Kharkiv astronomy in a certain period. The research activities