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Legal Aspects of Regulatory Unit Allocation Review: Balancing Control and Innovation

Ivan Voronkov[1*], *Roman* Ostrovskii[2], and *Yesita* Ganayeva[1]

[1] Moscow State University of Civil Engineering, 26, Yaroslavskoye shosse, Moscow, 129337, Russia
[2] ASE Joint Stock Engineering Company, 3 Svobody Sq., Nizhny Novgorod, 603006, Russia
[3] Kadyrov Chechen State University, Grozny, Russia

Abstract. The authors of the study compared the cost distribution of developing construction documentation for buildings, structures, and various work types involved in the design of combustion power plants. They used data from the state-estimated standard RBPD 81-2001-23 "Reference book of basic prices for design works in construction "Energy facilities. Energy generation" and compared it with the actual labor intensity distribution data from the design of buildings and structures at the Svobodnenskaya Thermal Power Plant (TPP). Based on the study's findings, the authors confirmed that, to some extent, the current regulatory distribution of the unit value of work in thermal power construction aligns with the actual labor intensity. Moreover, they identified groups of buildings where this regulatory distribution is not supported by the real design data. As assumptions based on the results of the study, it is proposed by the authors to classify buildings and structures in accordance with the KKS coding system and also to supplement the existing model of distribution of the unit value of design work by buildings and structures with a dependence on the value of the electric capacity of the station.

1 Introduction

Thermal and nuclear power plant design entails a complex, multi-stage process that necessitates the collaboration of a diverse array of specialists. In addition to the conventional civil engineering sections of construction documentation, the design of thermal and nuclear power facilities encompasses intricate aspects in the documentation, with a specific focus on the development of heat-mechanical and electrotechnical solutions, as well as the selection of primary technological equipment [1].

In the design of modern thermal power plants (TPP), over 50% of the design documentation is comprised of technological decisions. The selection of equipment, establishment of communication tracing, calculation of efficiency and safety of operational systems often takes precedence over the development of architectural and construction documentation, significantly impacting its complexity, volume, labor intensity, and development timeline [2].

* Corresponding author: voronkovie@mgsu.ru

In these circumstances, major players in the engineering services market specializing in the design of thermal and nuclear power facilities encounter a significant scientific and practical challenge surrounding the optimal calculation and projection of costs [3], labor intensity, and project duration [4]. The resolution to this issue partially relies on the implementation of existing regulatory documentation that governs the protocol for cost estimation and, consequently, the labor intensity involved in developing project documentation within the realm of thermal and nuclear energy construction [5].

Currently, the State Estimated Standard RBPD 81-2001-23 serves as the methodological foundation for calculating the cost in relation to the labor intensity of project and construction documentation for thermal power facilities. This is based on the "Reference Book of Basic Prices for Design Works in Construction.”Energy Facilities. Energy Generation" (RBPD Energy Generation). A similar document for nuclear energy construction is the State Estimate Standard “Reference Book of Basic Prices for Design Works in Construction “Nuclear Energy Utilization Facilities” (RBPD NEUF) [6].

It is worth noting that the two standards were approved in 2016 and 2015 respectively and exhibit a notable structural difference. Unlike the RBPD NEUF, the RBPD Energy Generation does not include details regarding the valuation or distribution of the design for specific buildings and structures within the thermal power plant complex that are classified using the KKS coding system [7]. This difference makes it impossible to determine the labour intensity, duration and resource requirements of individual thermal power plant buildings without considerable time.

In this context, the aim of this study was to compare and attempt to validate the prescribed RBPD Energy Generation unit values found in construction documentation [8] for buildings, structures, and various types of work that constitute the design of combustion power plants. This comparison was made with the actual labor intensity values observed during the execution of design works in recently constructed thermal power plants. According to the study's authors, this approach will provide a fresh perspective on certain aspects of the crucial challenges involved in managing the design of thermal power facilities [9].

2 Materials and Methods

The list of the largest thermal energy construction projects in the Table 1 implemented in the Russian Federation using an integrated approach [10] in the past 10 years reveals that out of the total of twelve projects, only five focused on the construction of steam turbine power plants. The most recently completed project in this category is the Svobodnenskaya TPP, boasting a capacity of 160 MW.

Table 1. Projects of construction of thermal power plants in Russia in 2014-2023.

Thermal power plant name	Number of units/unit electrical capacity/total installed electrical capacity	Type of power plant	Year of commissioning
Groznenskaya TPP	2/180 MW/360 MW	Gas turbine plant	2018/2019
Balaklavskaya TPP	2/250 MW/500 MW	Steam-gas turbine plant	2018/2019
Yujnouralskaya SDPP-2	1/420 MW/840 MW	Steam-gas turbine plant	2014

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Troickaya SDPP	1/660 MW/660 MW	Steam turbine plant	2016
Yakutskaya-SDPP-2	4/40 MW/160 MW	Gas turbine plant	2017
Sahalinskaya SDPP-2	2/60 MW/120 MW	Steam turbine plant	2019
Aleksinskaya CHPP	1/115 MW/115 MW	Steam-gas turbine plant	2019
Pregolskaya TPP	4/115 MW/460 MW	Steam-gas turbine plant	2019
Tavricheskaya TPP	2/235 MW/470 MW	Steam-gas turbine plant	2019
Primorskaya TTP	3/65 MW/195 MW	Steam turbine plant	2020
Sovgavanskaya CHPP	3/63 MW/126 MW	Steam turbine plant	2020
Svobodnenskaya TTP	2/80 MW/160 MW	Steam turbine plant	2021

Since RBPD Energy Generation contains detailed recommendations on the standard unit value of development of construction documentation only for steam turbine power plants, the project of Svobodnenskaya TES, the newest steam power plant in Russia at the moment [11], may be relevant for comparison.

The project and construction documentation for this power plant's construction was developed by JSC "Institute Teploelektroproekt," a part of the engineering group of JSC "TEC Mosenergo," from 2017 to 2021. During the design work, the extensive implementation and utilization of the Technical Data Management System (TDMS) enabled the smooth flow of technical and administrative documents [12]. Thanks to this system, it became possible to greatly reduce the time and resource costs associated with the interaction of executors. Production planning processes were automated through the synchronization of TDMS with MS Project and Oracle Primavera [13], and the implementation of an operational work management system was also achieved [14]. The introduction of TDMS also allowed to start accumulating a database of work performed in terms of:

- The planned and actual labor intensity for each set of documentation,
- The release dates,
- The number of audits issued,
- Specialization of the specialists involved,
- The history of performers interactions.

The utilization of the data accumulated by TDMS throughout the process of developing the construction documentation for the Svobodnenskaya TPP permits an analysis of the unit labor intensity value for the design of individual buildings and structures. This analysis can be compared against the related unit values presented in Table 6 of the RBPD Energy Generation.

It should be noted that the comparison being performed is not reliable enough, as it involves comparing the values of unit labor intensity and unit value. In real conditions, the cost of work in different sections of the construction documentation may vary. However, within the framework of this study, the stated discrepancy is accepted as minimal and allows for a direct comparison between the unit labor intensity of developing design products and the unit value of this development. The key difficulty in this matter is the inconsistency between the classification system of buildings and structures used in normative documentation and the classification system used in practical development.

The development of construction documentation for the Svobodnenskaya TPP was carried out using the KKS coding system. However, the current edition of the RBPD Energy Generation, as mentioned earlier, does not contain data on unit costs for individual KKS codes. Instead, it utilizes its own classification of buildings and structures, consisting of 23 items. Therefore, in order to compare the actual indicators obtained during the design of the Svobodnenskaya TPP with the regulatory values of the RBPD Energy Generation, it is necessary to classify all the buildings and structures from the list developed for this TPP according to the categories used in the RBPD Energy Generation.

3 Results

Based on the available information in the TDMS database regarding the actual labor intensity of the design work for the Svobodnenskaya TPP, including over 6600 sets of construction documentation, a classification of 145 buildings and structures of the power plant was carried out. Additionally, the unit labor intensity for carrying out work on these objects was calculated in accordance with the points of Table 6 of the RBPD Energy Generation. Comparative data on the normative values of the unit cost of designing individual buildings and structures and their actual labor intensity (using the Svobodnenskaya TPP as an example) are presented in Table 2.

Table 2. Comparative indicators of the regulatory unit value of designing individual buildings and structures of a power plant and their actual labor intensity (using the example of the Svobodnenskaya TPP).

№	**Name of buildings, constructions and types of works in accordance with Table 6 of RBPD Energy generation**	**Buildings and constructions of Svobodnenskaya TPP in accordance with KKS**	**Unit value according to RBPD Energy generation, %**	**Labor intensity according to the actual data of Svobodnenskaya TPP**
1	Main plant building	UHA, UHB, UHJ, UMA, UMH	34,46%	34,55%
2	Electrical facilities	UAA, UAC, UAG, UBA, UBH, UBL, UBM, UBN, UBV, UBW	5,04%	10,31%
3	Solid fuel sector	-	0,00%	0,00%
4	Liquid fuel sector	UEJ	3,55%	0,80%
5	Gaseous fuel sector	UEP	1,30%	0,67%
6	Production and distribution of special gases	USV, UTF	1,35%	0,32%

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7	Water treatment systems	UGE, UTA, UTC	7,05%	8,2%
8	Technical water supply	UGA, UPB, UPE, UPH, UPN, UPY, UQG, UQL, UTE	11,20%	11,74%
9	Technological communicatio n lines	UBZ, UTZ	3,00%	5,29%
10	Heating of own needs	UNB, UTH	1,65%	0,94%
11	Household and drinking water supply	UGG	2,57%	1,36%
12	Industrial-fire water supply	UGF	1,95%	2,24%
13	Sewerage	UGB, UGH, UGJ, UGM, UPY	2,83%	2,67%
14	Fuel supply hydrocleaning	-	0,00%	0,00%
15	Hydroash and slag removal	-	0,00%	0,00%
16	Sludge removal	UGR, UXD	0,90%	1,05%
17	Utility and service buildings	UYA, UYC, UYE, UYF	2,80%	8,90%
18	Civil defense protective structures	UZW	0,75%	1,16%
19	Transport infrastructure	UXD, UXE, UYB, UZA, UZD	7,10%	1,03%
20	Repair and maintenance workshops	USQ	1,35%	0,40%
21	Storage facilities	-	0,30%	0,00%
22	Power plant complex	UHG, UZJ	3,95%	4,52%
23	Other works	UER, UGZ, UHG, UYB, UZN	4,90%	3,84%

The conducted classification and analysis allowed for comparing and contrasting the regulatory and actual unit cost values, as well as the associated labor intensity in the development of working documentation for buildings and structures in a power plant, within the scope of this study. It should be noted that in the current edition of Table 6 of the RBPD Energy Generation, there is a slight arithmetic inaccuracy. The summation of unit cost values by categories adds up to 98%, rather than 100%, which is a significant discrepancy. In order to ensure the accuracy of calculations, this inaccuracy should be corrected in the next update of the considered regulations.

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The analysis also allowed identifying significant deviations of actual indicators from normative ones in several categories. However, taking into account the difficulties of correlating building classifications according to KKS and the RBPD Energy Generation, within which buildings and structures with the same KKS code can simultaneously belong to two groups according to Table 6 RBPD Energy Generation (for example, the UPY code includes both sewage system structures and technical water supply systems), it was decided to form generalized categories of buildings and structures that should include a complex of technologically related objects and exclude duplication of KKS codes in multiple groups. Data on the generalized categories of buildings and structures for the thermal power plant are presented in Table 3.

Table 3. Enlarged categories of buildings and structures of steam power plants

Enlarged group of buildings and structures	**Name of buildings, constructions and types of works in accordance with Table 6 of RBPD Energy generation**
Main plant building	Main plant building
Water supply, sewerage and heat supply	Technical water supply, Heating of own needs, Household and drinking water supply, Industrial-fire water supply, Sewerage, Fuel supply hydrocleaning, Hydroash and slag removal, Sludge removal
General plant buildings and structures	Storage facilities, Transport infrastructure, Power plant complex
Auxiliary-technological buildings and structures	Technological communication lines, Utility and service buildings, Civil defense protective structures, Repair and maintenance workshops
Water treatment	Water treatment systems
Fuel & special gases facilities	Solid fuel sector, Liquid fuel sector, Gaseous fuel sector, Production and distribution of special gases
Electrical facilities	Electrical facilities
Other works	Other works

Grouping power plant buildings and structures based on technological principles allowed to level out deviations between normative and actual indicators within adjacent items of Table 6 RBPD Energy Generation. It also provided the opportunity to focus on the most critical deviations. The visualization of data on the normative unit cost and specific labor intensity of designing the generalized groups of power plant buildings is presented in Figure 1.

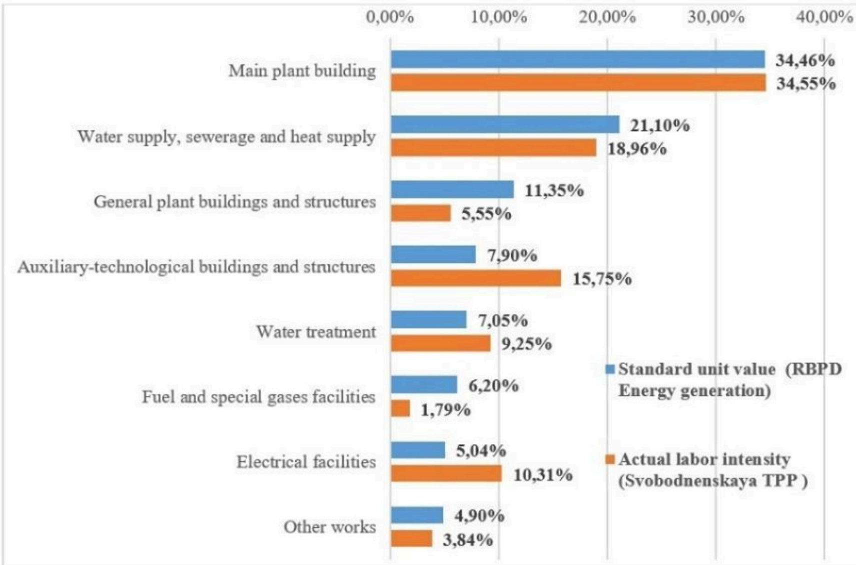

Fig. 1. The regulatory unit values and unit labor intensity of designing the generalized groups of power plant buildings.

4 Discussion

The integrated values of unit cost and labor intensity of developing documentation for power plant construction, as presented in Figure 1 for the generalized groups, allow us to draw the following conclusions:

1. For groups such as "Main plant building", " Water supply, sewerage and heat supply" and "Water treatment" the regulatory values of unit cost, as defined by Table 6 RBPD Energy Generation, have been verified against the actual values of labor intensity for the development of construction documentation for the Svobodnenskaya TPP. The relative deviation between normative and actual indicators in these groups does not exceed 1% (for the "Water Treatment" group - 31.2%), which, in the context of analyzing only one implemented project, can be considered acceptable.

2. Significant deviations are observed between the normative and actual indicators for generalized groups such as " General plant buildings and structures", " Fuel & special gases facilities", "Electrical facilities" and "Other works." Within these groups, there is a considerable disproportion, which requires a detailed examination.

2.1. The generalized group " General plant buildings and structures " includes the items "Transport infrastructure", “Storage facilities" and " Power plant complex " from Table 6 RBPD Energy Generation. Within these items, a significant deviation is primarily observed in the Transport infrastructure category (normative - 7.10%, actual - 1.03%). This is mainly due to the fact that modern thermal power plant projects, especially smaller ones like Svobodnenskaya TPP, do not require significant investments in creating transportation infrastructure, whereas the RBPD Energy Generation implies the construction of flyovers, tunnels, and railway tracks within this category.

2.2. The significant deviation in the generalized group " Auxiliary-technological buildings and structures " is due to a substantial exceeding of the normative values for the labor intensity of designing auxiliary and service buildings (normative - 2.8%, actual - 8.9%). This deviation is driven by the requirement to design fully functional administrative, engineering, and laboratory buildings even for smaller power plants, allowing for the management of all technological and administrative processes.

2.3. Within the group "Fuel and Special Gases Facilities," the previously described trend identified in section 2.1 is also evident. The modern trend of moving away from creating full-scale production infrastructure for newly constructed power plants leads to a decrease in the need for specialized productions within the power plant facilities. For example, there may be a reduced necessity for on-site production and distribution of special gases such as nitrogen, oxygen, acetylene, and others. It should also be mentioned that Svobodnenskaya TPP was designed in close proximity to the Amur Gas Processing Plant, which theoretically justifies the absence of certain specialized productions within its facilities.

2.4. The generalized group "Electrical facilities" also exhibits a significant deviation between the actual and normative indicators (normative - 5.04%, actual - 10.31%). According to the authors of the study, this deviation is due to the underestimated normative values for smaller power plants. The design of electrical facilities for Svobodnenskaya TPP involved developing solutions for the construction of two open-type distribution switchyards at 110 and 220 kV. Considering the relatively low installed electrical capacity of Svobodnenskaya TPP (160 MW) and the conservative approach of using outdoor switchgear instead of indoor switchgear [15], the authors argue that the normative value of 5.04% for the unit cost is fundamentally insufficient by contemporary standards.

Conclusions

The completed research allows the authors to form a reasoned position on the objectivity, sufficiency, and practical applicability of individual provisions (distribution of specific indicators for the cost of developing construction documentation for buildings, structures, and types of work included in the design of steam power plants) of the key regulatory document regulating the determination of the cost of developing project and construction documentation for the construction of electric and thermal power generation facilities in the Russian Federation.

By comparing the regulatory indicators of the unit value of designing individual groups of buildings with the actual indicators obtained during the development of working documentation for the construction of the Svobodnenskaya TPP, it has been revealed that the normative indicators established by table 6 of the RBPD Energy Generation partially correspond to practical implementation. However, the deviations observed demonstrate the inconvenience of the building classification used in RBPD Energy Generation and the absence of the necessary dependence for variational cost calculation, specifically the distribution of regulatory values for the specific cost of designing individual buildings and structures, based on the installed electrical power capacity of the station.

In order to solve these shortcomings, the authors of the study consider it expedient and relevant to implement the following actions during the next update of the RBPD Energy Generation:

1. Based on existing experience and actual data on the labor intensity of implementing projects in the field of thermal electric construction, it is recommended to develop a proportional model for distributing the specific cost of developing construction documentation for buildings, structures, and types of work using the international KKS coding system.
2. To update the data in Table 6 of the RBPD Energy Generation, it is recommended to establish a relationship between the regulatory values and the installed capacity of the

power plant, allowing for variable forecasting of the distribution of unit cost values for the design of individual buildings and structures for projects of different scales.

3. Supplement the existing method of distribution of unit values of development of construction documentation on buildings, structures and types of work with options not only for steam-turbine power plants, but also for steam-gas and gas turbine power plants.

The announced proposals for their comprehensive implementation will allow engineering companies implementing projects in the field of thermal energy construction, to improve the accuracy and objectivity of the forecast calculation and distribution of the cost and labour intensity of work on the development of construction documentation. This in turn will have a positive impact on the resourcing of the design process, will minimize the risks of failure of contract deadlines, will improve the quality of design work, and will create conditions for a systemic increase in the reliability of investment participants in construction projects [16].

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