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Multi-Criteria Assessment of Organizational Forms for the Production Base for Construction of NPP with VVER-1200

The paper is devoted to solving the scientific-practical problem of multi-criteria assessment of alternative organizational forms for the production base (OFPB) for the construction of nuclear power plants with VVER-1200 reactor units. A classification of Russian regions into four categories is proposed, depending on the availability and degree of development of existing production and transport infrastructure and other criteria influencing the determination of the preferred OFPB. Six alternative organizational forms are formulated, including a comprehensive production base at the NPP construction site, a large inter-district base, a self-sufficient regional base, a mobile on-site base, a minimally necessary base oriented towards external supply, as well as repair and modernization of existing capacities. Each alternative is assessed against a number of criteria: economic, territorial, reliability assurance criteria, temporal and organizational criteria. To solve the multi-criteria problem, the globally proven Analytic Hierarchy Process (AHP) method by T. Saaty is applied, including procedures for pairwise comparisons of criteria and alternatives with verification of the consistency of expert assessments. Full calculations are carried out with the determination of local and global priorities for all alternatives. The results of the study demonstrate that the determination of the preferred organizational form for the production base significantly depends on regional conditions, including the level of infrastructure development, investment strategy, and long-term plans for nuclear energy development in the region. The presented methodology can be applied to justify organizational and technological decisions at the pre-project stage of constructing new power units for NPP with VVER-1200.

Keywords: organizational form of the production base, VVER-1200, Analytic Hierarchy Process, multi-criteria assessment, Saaty method

The construction of nuclear power plants is one of the most complex and resource-intensive types of production activity. The modern energy strategy of Russia envisions the development of nuclear energy as a priority direction to ensure the country's energy security and increase the share of peaceful nuclear power in the nation's generating capacity. In accordance with the General Scheme for the Placement of Electricity Generation Facilities for the Period up to 2042¹, the construction of new nuclear capacities of about 29.3 GW is planned on the territory of the Russian Federation, including replacement power units at existing sites and completely new stations in the territories of Siberia, the Urals, and the Far East.

The core of this development programme consists of power units with Generation III+ VVER-1200 reactor units. This reactor type possesses high safety characteristics, economic efficiency, and has a unified nature, allowing for the application of standard design solutions at various construction sites.

The construction of complex multi-unit facilities, which include nuclear power plants, is based on the organizational and technological principles of flow production. The application of the flow construction method allows for the rationalization of labour resource use, reduction of overall construction timelines for the complex of buildings and structures, and reduction of work costs [1, 2]. However, the implementation of the flow method requires the creation of an adequate production base.

The production base for construction represents an integrated complex of stationary and temporary facilities, enterprises, engineering and transport infrastructure, and logistics systems designed to provide construction with material and technical resources: structures, products, semi-finished goods, technological equipment, etc., performing functions of receiving, storing, pre-processing, kitting, and supplying resources to the site of construction and installation works. The purpose of this complex is to create finished construction products, namely fully prepared for operation objects of production and non-production purposes.

The organizational form of the production base significantly influences the technical and economic indicators of the project, and its assessment is a multi-criteria task, the solution of which requires analysis of many parameters, including regional conditions of the construction site, availability of existing production capacities, investment strategy, and the need for a multiplier effect in regional economic development.

The aim of this study is to formulate and solve the task of assessing organizational forms for the production base for construction of NPP with VVER-1200 using the Analytic Hierarchy Process (AHP).

Determination of the preferred organizational form of the production base significantly depends on the regional conditions of construction. Regional conditions in this work are understood as the availability and quality of existing production and transport infrastructure, geographical location relative to centers of raw material and material production, availability of qualified labour resources, and other socio-economic criteria.

¹ General plan for the placement of power generation facilities on the territory of the Russian Federation for the period up to 2042. Moscow, Ministry of Energy of Russia, 2024. URL: <http://government.ru/docs/53923/> (rus.).

The availability of existing production capacities significantly influences the choice of OFPB. Regions with developed industry (Ural Federal District, Krasnoyarsk Krai) possess sufficient potential for localizing production. Remote regions (Far Eastern Federal District) have limited localization potential and often require the development of new production capacities or transportation of material resources over long distances.

Transport accessibility determines the cost of material delivery. Thus, the availability of railway and water transport significantly reduces transportation costs. Territories remote from main transport arteries require the creation of temporary roads and ports, which increases capital costs.

Labour resources and the availability of a qualified workforce with experience in NPP construction influence the choice of construction production technologies. Regions with a shortage of such labour resources require attracting personnel from other regions or training and upskilling existing specialists.

Based on the analysis of regional conditions of the Russian Federation, the following groups of regions can be distinguished. The first group includes industrially saturated regions of the European part of Russia with well-developed industrial and transport infrastructure (Leningrad, Voronezh, Smolensk, Rostov, and Kursk oblasts). The group is characterized by a high concentration of suppliers and a relatively short delivery distance.

The second group is proposed to include resource-self-sufficient regions with a developed industrial cluster (Sverdlovsk, Chelyabinsk oblasts).

The third group includes territories with limited transport accessibility (Murmansk Oblast). There is railway and water communication, but it is overloaded or has a limited navigation period.

The last group includes pioneering development territories (Primorsky Krai, Khabarovsk Krai, Norilsk, Republic of Sakha (Yakutia), Chukotka Autonomous Okrug), characterized by the absence of sufficient infrastructure for constructing high-capacity NPP and significant remoteness from domestic suppliers.

A comparison of groups of regions where NPP power units are being built or planned for construction (according to the General Scheme for the Placement of Electricity Generation Facilities up to 2042)¹ is provided in Table 1.

In accordance with the analysis of regional conditions, the following alternative organizational forms for the production base for construction of NPP with VVER-1200 are proposed for consideration:

1. *Comprehensive production base at the NPP construction site.* A fully deployed construction base, whose production capacities allow for the manufacture of the entire range of reinforced concrete products, the entire quantity of commercial concrete and metal products, and the storage and processing of all material resources necessary for the construction process².

2. *Large self-sufficient production base of inter-district, inter-oblast significance,* intended for the construction of a series of power units or several stations in areas with underdeveloped infrastructure and significant remoteness from manufacturers of technological equipment. Such a base covers the construction needs for materials, products, and structures; long-term storage of the entire set of incoming equipment is provided on its territory, along with its inspection, pre-installation preparation, and assembly into larger units. The use of such a base occurs over 10–12 years, and in some cases, it is used as a regional base, meeting the needs of NPP construction at other sites located at a distance from the construction and installation base. For such bases, it is advisable to design buildings and structures in a permanent version [3].

3. *Self-sufficient production base of district, nodal significance.* This alternative is similar to the previous one but is used within the needs of an economic administrative district or a node of concentrated construction — a single NPP project.

4. *Small on-site base in a mobile version.* Designed for the construction of one or two NPP power units in an industrially developed area. Performs limited functions and, as a rule, serves as a complement to the main method of supplying material resources from large nodal enterprises capable of meeting most of the construction needs. An on-site base from a previously built industrial object or a construction plant intended to meet the needs of mass construction can be used. The base is equipped with temporary buildings

² OTPS, VOLUME 10 SECTION 1. Organizational and technological rules for the construction of nuclear power plants with WWER 1200 reactors : Order of the State Corporation Rosatom dated December 28, 2022 No. 1/1807-P (rus.).

Table 1. Comparison of regional groups

Regional group	Group characteristics	Regions in the group where NPP power units are being built or planned for construction	NPP Unit Types
1. Industrially-saturated regions	High supplier concentration (average delivery distance < 300 km). Developed transport network. Presence of an operating NPP and a satellite city with qualified labour resources	Leningrad Oblast (LAES-2) Voronezh Oblast (NAES-2) Smolensk Oblast (Smolensk NPP-2) Rostov Oblast (Southern NPP) Kursk Oblast (Kursk NPP-2)	VVER-1200 VVER-1200, VVER-optim VVER-optim VVER-optim VVER-TOI
2. Resource-self-sufficient regions with a developed industrial cluster	Regions with powerful metallurgical, cement, and other industries	Sverdlovsk Oblast (Reftinskaya NPP) Chelyabinsk Oblast (South Ural NPP)	RBN RBN
3. Territories with limited transport accessibility	Regions with limited logistics, predominantly by sea or overloaded railway routes	Murmansk Oblast (Kola NPP-2)	VVER-S/600
4. Pioneering development territories	Absence of infrastructure sufficient for constructing high-capacity NPP. Significant remoteness from suppliers (delivery distance reaches > 5,000 km). Presence of seismic activity and harsh climate. Shortage of specialized personnel and material resources	Primorsky Krai (Primorskaya NPP) Khabarovsk Krai (Khabarovskaya NPP) Krasnoyarsk Krai (Norilsk ASMM) Republic of Sakha (Yakutsk ASMM) Chukotka Autonomous Okrug (Chukotka ASMM)	VVER-1000 VVER-S/600 RITM-400 RITM-200N Shelf-M

▶ with mobile equipment, designed for multiple uses and rapid relocation. During NPP construction using such a production base, the organization of material, component, and technological equipment supplies must strictly follow the schedule to avoid construction delays [3].

5. *Minimally necessary on-site base with an orientation towards external supply* of the maximum possible quantity of products. The mandatory facilities of such a base must include: a concrete plant for constructing critical structures with a capacity, reinforcement and formwork shop for manufacturing small piece metal products and sites for their assembly into installation fragments, storage and pre-installation preparation sites for main equipment, sections for ventilation, anti-corrosion, painting, and insulation works, as well as a canteen and an administrative and amenity building (AAB)².

6. *Repair and modernization of existing production capacities*. This organizational form, unlike the previous considered alternatives, does not involve investing capital expenditures in the erection of new production capacities. All funds are directed towards the repair and modernization of existing production facilities of inter-district, inter-oblast, and district, nodal significance located in the construction region, with subsequent contractual reservation of all or part of the capacities for the construction of the NPP.

The task of assessing organizational forms of production bases is multi-criteria, as all alternatives possess advantages and disadvantages relative to each other. Solving such a task requires the application of mathematical methods that allow synthesizing multiple criteria into a single assessment of the preference of each alternative.

The Analytic Hierarchy Process (AHP), developed by Thomas Saaty [4], is one of the most effective approaches to solving multi-criteria choice problems. AHP is based on pairwise comparisons of criteria by importance and alternatives for each criterion, which allows considering subjective expert assessments and overcoming the problem of incommensurability of different criteria.

Based on the conducted analysis of design-estimate and working documentation for various NPP projects with VVER-1200, as well as regulatory and technical documentation, scientific, educational, and methodological literature^{3, 4} [5–11], the following assessment criteria are proposed for use:

1. Economic:

- *capital costs for creation, repair, or modernization of production capacities* — one of the key indicators of the economic feasibility of the assessed OFPB. Minimizing capital costs allows reducing the project's investment requirements;
- *logistics costs for the supply of material and technical resources*: structures, products, semi-finished goods, technological equipment, etc. Determined by logistics supply schemes, transportation distance, cost of transport services, and capital investments in creating transport infrastructure and transshipment points. High logistics costs significantly affect the final cost of materials;
- *risk of cost increase for produced products* — the criterion is associated with inflationary costs, currency fluctuations, changes in the regulatory framework, and other factors influencing the cost of material and technical resources.

³ Morozenko A.A., Subbotin A.S., Kolchin V.N., Shashkov A.A. *Organizational and technological solutions for the main buildings of thermal power plants and nuclear power plants : a teaching aid (educational electronic publication)*. Moscow, Publishing house of MISI – MGSU, 2019. URL: https://rusneb.ru/catalog/000199_000009_010358433/ (rus).

⁴ Subbotin A.S., Shashkov A.A., Kuzmin N.Yu., Voronkov I.E. *Technology and organization of construction of buildings and structures of thermal and nuclear power engineering : a teaching aid (educational electronic publication)*. Moscow, MISI – MGSU, 2020. URL: https://rusneb.ru/catalog/000199_000009_010669863/ (rus).

2. Territorial:

- *proximity of the production base to the construction site* — influences both logistics costs and the possibility of real quality control and storage conditions;
- *area of alienated territories* — the total area of land plots required for locating the NPP construction production base.

3. Reliability Assurance Criteria:

- *supply reliability* — characterized by the fault-free normal functioning of the supply chain (under given operating conditions) considering the influence of the external environment [12];
- *quality control of incoming products* — determines the possibility of ensuring that material and technical resources comply with the requirements of design and working documentation and regulatory documents. A high level of quality control is critically important for nuclear energy facilities.

4. Temporary:

- *timeframes for production capacities to reach the required productivity level* — influence the duration of the preparatory period and represent the time interval from the decision to erect, repair, or modernize production capacities until reaching a productivity level capable of covering the NPP's needs at the construction stage corresponding to the commissioning of said capacities;
- *risk of schedule disruption (of the Work Production Schedule — WPS)* — characterizes the probability of disruption to the Work Production Schedule (WPS) timeline in case of problems with the main supply channel for material and technical resources.

5. Organizational:

- *manageability* — characterizes the degree of complexity in managing and coordinating various elements of the production base and the necessary costs for managerial personnel and control systems.

Based on the results of forming various alternative OFPB for NPP construction with VVER-1200 and selecting assessment criteria, a hierarchical representation of the task was built (Fig. 1).

The further algorithm for solving the task includes the following steps [15]:

- formation of a table of characteristics for economic, territorial, reliability, temporal, and organizational criteria K_j of alternatives A_i for the OFPB for NPP construction with VVER-1200;
- selection of a set N of non-dominated alternatives (Pareto set) from the general set of alternatives n . All alternatives are pairwise compared with each other according to all criteria. If during the comparison of any alternatives it turns out that one is not better than the other in any criterion, then it can be excluded from consideration. The excluded alternative does not need to be compared with other alternatives, as it is clearly unpromising;
- expert assessment of the criteria for choosing a rational OFPB by degree of importance is performed. The expert fills out a pairwise comparison matrix of size $K \times K$, where K is the number of criteria. The rules for filling the matrix are indicated in Table 2.

Intermediate values (2, 4, 6, 8, 1/2, 1/4, 1/6, 1/8) can be used for assessment;

- processing of assessments using methods of expert analysis is performed. There are a number of algorithms implementing the pairwise comparison method: they differ in the number of expert assessments used (individual and collective

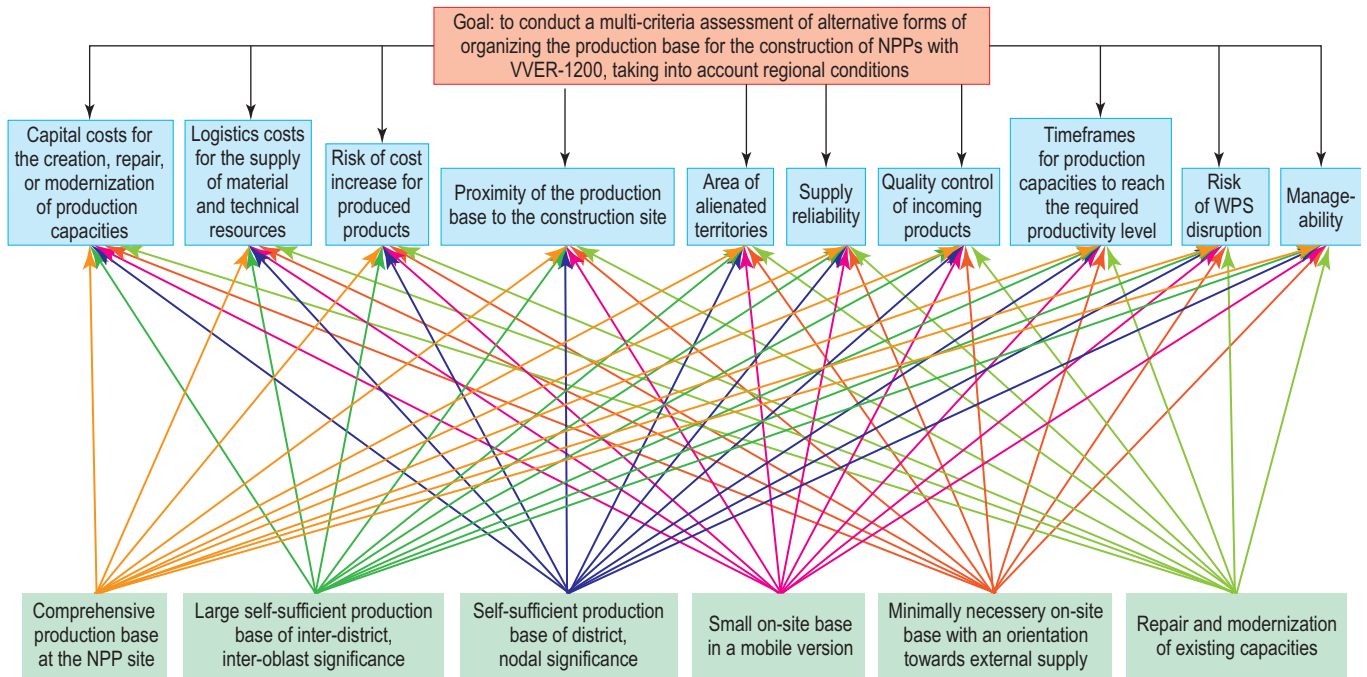


Fig. 1. Hierarchical representation of the multi-criteria task for assessing organizational forms of the production base for NPP construction with VVER-1200 for solution by the Analytic Hierarchy Process method

Table 2. Rules for filling the pairwise comparison matrix according to the Saaty method

X_{ij}	Value
1	The i -th and j -th criteria are approximately equal in value
3	i -th criterion is slightly more important than the j -th
5	i -th criterion is more important than the j -th
7	i -th criterion is significantly more important than the j -th
9	i -th criterion is clearly more important than the j -th

assessments), in scales for comparing alternatives, etc. This work uses the most widely applied pairwise comparison method (Saaty method). However, since the Saaty method is based on comparing alternatives performed by one expert, the agreed assessment of the author's team will be adopted as the criterion importance assessments in the further calculation.

The PRICE of each criterion is determined by formula (1) — geometric means of the matrix rows:

$$C_i = \sqrt[k_i]{\prod_{j=1}^{k_i} X_{ij}}, \quad (1)$$

where X_{ij} is the importance assessment of criterion K_i relative to K_j ; $i = 1, \dots, K$.

The sum of the prices of all criteria is found (2):

$$C = \sum_{i=1}^K C_i. \quad (2)$$

Local priorities (criterion weights) are calculated, formula (3):

$$L_{K_i} = V_i = C_i / C; \quad (3)$$

- verification of expert assessments for consistency is performed.

The sums of the columns of the pairwise comparison matrix is determined (4):

$$R_j = \sum_{i=1}^K X_{ij}, \quad (4)$$

where $j = 1, \dots, K$.

An auxiliary quantity λ is calculated by summing the products of the column sums of the matrix by the criterion weights, formula (5):

$$\lambda = \sum_{j=1}^K R_j \cdot V_j; \quad (5)$$

- using formula (6), a quantity called the Consistency Index (CI) is found:

$$CI = (\lambda - N) / (N - 1). \quad (6)$$

- depending on the dimension of the pairwise comparison matrix, the Random Consistency Index (RCI) is found. The RCI values are given in Table 1.6 [15]. For the previously selected ten criteria ($K = 10$), $RCI = 1.49$.
- the Consistency Ratio (CR) is found (7):

$$CR = CI / RCI. \quad (7)$$

If the consistency ratio exceeds 0.2, then refinement of the pairwise comparison matrix is required:

- formation of $N \times N$ matrices of pairwise comparisons of alternatives A_i for each criterion K_j ;
- determination of local priorities of alternatives A_i relative to criterion K_j ($L_{A_i}^{K_j}$) similarly using formulas (1)–(3);
- calculation of global priorities of alternatives using formula (8):

$$G_{A_i} = \sum_{j=1}^K L_{A_i}^{K_j} \cdot L_{K_j}, \quad (8)$$

where $i = 1, \dots, N$;

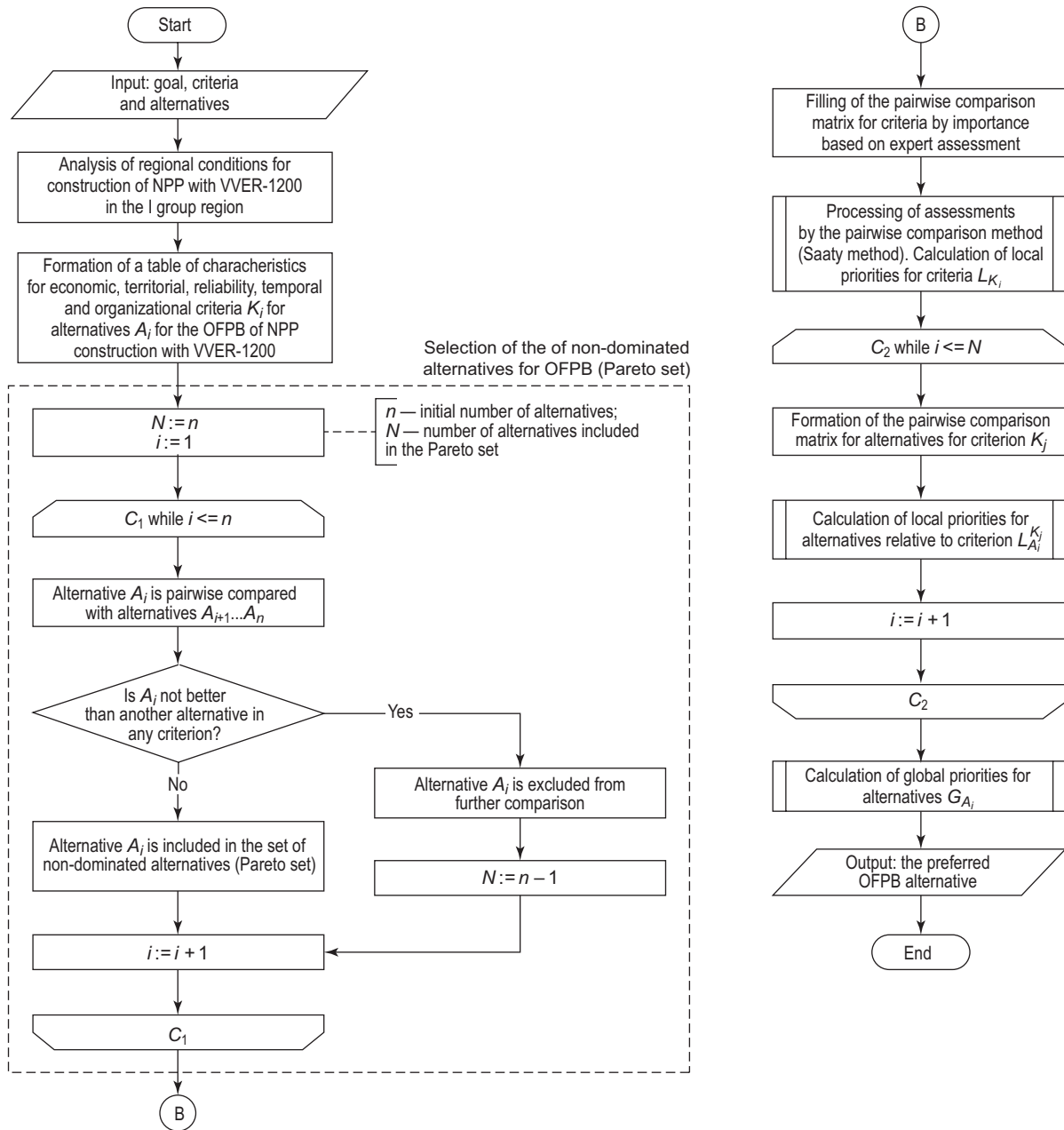


Fig. 2. Flowchart of the algorithm for assessing the OFPB for NPP construction with VVER-1200

- the highest global priority corresponds to the preferred alternative for the organizational form of the production base for NPP construction with VVER-1200 (considering all criteria and their degree of importance) in the selected regional conditions.

Let's consider a calculation example for an NPP project with VVER-1200 in a Category I region, as the most realistic within construction in the Russian Federation.

Goal: to perform a multi-criteria assessment of alternative organizational forms for the production base for NPP construction with VVER-1200 considering regional conditions.

The algorithm flowchart is presented in Fig. 2.

Let's form a table of characteristics for criteria K_j of alternatives A_i (Table 3).

None of the alternatives is worse than another in all criteria; the Pareto set includes all 6 presented alternatives.

The expert assessment of criteria for choosing a rational OFPB by degree of importance is presented in Table 4.

Table 5 summarizes the values of local priorities for all criteria.

The Consistency Ratio $CR = 0.046 < 0.2$, therefore, matrix refinement is not required.

Similarly, the local priorities of alternatives A_i relative to criterion K_j are determined (values are presented in Fig. 3).

The final values of global priorities for alternatives are indicated in Table 6.

Based on the obtained results, it can be concluded that the preferred organizational form for the production base for NPP construction with VVER-1200 for conditions in the European part of Russia is the erection of a comprehensive production base at

Table 3. Characteristics of alternatives

Criteria \ Alternatives	A ₁ . Comprehensive production base at construction site	A ₂ . Large self-sufficient inter-district base	A ₃ . Self-sufficient district base	A ₄ . Small mobile on-site base	A ₅ . Minimally necessary base with external supply orientation	A ₆ . Repair and modernization of existing capacities
K ₁ . Capital costs for creation, repair, or modernization of production capacities	High	Very high	High (slightly higher than A ₁)	Medium-low	Low	Medium
K ₂ . Logistics costs for supply of material and technical resources	Low	High	Medium	High	Very high	Medium
K ₃ . Risk of cost increase for produced products	Low	Medium	Medium-high	High	Very high	Medium
K ₄ . Proximity of production base to construction site	Very close	Far	Medium distance	Close	Medium distance	Medium distance
K ₅ . Area of alienated territories, Ha	40–80+	70–100+	45–85+	20–30	10–20	< 5
K ₆ . Supply reliability	Very high	High	High	Medium	Low-medium	Medium-high
K ₇ . Quality control of incoming products	Very high	High	High	Medium	Low-medium	Medium-high
K ₈ . Timeframes for production capacities to reach required productivity level, months	15–27+	24–36	18–30	< 2–5	3–9	6–18
K ₉ . Risk of WPS schedule disruption	Low	Low-medium	Low-medium	Medium-high	High	Medium
K ₁₀ . Manageability	Medium complexity	High complexity	Medium-high complexity	Low-medium complexity	Very complex	Medium complexity

Table 4. Pairwise comparison matrix of criteria by importance

K _i \ K _j	K ₁	K ₂	K ₃	K ₄	K ₅	K ₆	K ₇	K ₈	K ₉	K ₁₀
K ₁	1	1	5	3	7	1/5	2	1/2	1/4	6
K ₂	1	1	5	2	7	1/5	2	1/3	1/4	5
K ₃	1/5	1/5	1	1/2	3	1/7	1/2	1/5	1/7	2
K ₄	1/3	1/2	2	1	5	1/6	1/2	1/5	1/6	3
K ₅	1/7	1/7	1/3	1/5	1	1/9	1/5	1/7	1/8	1/2
K ₆	5	5	7	6	9	1	6	3	2	9
K ₇	1/2	1/2	2	2	5	1/6	1	1/3	1/5	3
K ₈	2	3	5	5	7	1/3	3	1	1/2	7
K ₉	4	4	7	6	8	1/2	5	2	1	7
K ₁₀	1/6	1/5	1/2	1/3	2	1/9	1/3	1/7	7	1

Table 5. Values of Local Priorities for Criteria

L _{K1}	0.093
L _{K2}	0.084
L _{K3}	0.029
L _{K4}	0.043
L _{K5}	0.014
L _{K6}	0.292
L _{K7}	0.055
L _{K8}	0.149
L _{K9}	0.221
L _{K10}	0.020

Table 6. Values of Global Priorities for Alternatives

G _{A1}	0.3094
G _{A2}	0.1321
G _{A3}	0.1484
G _{A4}	0.1601
G _{A5}	0.1112
G _{A6}	0.1388

the NPP construction site. This alternative provides the most favorable balance between supply reliability, capital and logistics costs, quality control, and other criteria, which is critically important for nuclear energy projects.

The assessment of organizational forms for the production base for NPP construction with VVER-1200 is a complex task requiring analysis of many interrelated criteria of a technical, economic, and organizational nature. The application of the Analytic Hierarchy Process allows systematizing the process, considering criteria in their mutual hierarchy of priorities, and obtaining a justified solution corresponding to the specific conditions of each project.

The results of the conducted study show that for most construction sites in Russia in Category I regions, the preferred OFPB is the creation of a comprehensive production base at the NPP construction site. Despite the developed production and transport infrastructure of the considered region, organizational forms oriented towards supplies turn out to be significantly less preferable. This can be explained by the relatively low reliability of supplies, high risk of WPS schedule disruption, and significant logistics costs, which is generally characteristic of the Russian Federation due to highly extended transportation schemes and a high risk of untimely deliveries².

At the same time, the determination of the preferred OFPB should be carried out considering specific regional conditions, the availability of existing production infrastructure, the long-term development programme of the site, and the strategy for investing

L_{A1}^{K1}	0.081	L_{A1}^{K2}	0.420	L_{A1}^{K3}	0.413	L_{A1}^{K4}	0.452	L_{A1}^{K5}	0.059
L_{A2}^{K1}	0.036	L_{A2}^{K2}	0.078	L_{A2}^{K3}	0.184	L_{A2}^{K4}	0.039	L_{A2}^{K5}	0.028
L_{A3}^{K1}	0.054	L_{A3}^{K2}	0.193	L_{A3}^{K3}	0.112	L_{A3}^{K4}	0.093	L_{A3}^{K5}	0.040
L_{A4}^{K1}	0.264	L_{A4}^{K2}	0.078	L_{A4}^{K3}	0.071	L_{A4}^{K4}	0.230	L_{A4}^{K5}	0.192
L_{A5}^{K1}	0.391	L_{A5}^{K2}	0.036	L_{A5}^{K3}	0.035	L_{A5}^{K4}	0.093	L_{A5}^{K5}	0.279
L_{A6}^{K1}	0.175	L_{A6}^{K2}	0.193	L_{A6}^{K3}	0.184	L_{A6}^{K4}	0.093	L_{A6}^{K5}	0.403
L_{A1}^{K6}	0.413	L_{A7}^{K7}	0.413	L_{A8}^{K8}	0.077	L_{A9}^{K9}	0.342	L_{A10}^{K10}	0.209
L_{A2}^{K6}	0.182	L_{A2}^{K7}	0.182	L_{A2}^{K8}	0.027	L_{A2}^{K9}	0.208	L_{A2}^{K10}	0.078
L_{A3}^{K6}	0.182	L_{A3}^{K7}	0.182	L_{A3}^{K8}	0.052	L_{A3}^{K9}	0.208	L_{A3}^{K10}	0.124
L_{A4}^{K6}	0.068	L_{A4}^{K7}	0.068	L_{A4}^{K8}	0.450	L_{A4}^{K9}	0.076	L_{A4}^{K10}	0.342
L_{A5}^{K6}	0.045	L_{A5}^{K7}	0.045	L_{A5}^{K8}	0.235	L_{A5}^{K9}	0.052	L_{A5}^{K10}	0.038
L_{A6}^{K6}	0.109	L_{A6}^{K7}	0.109	L_{A6}^{K8}	0.159	L_{A6}^{K9}	0.114	L_{A6}^{K10}	0.209

Fig. 3. Local priorities of alternatives relative to criteria

capital funds. The application of the presented methodology for assessing organizational forms of the production base using AHP allows making justified decisions that ensure the optimization of technical and economic indicators for NPP construction projects with VVER-1200.

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Многокритериальная оценка форм организации производственной базы строительства АЭС с ВВЭР-1200

Статья посвящена решению научно-практической задачи многокритериальной оценки альтернативных форм организации производственной базы (ФОПБ) строительства атомных электростанций с реакторными установками ВВЭР-1200. Предложена классификация российских регионов на четыре категории в зависимости от наличия и степени развития существующей производственной и транспортной инфраструктуры и других критериев, оказывающих влияние на определение предпочтительной ФОПБ. Сформулированы шесть альтернативных форм организации, включая комплексную производственную базу на площадке строительства АЭС, крупную межрайонную базу, само-

достаточную районную базу, мобильную приобъектную базу, минимально необходимую базу с ориентацией на внешнюю поставку, а также ремонт и модернизацию существующих мощностей. Каждая альтернатива оценена по ряду критериев: экономическим, территориальным, критериям обеспечения надежности, временным и организационным критериям. Для решения многокритериальной задачи применен апробированный в мировой практике метод анализа иерархий Т. Саати, включающий процедуры парных сравнений критериев и альтернатив с проверкой согласованности экспертных оценок. Проведены полные расчеты с определением локальных и глобальных приоритетов всех альтернатив. Результаты исследования демонстрируют, что определение предпочтительной формы организации производственной базы в значительной степени зависит от региональных условий, включая уровень развития инфраструктуры, страте-

гию инвестирования и долгосрочные планы развития атомной энергетики в регионе. Изложенная методика может быть применена при обосновании организационно-технологических решений на предпроектной стадии строительства новых энергоблоков АЭС с ВВЭР-1200.

Ключевые слова: форма организации производственной базы, ВВЭР-1200, метод анализа иерархий, многокритериальная оценка, метод Саати

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