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Issue Article

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ON NEW POSSIBILITIES OF STATISTICAL METHODS OF QUALITY CONTROL WHEN USING DIGITAL PRODUCTION OF PRIORITY PRODUCTS

Abstract: *In the article, the authors note the Russian reality of the tendency of entrepreneurs and their employees to bribe, hide income from the tax service, forge documents, and disregard for ethical standards in relation to competitors. There is a gap in communication between the manager and employees, in other words, the manager of the enterprise is inaccessible to lower-level workers. It is also noted that Russians have an average level of individuality and often try to escape from uncertainty.*

As a result of all the above, the conclusion suggests itself that in Russia the enterprise and the management of personnel management are formed ineffectively and working collective ties are practically absent. Enterprises devote all their attention to fulfilling the conditions that the employees of the state bureaucratic apparatus set before them, and not to fulfilling responsibility to consumers and society. Therefore, there is a difficulty in introducing progressive foreign management methods into Russian practice. The authors recommend that the market reconsider the concept of filling it with popular and priority goods, taking into account their demand. Such a concept will fully correspond to the desire of the consumer to satisfy his desire and desire to make a purchase, taking into account his social status, ensuring that manufacturers sell their products in full and guaranteeing enterprises sustainable TEP from their activities.

Key words: *quality, import substitution, consumers, producers, profit, sales, demand, relevance, competitiveness, sustainable energy efficiency, economic policy, financial condition, innovation, flexible process, digital production, efficiency, market, implementation.*

Language: *English*

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Introduction

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Quality is "written in fate" to be at all times at the epicenter of both scientific and amateurish reflections. The problem of ensuring the quality of activity is not just universal, relevant, it is strategic.

What is the essence of economic reforms and the importance of industrial policy in them, which are theoretically substantiated and tested in practice in a number of developed countries?

This is the fight against inflation, strengthening of the national currency and financial stabilization. This is a change in the forms of ownership in various spheres of the economy through the process of privatization. This is a structural reorganization of the economy to the conditions of market relations.

At the same time, structural restructuring must be the basis of all these fundamental processes of economic reform. Both financial stabilization and privatization must be subordinated to the process of structural restructuring, since it is precisely structural restructuring that determines the final result of reforms and the effectiveness of the adaptation of various forms of production to civilized market relations.

The basis for the structural restructuring of the economy must also be the final result. And this is the products, services - their competitiveness in the domestic and world markets.

Main part

At JSC Shakhtinsky Zavod Gidroprivod in Shakhty, Rostov Region, a quality management system has been implemented that meets the requirements of the international standard ISO 9001. A certificate of conformity for the quality management system of JSC SHZG is available.

The quality management system of JSC "ShZG" includes:

– the management structure of the Managing Director of JSC “ShZG” and the management structure of the structural divisions of JSC “ShZG”;

– processes of the Quality Management System of JSC “SHZG”, their application, sequence and interaction;

– documentation of the Quality Management System of JSC "SHZG", containing the requirements in accordance with which the personnel perform activities in the field of quality, and records (data) confirming the fulfillment of these requirements;

– resources necessary for the effective and efficient functioning of processes and the Quality Management System of JSC “SHZG” as a whole.

The quality management system of JSC "SHZG" operates on the basis of processes covering all types of activities that determine the quality of manufactured products. The top management of JSC "SHZG" determines and forms the management, main and auxiliary processes, as well as processes aimed at continuous improvement of the quality management system of JSC "SHZG". The tasks of determining the structure of processes, their documentary registration are solved as a means of ensuring the implementation of the Policy of JSC "SHZG" in the field of quality, achieving goals and compliance of products with established requirements.

The diagram of interaction of processes within the quality management system of JSC "ShZG" is shown in Figure 1.

The list of processes of the quality management system of JSC "SHZG" is given in Table 1.

Table 1. Processes of the quality management system of JSC "SHZG"

QMS process code	Name of the quality management system process
1	Management processes
1.1	Planning a Quality Management System
1.2	Management review
1.3.1	Training and professional development of personnel
1.3.2.1	Rail transport management
1.3.2.2	Management of control systems
1.3.2.3	Management of motor transport and special equipment
1.3.2.4	Management of construction and operation of industrial facilities
1.3.3	Production Environment Management
1.3.4	Management of financial and economic activities

2	Main processes
2.1	Contract analysis, customer communication
2.2	Design and development of products and technological processes
2.3	Production planning
2.4.1	Purchase of raw materials, materials, equipment, spare parts
2.4.2	Energy resource procurement
2.5.1	Production of pig iron in blast furnace shops
2.5.2	Production of continuously cast steel slabs in converter shops
2.5.3	Rolled products production in PGP
2.5.4	Rolled products production in PKhPP
2.5.5	Production of rolled electrical steel in PDS
2.5.6	Production of rolled electrical anisotropic steel in PTS
2.5.7	Production of low-carbon steel rolled products (including zinc-coated ones) in PDS
2.6	Loading and unloading operations, storage, packaging and delivery of products
3	Auxiliary processes
3.1	Monitoring and measurement of technological processes and products
3.2	Management of monitoring and measurement equipment
3.3	Product identification and traceability
3.4	Management of nonconforming products
3.5	Equipment maintenance and repairs
4	Analysis and continuous improvement processes
4.1	Customer Satisfaction Assessment
4.2	Internal audit

The documentation of the quality management system of JSC "ShZG" includes:

– the Policy of the ShZG Group in the field of quality and the objectives in the field of quality formed by the top management of JSC ShZG and approved.

– Quality Manual of JSC "ShZG", defining the quality management system of JSC "ShZG" in accordance with the requirements of ISO 9001 and ISO/TS 16949;

– process maps that establish the purpose of the process, the inputs and outputs of the process, the main stages of its implementation, resources, parameters and control methods; process performance indicators and efficiency indicators (for main and auxiliary processes), current documents, in accordance with the requirements of which activities are carried out on this process;

– standards for the organization of the quality management system, establishing the procedures of the quality management system of JSC "SHZG";

– documents developed in accordance with the requirements of the enterprise quality management system standards (regulations on structural divisions, job descriptions and production and technical instructions, process instructions, process operation sequence charts, process maps, technical conditions, product standards, etc.);

Tables 2 and 3 present the list of defects for constructing Pareto diagrams for 2024 and 2025, respectively.

Table 2. Characteristics of defects identified at JSC "ShZG" in 2024

Defect	Number of defects detected	Cumulative detection rate	Total number of defects, %
Defective washer	78	16.5%	16%
Block defect	74	15.6%	32%
Marriage of the hull	70	14.8%	47%
Broken finger	64	13.5%	60%
Piston ring failure	57	12.1%	73%
The distributor has opened	54	11.4%	84%
Connecting rod piston breakage	32	6.8%	91%
Scuffs on the distributor	30	6.3%	97%

Other defects	14	3.0%	100%
Total	473		

Table 3. Characteristics of defects identified at JSC "ShZG" for 2025 (expected)

Defect	Number of detections	Cumulative detection rate	In total
Bullieson the distributor	27	12.4%	12%
Defective washer	23	12.4%	25%
Connecting rod piston breakage	22	11.9%	37%
The distributor has opened	21	11.3%	48%
Marriage of the hull	20	11.3%	59%
Block defect	19	11.3%	71%
Broken finger	18	10.3%	81%
Piston ring failure	17	9.8%	91%
Other defects	8	9.3%	100%
Total	27		

Figures 1 and 2 show the results of the studies characterizing the defects in the form of a Pareto diagram for 2024 and 2025, respectively.

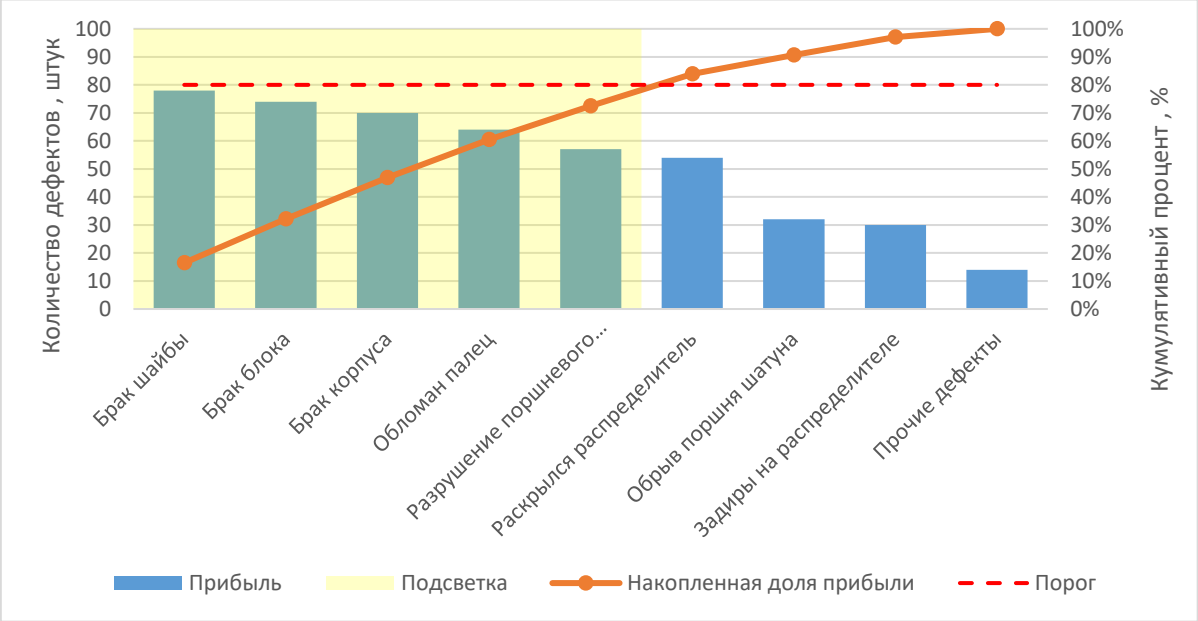

Figure 1- The results of the research, characterizing the defects in the form of a Pareto diagram, respectively for 2024

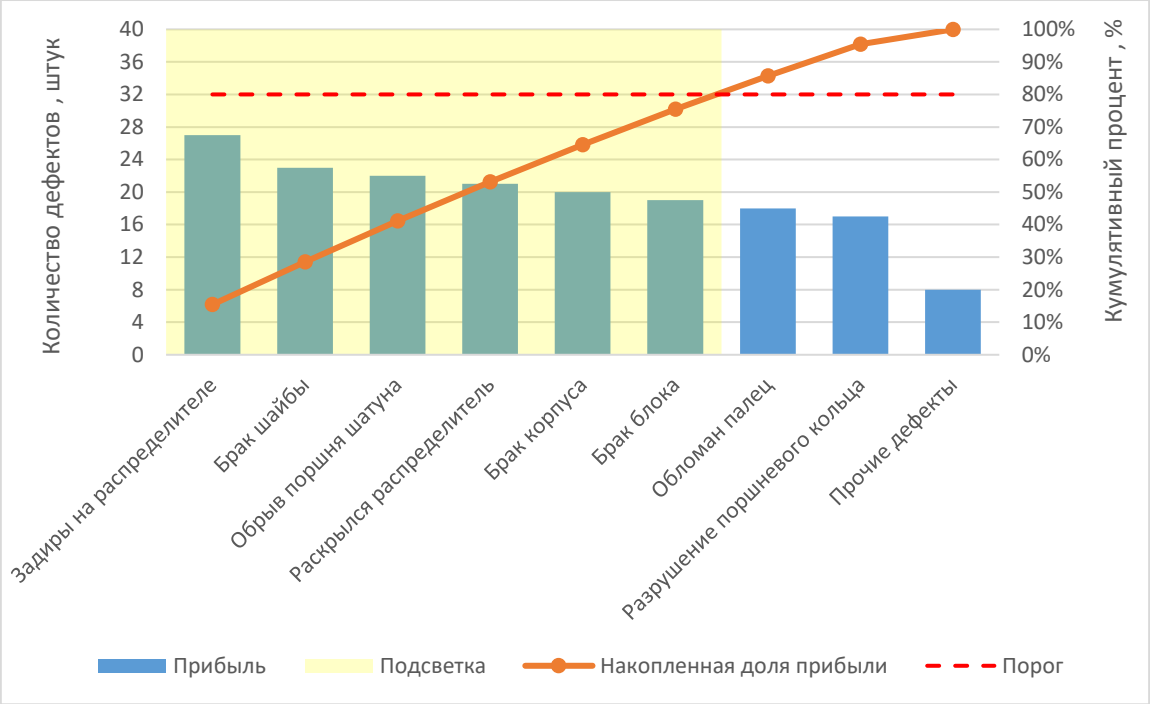

Figure 2 - Research results characterizing defects in the form of a Pareto diagram for 2025 (expected)

Were calculate economic efficiency from implementation proposed activities, economic effect conditional and the payback period. Received platforms the data confirms working the effectiveness of the proposed improvement activities provision capable product quality, enterprise produced by JSC Shakhtinsky Hydroprivod Plant (SHZG).

The obtained results confirm the correctness of the chosen decision on the implementation of the QMS and participatory production management and suggest their strict implementation in the future in order to guarantee enterprises the successful production of import-substituting products.

The analysis of the Pareto diagram helps to evaluate the efficiency of the enterprise's business. The Pareto law (Pareto rule) in general sounds like "20% of the efforts give 80% of the result, the remaining 80% of the efforts give the remaining 20% of the result." Therefore, a competent analysis will help to identify the strengths of the business (resources that need to be developed and strengthened), as well as weaknesses (resources that also need to be significantly improved or abandoned).

The defining advantage of the Pareto diagram is that it allows us to divide factors into significant (most frequently encountered) and insignificant (relatively rare). For example, analysis of the diagram shows that shrinkage cavities, gas porosity and other cracks in cast parts account for 89.5% of all nonconformities. Consequently, work on ensuring the quality of parts should begin with eliminating these nonconformities.

In addition to identifying and ranking factors according to their importance, the Pareto diagram is successfully used to clearly demonstrate the effectiveness of certain quality assurance measures: it is enough to construct and compare two Pareto diagrams - before and after the implementation of measures within the QMS.

Production efficiency is the ratio between the obtained results of production, on the one hand, and the costs of labor and means of production, on the other. It is the most important qualitative indicator of the economy, its technical equipment and labor qualifications. Comparison of costs and results is used in the practice of managing firms, enterprises and other economic entities.

The main indicators of production efficiency are: labor productivity; capital intensity of a unit of GDP or specific types of products; return on assets per unit of fixed assets; material intensity of a unit of GDP or specific types of products; the ratio of extensive and intensive factors in GDP growth; competitiveness of manufactured products; payback period of costs, etc. Efficiency is understood as the correspondence of the social effect of applying the results of standardization work in production and the costs associated with their application. Ensuring product quality is associated with costs. Product quality must guarantee the consumer the satisfaction of his needs, its reliability and cost savings. These properties are formed in the process of all reproduction activities of the enterprise, at all its stages and in all links. Together with them, the cost value of the product is formed, characterizing these properties from product development planning to its implementation and after-sales service. A complaint is a claim made by a buyer to a seller due to a discrepancy between the quality or quantity of the supplied goods and the terms of the contract.

Complaints may be made only on issues that were not the subject of acceptance of the goods carried out in accordance with the terms of the contract.

The policy of the enterprise should initially aim at high quality of the products. However, defects, which are its opposite, can occur at any enterprise. It must be taken into account. Defects can be found at the enterprise itself - the manufacturer of the products and beyond.

The batch of products shipped to the consumer in 2024 was 46,300 pieces. The number of defective products for 2024 was 473 pieces. We will determine the economic effect associated with the implementation of measures to improve the plant's regulatory documentation within the QMS.

The planned annual supply volume of sales of JSC "ShZG" for 2024 amounted to:

Op=(4300·11600)+(4200·12200)+
(4400·20000)+(5000·12420)+(3600·38500)+
(3548·35900)+(4365·130900)+(4502·25000)+
(638·48600)+(4690·59900)+(39800·7057)=
1541148100 rubles

Taking into account the return of products due to defects, the losses amounted to:

P=(40·11600)+(46·12200)+(50·20000)+(36·124
20)+(42·38500)+(70·35900)+(19·130900)+
(11·25000)+(22·48600)+(14·59900)+(123·39800)=
=16167620 rubles

Let's determine the percentage of losses from the volume of product sales in 2018:

adf= 16167620/1541148100·100%= 1.05%

Let's determine the average weight of one pump:

Avg.af.v=((7+12+15+20+30+50+48+70+80+
27+58))/11=38 kg

Considering that defective products cannot be restored or repaired, the enterprise recycles them, and the resulting metal is used to produce new products. The total mass of metal obtained through the recycling of goods is:

m=473·38=17974 kg

The disposal costs will consist of the cost of electricity (23 rubles per 1 kg), the worker's salary (13 rubles per 1 kg), and depreciation charges due to the use of equipment (76 rubles per 1 kg).

C = (76+13+23) ·17974 = 2013088 rubles

Taking into account the contract prices for metal, after remelting we will receive: (contract price of 1 kg of metal products is 350 rubles):

R = 17974·350 = 6290900 rubles

The return of money to the enterprise for 2017 due to recycling, taking into account the costs of it, will be equal to:

EuB = 6290900 - 2013088 = 4277812 rubles

Let's determine the annual sales volume minus losses:

OR = 15541148100 - 16167620 + 4277812 = 15529258292 rubles

According to the enterprise data on the sales of JSC "SHZG" products, it is known that in 2024 the sales volume amounted to 48,700 pieces, the volume of defective products amounted to only 194 pieces, then we can conclude that the annual sales volume of JSC "SHZG" for 2025 amounted to:

OR = 4300·11700+4200·12300+4400·20100+
5000·12520+3600·38600+3548·35900+
4365·130900+4502·25100+638·48700+4690·59900+
39900·7057=17402521000 rubles

Taking into account the return of products due to defects, the losses amounted to:

P=18·11700+19·12300+17·20100+18·12520+
19·38600+18·35900+16·130900+19·25100+
18·48700+17·59900+39900·15=7455660 rubles

Let's determine the percentage of losses from sales volume in 2024

adf= 7455660/1740252100·100%= 0.043%

Considering that defective products cannot be restored or repaired, the enterprise recycles them, and the resulting metal is used to produce new products. The total mass of metal obtained through the recycling of goods is:

m=194·38=7312 kg

The costs of disposal will consist of the costs of electricity (25 rubles per 1 kg), workers' salaries (15 rubles per 1 kg), and depreciation charges due to the use of equipment (80 rubles per 1 kg).

C = (80+15+25) ·7312 = 877400 rubles

Taking into account the contract prices for metal, after remelting we will receive: (contract price of 1 kg of metal - 360 rubles):

P=7312·360 = 2632300 rubles

The return of money to the enterprise in 2024 due to the disposal of defective goods from 2023, taking into account the costs for it, will be:

EuB = 2632300 - 877440 = 1754880 rubles

Let's determine the annual sales volume minus losses for 2024:

OR = 17402521000 - 7455660 + 1754880 = 17310415600 rubles

The percentage reduction in losses in 2024 compared to 2023 was:

PU=1.05-0.043= 1.007%

The effect of the implementation of measures to eliminate defects by improving the regulatory documentation of JSC "ShZG" was:

E = 17310415600 - 15422582920 = 1887832680 rubles

The obtained data confirm the effectiveness of the developed regulatory and legal documentation within the framework of the QMS for the production of high-quality products manufactured by JSC Shakhty Plant Gidroprivod.

In 2025, a further reduction in defective products and improvement in the efficiency of production results of JSC "ShZG" is expected, which assumes the successful implementation of the developed enterprise plan within the framework of the QMS and in accordance with the Law on Technical Regulation and GOST R 57189-2016 / ISO / TS 9002-2015. Quality

Management System. Guidelines for the application of ISO 9001 - 2015 the range of main products is shown in figures (24-34).

Table 4. Characteristic detection product range of 8AO "ShZG"

Name products	Price, RUB/piece	Shipped to the consumer in 2018	Marriage productsin 2018	Shipped to the consumer in 2019	Marriage products in 2019
MG 12/32	11600	4600	50	4300	40
MG 2 28/32	12200	4200	47	4200	46
MG 112/32M	20000	4400	50	4400	50
MN 56/32	12420	5000	53	5000	36
MG 80/32	38500	3600	43	3600	42
AN 112.80/32	35900	3540	57	3548	70
NPA 16/32-01	130900	4360	40	4365	19
AT 1.50/32	25000	4500	60	4502	11
MN250/160	48600	600	90	638	22
NGM 56/32	59900	4780	10	4690	14
MGP 112/32.M	39800	7000	50	7057	123
Total	-	46580	550	46300	473

Assortment purpose manufactured products bullies JSC "SHZG"

Figure 3 - Axial piston pump motor development unregulated MG 12/32.

Table 5. Main meanings characteristics

Наименование параметра	Величина	
	насос	мотор
Рабочий объем, см³	12±0,36	12±0,36
Частота вращения, с-1 (об/мин)	40(2400)	40(2400)
Подача/ Расход, л/мин	не менее $27_{-0,9}$	не более $30^{+0,9}$
Давление на выходе, МПа (кгс/см²)	32(320)	
Давление на входе, МПа (кгс/см²)		32(320)
Масса (без рабочей жидкости), кг	7	7

Figure 4 - Axial piston pump motor receiving unregulated MG 2.28/32.

Table 6. Main meanings characteristics

Наименование параметра	Величина	
	насос	мотор
Рабочий объем, см³	28±0,8	28±0,8
Частота вращения, с-1 (об/мин)	32(1920)	32(1920)
Подача/ Расход, л/мин	не менее $51_{-1,5}$	не более $56,6^{+1,5}$
Давление на выходе, МПа (кгс/см²)	32(320)	
Давление на входе, МПа (кгс/см²)		32(320)
Масса (без рабочей жидкости), кг	12	12

Figure 5 - Axial piston pump motornon-adjustable MN 250/160.

Table 7. Main meanings characteristics

Наименование параметра	Величина	
	насос	мотор
Рабочий объем, см³	250±7,5	250±7,5
Частота вращения, с-1 (об/мин)	16,7(1000)	25(1500)
Подача/ Расход, л/мин	не менее $240_{-7,2}$	не более 390,6±11,7
Давление на выходе, МПа (кгс/см²)	16(160)	
Давление на входе, МПа (кгс/см²)		16(160)
Масса (без рабочей жидкости), кг	80	87

Figure 6 - Axial piston pump motor unregulated MGP112/32M.

Table 8. Main meanings characteristics

Наименование параметра	Величина	
	насос	мотор
Рабочий объем, см³	112	112
Частота вращения, с-1 (об/мин)	25(1500)	25(1500)
Подача/ Расход, л/мин	не менее $159{,}6_{-4{,}8}$	не более 182,6
Давление на выходе, МПа (кгс/см²)	32(320)	
Давление на входе, МПа (кгс/см²)		32(320)
Масса (без рабочей жидкости), кг	58	58

Figure 7. Pump-motor steel axial piston non-adjustable management MN 56/32.

Table 9. Main meanings characteristics

Наименование параметра	Величина	
	насос	мотор
Рабочий объем, см³	56±1,5	56±1,5
Частота вращения, с-1 (об/мин)	25(1500)	33,3(2000)
Подача/ Расход, л/мин	не менее 80_{-2}	не более $117{,}8^{+3{,}2}$
Давление на выходе, МПа (кгс/см²)	32(320)	
Давление на входе, МПа (кгс/см²)		32(320)
Масса (без рабочей жидкости), кг	20	20

Figure 8 - Pump-motor security axial piston non-adjustable steelMG 80/32.

Table 10. Main meanings characteristics

Наименование параметра	Величина	
	насос	мотор
Рабочий объем, см³	80±2,4	80±2,4
Частота вращения, с-1 (об/мин)	25(1500)	25(1500)
Подача/ Расход, л/мин	не менее $114_{-3,6}$	не более $126,5^{+3,8}$
Давление на выходе, МПа (кгс/см²)	32(320)	
Давление на входе, МПа (кгс/см²)		32(320)
Масса (без рабочей жидкости), кг	30	30

Figure 9 - Pump-motoraxial piston non-adjustableMG 112/32M.

Table 11. Main meaning scharacteristics

Наименование параметра	Величина	
	насос	мотор
Рабочий объем, см³	112±3,4	112±3,4
Частота вращения, с-1 (об/мин)	25(1500)	33,3(2000)
Подача/ Расход, л/мин	не менее $159,6_{-4,8}$	не более $235,8^{+7}$
Давление на выходе, МПа (кгс/см²)	32(320)	
Давление на входе, МПа (кгс/см²)		32(320)
Масса (без рабочей жидкости), кг	36	36

Figure 10 - Pump-motoraxial piston non-adjustable NGM 56/32.

Table 12. Main meanings characteristics

Наименование параметра	Величина
	насос
Рабочий объем, см³	56
Частота вращения, с-1 (об/мин)	25(1500)
Подача, л/мин	не менее 80 -2
Давление на выходе, МПа (кгс/см²)	32(320)
Давление на входе, МПа (кгс/см²)	1,6(16)
Масса (без рабочей жидкости), кг	27

Figure 11 - Pumping hydraulic unit AN 122.80/32.

Table 13. Main is significant characteristics

Наименование параметра	Величина
Потребляемый крутящий момент, Н•м, (кгс•м)	95(9,5)
Частота вращения приводного вала агрегата, с-1(мин-1)	25(1500)
КПД полный	0,90

Figure 12 - Axial piston pump motorunregulated NPA/32-01.

Table 14. Main meanings characteristics

Наименование параметра	НПА 4/32	НПА 16/32	НПА 32/32
Рабочий объем, см³	4	16	32
Частота вращения, с-1 (об/мин)	25(1500)	25(1500)	25(1500)
Подача, л/мин	4,7	19,5	40,8
Давление на выходе, МПа (кгс/см²)	32(320)	32(320)	32(320)
Номинальная мощность, кВт	3,3	13,6	27
Масса (без рабочей жидкости), кг	21	48	48

Figure 13 - Non-adjustable axial piston pump-motor NA 1.50/32.

Table 15. Main meanings characteristics

Наименование параметра	Величина
	насос
Рабочий объем, см³	50
Частота вращения, с-1 (об/мин)	25(1500)
Подача, л/мин	67,5
Давление на выходе, МПа (кгс/см²)	25(250)
Давление на входе, МПа (кгс/см²)	0,15(1,5)
Масса (без рабочей жидкости), кг	14,5

The rack profile for plasterboard is used for the main vertical racks in plasterboard structures. The rack profile is made by rolling steel strips through a profile bending machine. The standard size of the finished product is 300 cm, when ordering non-standard products, the profile can have a length of 350, 400 cm. (Figure 14)

The rack profile has three types of sizes depending on the area of application.

The 50*50mm rack profile has a small wall size, which allows it to be used in small rooms to level walls or hide wires (Figures 15-24).

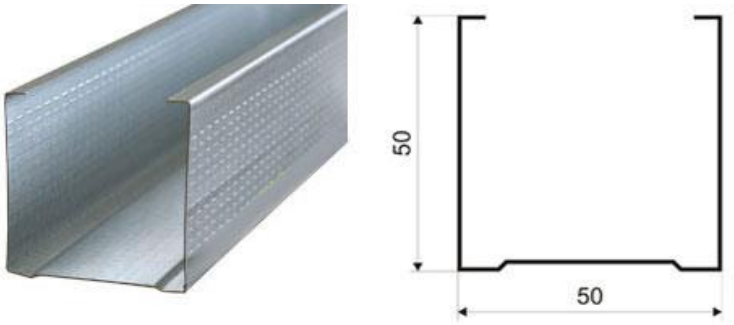

Figure 14 - Rack profile 50*50mm

The rack profile 75*50mm is used to strengthen the wall frame, in case of mounting heavy elements on the wall (Figure 16).

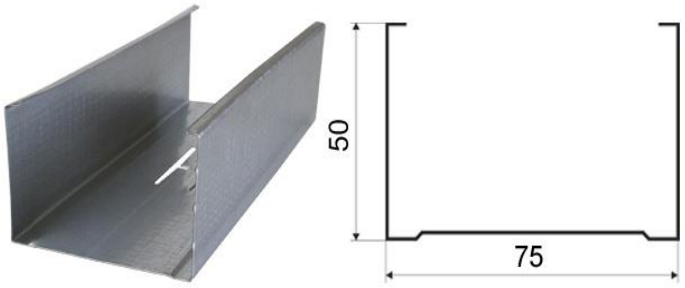

Figure 15 - Rack profile 75*50mm

The rack profile 100*50mm is used for insulating walls with insulation, due to the large size of the wall (Figure 16).

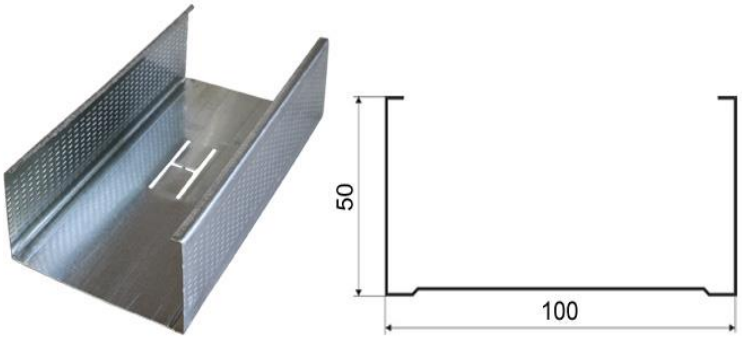

Figure 16 - Rack profile 100*50mm

The guide profile for plasterboard is used to strengthen the frame of walls and ceilings. The guide profile is installed simultaneously with the rack profile, taking into account the dimensions of the shelf, which allows you to install a strong frame. The guide profile also has three types of sizes.

Guide profile 50*40mm is used for low loads on the frame (Figure 17).

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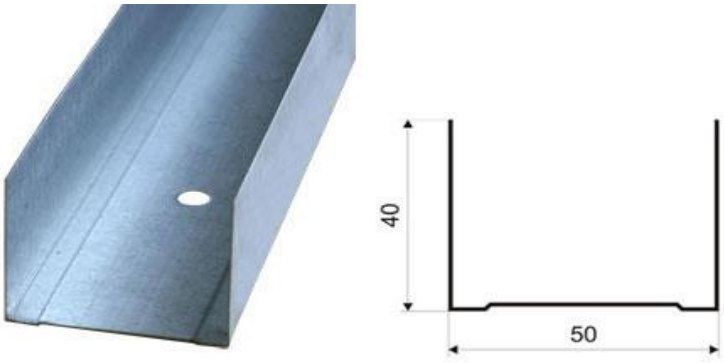

Figure 17 - Guide profile 50*40mm

The 75*40mm guide profile is used as a lintel in frames (Figure 18).

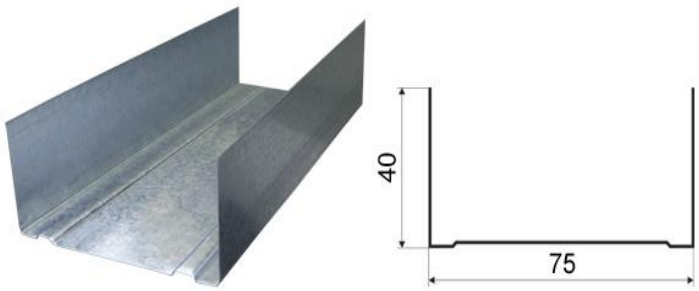

Figure 18 - Guide profile 75*40mm

Guide profile 100*40mm is used to strengthen the frame under heavy loads (Figure 19).

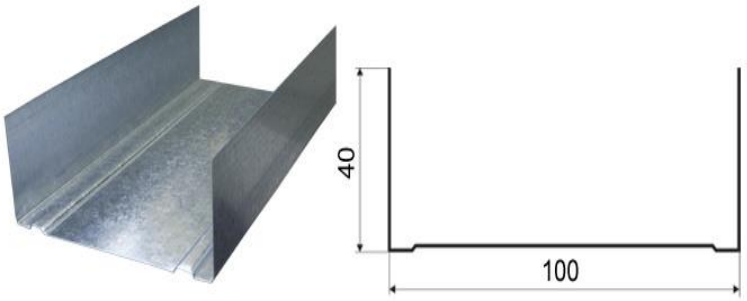

Figure 19 - Guide profile 100*40mm

The ceiling profile is the basis for creating suspended ceiling frames (Figure 20).

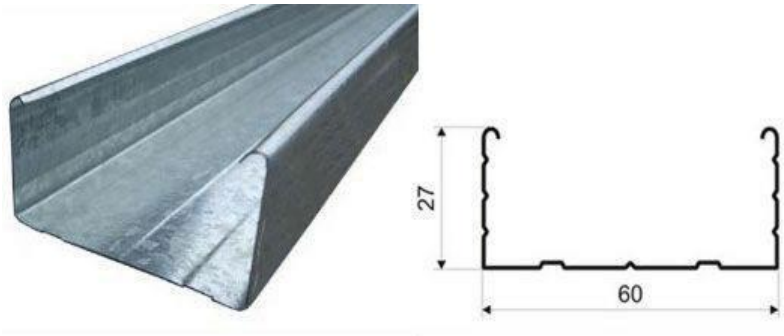

Figure 20 - Ceiling profile 60*27mm

The ceiling profile has the following dimensions: depth 27 mm, width 60 mm. The ceiling profile is similar to the rack profile. For additional rigidity, the ceiling profile has three stiffening ribs.

The ceiling guide profile has found its application in the production of ceiling lathing. It serves as the basis for the entire ceiling structure (Figure 21).

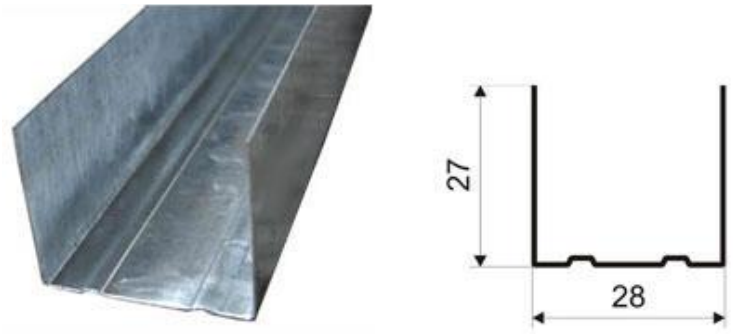

Figure 21 - Ceiling guide profile 28*27mm

The corner profile is used to protect external partition corners and wall cladding (Figure 22).

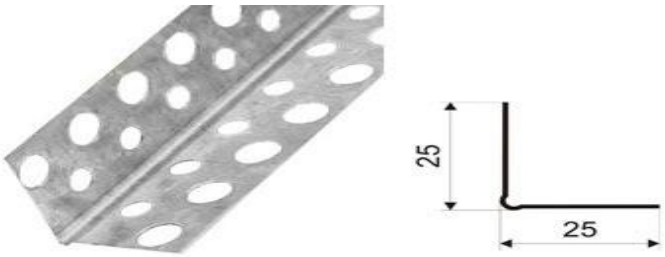

Figure 22 - Corner profile

Using a corner profile makes it easier to align the external corners of walls.

A reinforcing profile is a profile located inside the window block and serving as a reinforcing element (Figure 23).

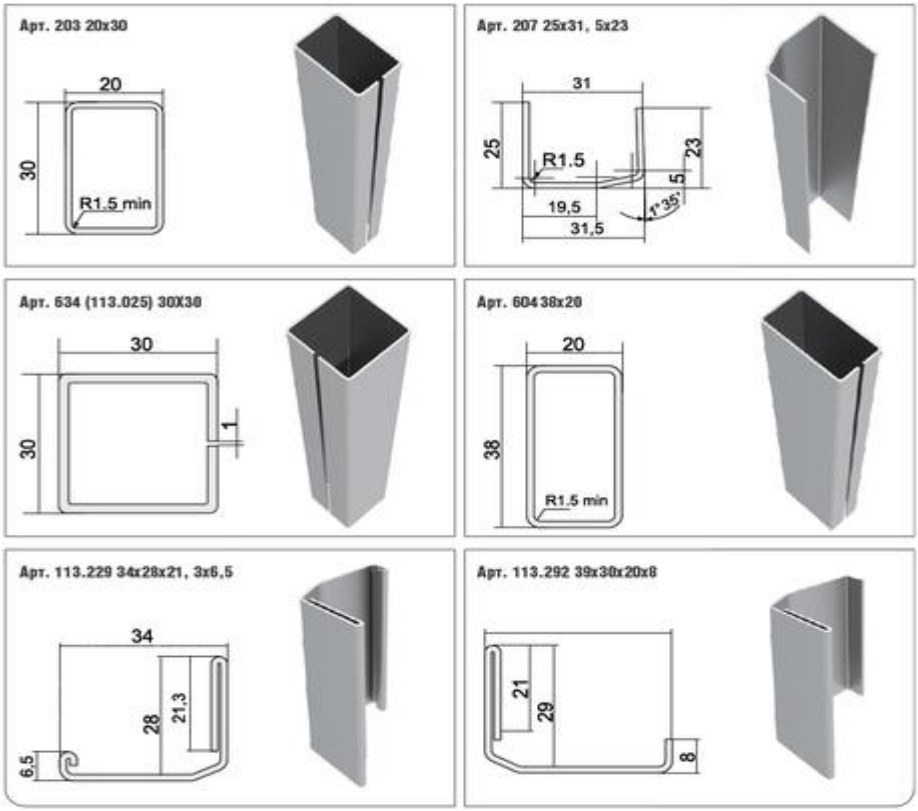

Figure 23 - Types of reinforcing profile

The reinforcing profile is necessary to provide rigidity to the window structure and to strengthen the structure under operational loads.

OOO "Shakhtinsky Profile" produces reinforcing profile in assortment, different types, sizes, thicknesses. Reinforcing profile is produced by cold rolling method from galvanized steel corresponding to all established requirements. Reinforcing profile thickness fluctuates from 1.2 to 2.0 mm.

Types of reinforcing profile assortment:

- L-shaped reinforcing profile;
- U-shaped reinforcing profile;
- reinforcing profile with square cross-section.

The rack profile is made of thin-sheet galvanized rolled steel according to GOST 14918 “Thin-sheet galvanized steel from continuous lines”, GOST R 52146 “Cold-rolled and cold-rolled hot-dip galvanized thin-sheet products with polymer coating from continuous lines”.

Galvanized steel is examined visually, without additional devices. The rack profile must be rolled from galvanized steel of class C 255 or C 345 according to GOST 27772-2015 "Rolled products for building steel structures".

According to GOST 3640-94 "Zinc. Technical conditions", steel is immersed in a container with molten zinc, as a result of a chemical reaction, steel and zinc adhere. Galvanized steel is resistant to corrosion.

Inspection of the edges when cutting galvanized steel for the production of rack profiles is used to control delamination of the rolled product.

The quality of the rack profile coating is checked visually. The following profiles are not allowed:

- having a crushing of the bends of the shelves of the rack profiles;
- having a curvature of the profile shelves;
- having a damaged zinc coating;
- having dents on the shelves and walls of the rack profiles more than 3 mm;
- having burrs protruding more than 1 mm at the ends and edges of the rack profiles.
- Deviations in the shape of rack profiles are measured: with a measuring ruler according to GOST 427, a metal measuring tape according to GOST 7502, and a caliper according to GOST 166.

Deviations from plane and straightness are measured along the entire length of the profile or over a length of 1000 mm. The waviness and deflection of the profile are determined by the maximum value between the flat surface and the lower surface of the rack profile or between the upper surface and the adjacent plane or a straight line parallel to the plane of the surface. Such measurements of deviation of rack profiles are performed in the following ways:

- using a measuring ruler, caliper or feeler gauge applied to the end of the profile in a vertical position;
- using a rigid steel ruler adjacent to the upper surface of the profile, in a vertical position;
- using a tensioned steel string adjacent to the upper surface of the profile, in a vertical position;

The difference in thickness of profiles is determined by the difference between the largest and smallest values of the profile thickness at a given distance from the edge.

Convexity and concavity are determined by the maximum distance between the surface of the rack profile and the adjacent horizontal or vertical plane in any cross-section along the length of the profile.

The curvature of the profile is determined using a ruler or a stretched steel string and the distance between the profile surfaces.

The deviation from the symmetry of the profile shape is measured by the difference in the distances of the opposite extreme points lying on the profile surface from the axis of symmetry. The deviation from the symmetry of the profile is measured with a ruler and a square."

The twist angle around the longitudinal axis per meter of the length of any section of the profile shall not exceed 2; the tangent of the twist angle is determined by the ratio of the deviation of the end of the profile shelf from the basal plane to the length of the profile. The maximum deviation of the angular dimensions of the cross-section of the profile is ±1.5. The permissible smooth longitudinal curvature relative to any plane on any section of the profile 1 m long is no more than 2 mm. For profiles with a cross-sectional area of less than 0.5 cm2, the permissible longitudinal curvature on any section 1 m long is no more than 4 mm. The total curvature and angles of the calibrated profiles are presented in Table 16.

Table 16. Limit deviations of the values of the radii of rounding of profile corners

Radius of profile corners, mm	Maximum deviations of corner rounding radii, mm
From 1.5 to 2.0	+1.5 and -0.5
From 2.0 to 5.0	+2.0 and -0.5

Permissible deviations of the nominal overall dimensions of the profile are, in mm: +2 and -1 for nominal dimensions of 10 - 30 mm; +4.0 and -1.0 for 30 - 80 mm.

The method of bending tests of the rack profile consists of deforming the rack profile sample by bending the direction of the force until a specified bending angle is reached.

The bending test method is carried out on presses or testing machines, which include the following devices:

- a bending device with two supports and a mandrel;
- V-notch bending device with mandrel;
- bending device with a vice.

At a temperature from 10°C to 35°C, a bending test of the rack profile is carried out. At a temperature of (23 ± 5) °C, the test is carried out in the event of disagreement in the assessment of the quality of the rack profile.

Bending tests of the rack profile can be carried out in three ways:

- applying force to the rack profile until a specified bending angle is reached;
- applying force to the rack profile until the sides of the sample are parallel;
- applying force to the rack profile until the sides of the sample come into contact.

All types of bending tests are carried out with a continuously increasing force on the sample of the rack profile, to ensure plastic flow of the metal product. If these methods do not bend the rack profile to the specified angle, then the sample is bent by compressing the ends.

According to the regulatory documentation, the results of the rack profile bending are assessed. If there are no such indications in the regulatory documentation, the rack profile is assessed visually. There should be no cracks on the sample that has passed the test."

According to GOST 9.401-91 "Unified system of protection against corrosion and aging of materials and products. General requirements and methods of accelerated testing for resistance to the effects of climatic factors", the rack profile undergoes a series of tests on various equipment.

Methods of testing various factors of influence on the surface of a rack profile sample:

- cold chamber, it provides a test mode with deviations not exceeding those specified in this standard. In the cold chamber, the sample
- the rack profile is kept for 2 hours at a temperature of minus (60±3) °C, if the adhesion of the coating by the lattice cut method is no more than point 3 GOST 15140 the sample of the rack profile passed the test;
- salt spray chamber. Sodium chloride is sprayed in the chamber at a temperature of (35±2) °C. At an angle of 20°±5° to the vertical with the test surface facing upwards at a distance of at least 20 mm from each other, at least 100 mm from the walls, and at least 200 mm from the bottom of the chamber. A sample of the rack profile is placed in the salt spray chamber and kept for at least 240 hours at a temperature of (35±2) °C and a sodium chloride concentration in the continuously sprayed solution of (50±5) g/dm^3;
- a salt fog chamber containing sodium chloride and sulfur dioxide to create a corrosive active environment. The rack profile samples are placed in the salt fog chamber at an angle of 45° and are exposed to salt fog with aggressiveadditives obtained by spraying a solution with a sodium chloride concentration of (50±5) g/dm^3 and sodium sulphite with a concentration of (10±1) g/dm^3, at a temperature of (35±2) °C for 4 hours. From the salt fog chamber, the rack profile samples are transferred to a solar radiation chamber and kept under the influence of xenon lamps with an integral surface radiant flux density of (1125±140) W/m^3 and a temperature of (55±2) °C, for 16 hours. From the solar radiation chamber, the rack profile samples are transferred to the humidity chamber and maintained at a temperature of (55±2) °C and a relative air humidity of (95±3)% for 16 hours. Then, over the course of 1 hour, the temperature in the chamber is lowered to (45±2) °C and the rack profile samples are maintained at a relative air humidity of (97±3)% for 38 hours. From the humidity chamber, the samples are transferred to a salt fog chamber and exposed to salt fog obtained by spraying a solution with a sodium chloride concentration of (50±5) g/dm^3 at a temperature of (35±2) °C for 4 hours. From the salt fog chamber, the samples are transferred to the humidity chamber and kept attemperature of (60±2) °C and relative air humidity less than 50% for 2 hours, then at relative air humidity of (95±3)% and temperature of (55±2) °C, for 8 hours. From the humidity chamber, the samples are transferred to the cold chamber and kept at a temperature of minus (40±2) °C for 6 hours. The samples are removed from the cold chamber and kept in air at a temperature of 15-30 °C and relative air humidity of no more than 80% for 2 hours. The cycle is repeated at least 4 times. A fresh solution is prepared for each spray cycle. The concentration of sulfur dioxide in the atmosphere of the test chamber should be (40±10) mg/m^3;
- humidity chamber, ensures a test mode with deviations not exceeding those specified in this standard. At a temperature of (40±2) °C and a relative air humidity of (97±3)%, the rack profile samples are kept for 1 hour in the humidity chamber, then kept for 2 hours without heating. From the humidity chamber, the rack profile samples are transferred to an artificial weather apparatus operating in mode 3-17, and kept for 2 hours. The rack profile samples are removed from the artificial weather apparatus and kept in air at a temperature of 15-30 °C and a relative air humidity of no more than 80% for 19 hours. The cycle is

repeated at least 5 times."

These tests allow us to check the quality of the zinc coating on the steel and the resistance of the surface quality of the rack profile to corrosion and aging.

The rack profile was chosen as the object. Due to the fact that the rack profileis not included in the "Unified list of products subject to mandatory assessment (confirmation) of conformity within the Customs Union (EAEU) with the issuance of uniform documents", therefore it is subject to confirmation of conformity in the GOST R system.

The declaration of conformity is proof that the product meets all requirements imposed on it and is safe.

Based on evidence provided by the supplier or manufacturer, confirmed by an independent examination, the declaration of conformity (declaration of conformity) is accepted by the manufacturer or supplier of the products. The accepted declaration is registered by certification bodies accredited in the GOST R certification system. The period for registering the declaration of conformity (declaration of conformity) is set by the manufacturer or supplier of the products. The period for registering the declaration of conformity is calculated from the date of manufacture of the products or the validity period of the accompanying documentation.

The declaration of conformity is concluded by Russian manufacturers or foreign organizations registered as legal entities in the Russian Federation.

The following documents may serve as evidence on the basis of which the declaration of conformity was adopted:

- protocols of control tests of products carried out by the manufacturer of the products or third-party organizations;
- test reports for raw materials, materials, components or certificates of conformity;
- sanitary and epidemiological reports, fire safety certificates, veterinary certificates and other documents;
- certificates confirming the quality or production system;
- other documents confirming the conformity of the products with established requirements.

When testing the rack profile, deviation from the shape, thickness variation, bending strength of the rack profile, corner rounding radius, resistance of the rack profile coating to corrosion and aging are checked. The indicators confirmed when declaring the rack profile are presented in Table 17.

Table 17. List of indicators confirmed when declaring conformity of a rack profile

Name of indicator, units. change	Normative document	Normative value
1	2	3
1 Deviation from shape, mm thickness variation	GOST 427 GOST 7502 GOST 166	from ±0.10 to ±0.20 from ±0.4 to ±0.14 from ±0.05 to ±0.08
2 Bending strength	GOST 14019-2003	The samples must withstand the load without destruction or cracking.
3 Corner rounding radius: - radius from 1.5 to 2.0 - radius from 2.0 to 5.0	GOST 10948	 ±1.5 and -0.5 ±2.0 and -0.5
4 Corrosion and aging of metals.	GOST 9.401-91	Samples must withstand tests in a cold chamber, a salt spray chamber, and a humidity chamber without the formation of corrosion or signs of aging.

Metall-Stroy LLC provided the following documents to the certification body to confirm the conformity of the rack profile:

- certificate of registration OGRN and certificate of registration with the tax inspectorate INN;
- charter of the organization;
- lease agreement for industrial premises;
- organization details;
- a list of regulatory documents in compliance with which the products were manufactured;
- certificates of conformity for raw materials for the manufacture of products;
- sanitary and epidemiological conclusion on the product.

The rack profile is a product made of galvanized steel, which is widely used in the construction industry. Accordingly, very high requirements are

imposed on the rack profile, such as strength, safety, durability. The safety of people's lives directly depends on the quality of the rack profile. Confirmation of compliance guarantees consumers that the product is of high quality, inspiring confidence.

Confirmation of compliance of the rack profile serves as a guarantee that the manufacturer, LLCMetal - Construction" is confident in the quality of its products (rack profile), and the organization LLC "Metal - Construction" is responsible and values her reputation.

In order to improve the process of confirming the conformity of the rack profile and the quality indicator of the products, it is recommended for OOO Metall-Stroy to conduct a voluntary confirmation of conformity of the product safety. In this case, the manufacturer will receive a voluntary certificate of conformity to GOST R.

Voluntary confirmation of conformity provides additional opportunities to gain a foothold in the market. Voluntary confirmation of conformity serves as proof of the organization's honest work and production of quality products.

The main advantages of voluntary certification of rack profiles at Metall-Stroy LLC are:

- high quality of products due to control and compliance with the technological production process;
- reduction of costs for product quality by eliminating defects;
- high production efficiency due to repetitive processes;
- increasing the responsibility and discipline of personnel.

Products that have received a certificate of conformity are subject to inspection control. Control is carried out in the form of scheduled and unscheduled inspections by the certification body that carried out the certification of the product (rack profile).

Products that have received a certificate are marked with a conformity mark. The conformity mark of voluntary certification is shown in Figure 24.

Figure 24 - Voluntary certification conformity mark

The key to success and quality assurance for Metall-Stroy LLC is the implementation of recommendations for improving the confirmation of compliance of the rack profile, and passing voluntary certification.

At Metall-Stroy LLC, the quality manual is the main defining document of the quality management system and describes it in accordance with the requirements of GOST R ISO 9001: 2015.

The quality management system of Metall-Stroy LLC includes:

- the management structure of the Managing Director of Metall-Stroy LLC and the management structure of the structural divisions of Metall-Stroy LLC;
- processes of the Quality Management System of Metall-Stroy LLC, their application, sequence and interaction;
- documentation of the Quality Management System of Metall-Stroy LLC, containing the requirements in accordance with which the personnel perform activities in the area of quality, and records confirming the fulfillment of these requirements;
- resources necessary for the effective and efficient functioning of the processes and quality management system of Metall-Stroy LLC as a whole.
- The main processes of the quality management system are:
  - product design and development;
  - drawing up a production plan;
  - production;
  - control and testing of products;
  - packaging and storage of products;
  - sale;
  - procurement;
  - provision of resources;
  - conducting marketing research.

The quality manual aims to apply the "process approach" in developing, implementing and improving the effectiveness of the quality management system in order to increase customer satisfaction by meeting customer requirements.

The enterprise quality management system is designed to solve the following main tasks:

- ensuring the quality of developed and manufactured products that meet consumer requirements;
- providing the customer with confidence that the developed and manufactured products comply with the requirements of standards, technical specifications, technical specifications, and contracts for the development and production of products;
- improving the activities of the enterprise to increase the quality of developed and manufactured products and to prevent the occurrence of discrepancies between product characteristics and specified requirements;
- stable level of quality of manufactured products and technological processes of their production;
- implementation of interrelated organizational and technical measures to ensure quality at the stages of the product life cycle;
- implementation of measures to protect state secrets.

The purpose of the consumer satisfaction study is to determine the degree of consumer satisfaction with the manufactured products, and to make decisions and take measures to improve it.

The level of consumer satisfaction with the quality of manufactured products is an important criterion for the effectiveness of the quality management system.

Customer satisfaction is measured by collecting and analyzing relevant information, including customer feedback.

Based on the results of measuring customer satisfaction, a report on the Analysis of the Quality Management System is prepared by senior management.

Consumer complaints, such as perceptions of dissatisfaction, are collected and processed by the marketing and quality departments.

The presence of defects in production was caused by a number of reasons:

- violation of compliance with the rules and regulations of the internal regulatory documentation of the enterprise;
- the products were not manufactured in accordance with the design documentation.

To solve this problem, it is necessary to strictly adhere to the rules in production in accordance with the design documentation. To achieve the greatest efficiency of production and minimize the amount of defective products manufactured by the enterprise, it is necessary to develop a standard.

To improve the quality of manufactured products, the enterprise must have its own quality management system. In most cases, top management implements ISO 9000 series standards, pursuing one of two main goals:

- - using them as a means of ensuring increased efficiency of the enterprise's activities, and then, as necessary, certification of the quality management system for compliance with the requirements of the standards;
- - their implementation for the purpose of certification of the quality management system.

Development of measures to reduce the release of non-conforming products and defects at Metall-Stroy LLC and corrective and preventive actions to reduce defects.

In order to improve the quality management system of LLCMetal - Construction" it was proposed to implement the STO QMSXX. XXX-2017«Analysis of the reasons for receiving non-conforming products and defects from Metall-Stroy LLC and development of corrective and preventive actions."

Table 18 shows the characteristics of defects and the reasons for their occurrence in the rack profile of the PS 50/50 brand.

Table 18. List of defects of rack profile PS 50/50

Item No.	Type of defect in the rack profile	Characteristics of the defect	Cause of the defect	Method of eliminating the defect
1	2	3	4	5
1	Deviation from form	Different distance between the part and the plane along the length of the product	Failure to comply with the parameters for the rack profile brand PS 50/50	They are eliminated by cold straightening in a stamp or manually with adjustment according to a template.

2	Thickness variation	Different thickness at a given distance from the edges	Insufficient amount of material used when rolling out the sheet	It is not corrected
3	Corrosion	Destruction of the surface layer of the part	Poor zinc plating of metal	It is not corrected
4	Twisting	Deviation of the axes and planes of a part from their correct geometric position	Failure to comply with the parameters for the rack profile brand PS 50/50	They are eliminated by cold straightening in a stamp or manually with adjustment according to a template.
5	Convexity, concavity	Different distance between the part and the plane along the length of the product	-	-
6	Deviation from the angle	The difference between the actual angle and the given one	Failure to comply with the parameters for the rack profile brand PS 50/50	Compliance with technical requirements
7	Hangnail	Uncut flashing residue	Poor installation and adjustment of dies	Removed by sharpening with an emery wheel
8	Curvature	Deviation of the axes and planes of a part from their correct geometric position	Failure to comply with the parameters for the rack profile brand PS 50/50	The curvature is corrected by cold straightening in a stamp or manually with adjustment according to a template.
9	Undercooking	Failure to fuse individual layers of the weld together during multilayer welding	Violation of welding conditions, low qualification of the welder	Cleaning and applying a new suture

Violation of compliance with the rules and regulations of the internal regulatory documentation of the measurement enterprise leads to the production of defective products. The efficiency of design and development of products depends not only on the equipment and software used, but also on the qualifications and professionalism of the personnel employed in the design bureau.It is necessary to introduce information on how to minimize defects in production.

The feasibility of developing a draft standard is confirmed by a justification of economic efficiency.

By properly organizing the process of managing non-conforming products, it becomes possible to reduce costs for products with deviations or defective products by timely detection and correction of non-conformities.

The standard is intended for production, responsible for the quality of manufactured products. STO defines the general procedure for managing non-conforming products, as well as conditions that ensure the identification, registration, analysis and decision-making on non-conforming products, taking into account the requirements of the interstate standard GOST ISO 9001-2015 in order to protect the consumer from products of inadequate quality.

Among the statistical methods of quality control, the most common are the so-called seven tools of quality control: Pareto diagram, Ishikawa cause and effect diagram, control chart, histogram, scatter diagram, stratification method and checklists.

To solve all sorts of problems related to the appearance of defects, equipment malfunctions, an increase in the time from the release of a batch of products to its sale, the presence of unsold products in the warehouse, and the receipt of complaints, the most effective method is the Pareto diagram.

The Pareto diagram allows you to distribute efforts to resolve emerging problems and establish the main factors from which you need to start acting in order to overcome emerging problems. Tables 19 and 20 present data for constructing Pareto diagrams for 2024 and a preliminary calculation for 2025, respectively.

Table 19. Data for constructing a Pareto diagram of product defects for 2024.

Defect	Number of defects	Accumulated share of defects, %	Cumulative percentage, %
1	2	3	4
Twisting	70	35,00	35,00
Convexity, concavity	50	25,00	60,00
Deviation from form	18	9.00	69,00
Curvature	15	7.50	76.50
Undercooking	12	6.00	82.50
Corrosion	9	4.50	87,00
Hangnails	5	2.50	89.50
Thickness variation	3	1.50	91,00
Deviation from a right angle	2	1.00	92,00
Others	16	8.00	100
Total	200	-	-

Table 20. Data for constructing a Pareto chart of product defects for 2025 (expected)

Defect	Number of defects	Accumulated share defects, %	Cumulative percentage, %
1	2	3	4
Twisting	25	31.25	31.25
Convexity, concavity	20	25,00	56.25
Deviation from form	10	12.50	68.75
Curvature	10	12.50	81.25
Undercooking	5	6.25	87.5
Thickness variation	2	2.50	90,00
Deviation from a right angle	1	1.25	91.25
Others	7	8.75	100
Total	80	-	-

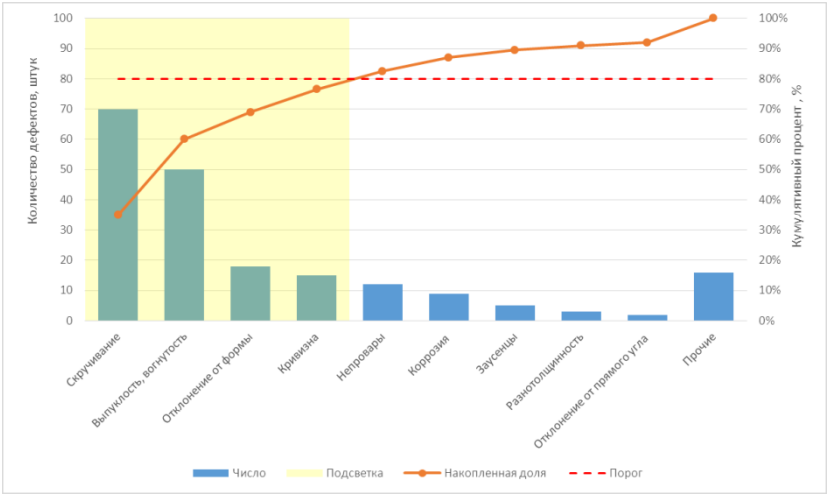

Figure 25 – Pareto diagram for product defects manufactured by LLC “Metal - Construction» for 2024.

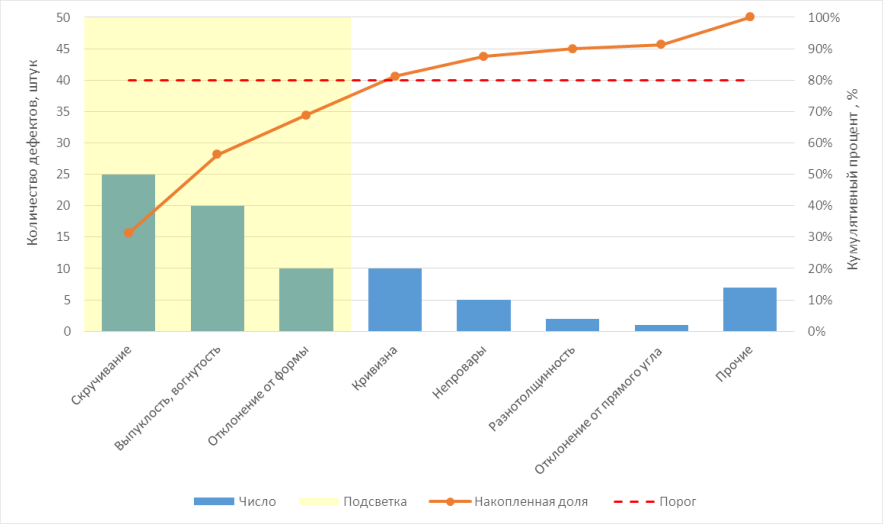

Figure 26 – Pareto diagram for product defects manufactured at LLC "Metal - Construction» for 2025. (expected)

According to the chart, the most common defects in manufactured products in 2024 were twisting, convexity, concavity, deviation from shape and curvature. Other defects include scratches, cavities, bulges, scratches, cracks, bubbles, etc.

An analysis of the Pareto diagram construction was conducted. For 2025, it was found that the number of defective products decreased, but the most common defects remained, as before, twisting, convexity, concavity, deviation from shape and curvature. Defects such as corrosion and burrs were completely eliminated. As a result of the implementation of STO to reduce defective products, it is clear that its number has significantly decreased.The effectiveness of the developed measures within the QMS to reduce the production of low-quality products is given and calculated at the end of the article.Don-Tex LLC is also a modern, highly developed enterprise for the production of soft containers for industrial bulk cargo. The enterprise manufactures high-tech products that are competitive and in demand in the CIS markets.

Soft specialized containers are large polypropylene bags with lifting elements in the form of slings and are intended for transportation by all types of transport and intermediate storage at temperatures from minus 25 to plus 60 of various bulk cargoes.

Soft containers consist of woven polypropylene shells and polyethylene (polypropylene or made of multilayer film) liners. Containers must be manufactured in accordance with design documentation and process flow charts. (Figures 27-33).

Containers must be manufactured in accordance with TI.Sh.09.12-3.2015-03 "Technological instructions for the manufacture of soft containers for bulk products from polypropylene fabric using "seamless" technology".

The shells of soft containers must be made from blanks by joining them on sewing machines with polypropylene sewing thread. The ends of the seams must be secured with a braid, no less than 2 cm but no more than 6 cm long. The strength of the sewing threads and the type of seam must ensure the required safety factor of the soft containers.

Soft containers made of polypropylene fabric include:

- single-sling soft containers;
- single-sling soft containers in a protective shell;
- two-sling soft containers;
- four-sling soft containers.
- Single-sling soft containers.

The shell of the single-sling soft container is made of UV-stabilized polypropylene fabric. The loading volume is from 400 to 2100 l. The sling of the soft container is assembled with a cuff made of colored polypropylene laminated fabric. Five-color printing on the shell is possible.

The design can be equipped with a lower unloading hatch, the top - with an assembly or loading neck. It is possible to complete with polyethylene liners, including those made in a design with a formed neck, as well as special properties (heat-resistant, antistatic). Complete set of soft containers with polyethylene liners (including heat-resistant and antistatic) and protective polyethylene covers.

Figure 27 – Single-sling soft containers

Single-sling soft containers in a protective shell.

The load-bearing shell of the soft container is made of UV-stabilized polypropylene fabric. It is equipped with polyethylene inserts, made in a design with a formed neck. The protective shell of the soft container is made of polyethylene tubular film, and also has a formed neck. Loading volume from 400 to 2100 l. The sling of the soft container is assembled with a cuff made of colored polypropylene tubular fabric. Five-color printing on the shell is possible.

Figure 28 – Single-sling soft containers in a protective shell

Two-sling soft containers.

The soft container shell is made of UV-stabilized polypropylene fabric. The loading volume is from 500 to 2240 l. The slings of the soft container are assembled with cuffs made of colored laminated polypropylene fabric. Five-color printing on the shell is possible. The design can be equipped with a lower unloading hatch, the top - with an assembly or a loading neck. It is possible to complete with polyethylene inserts, including those made in a design with a formed neck, as well as special properties (heat-resistant, antistatic).

Figure 29 – Two-sling soft containers.

Four-sling soft containers.

The load-bearing shell of this type of soft container is made of polypropylene UV-stabilized tubular fabric and has four load-bearing slings, which are an extension of the container body. The slings are formed by cuffs made of contrasting colored polypropylene laminated fabric. The upper part of the soft container can be made with a stitched assembly of polypropylene laminated fabric, providing protection for the products in the container. Polyethylene inserts can be supplied. Five-color printing on the shell is possible. Loading volume from 600 to 1800 l.

Soft belt containers include:

- four-sling soft containers with sewn-in slings;
- four-sling soft containers with overhead slings;
- four-sling soft antistatic containers;
- four-sling soft frame containers;
- Double-sleeved soft containers.

Four-sling soft containers with sewn-in slings.

This model is the most common and widely used type of four-sling soft containers. The load-bearing shell of this type of soft container is made of single-layer polypropylene (polypropylene laminated) UV-stabilized fabric.

Four belt load-bearing elements are made of polypropylene technical sling tape and are sewn into the corners of the shell.

It is possible to complete the package with polyethylene inserts, including those made in a design with formed necks, with a lower and upper shell hatch. Loading volume up to 1800 l. Five-color printing on the shell is possible.

Four-sling soft containers with overhead slings.

This model is one of the versions of a four-sling soft container with a tape type of slings. The load-bearing shell of this type of soft container is made of single-layer polypropylene UV-stabilized fabric. Four tape load-bearing elements are made of polypropylene technical sling tape and stitched through the corners onto the polypropylene shell. It is possible to complete the set with polyethylene inserts, including those made in a design with formed necks. The loading volume is from 500 to 2000 l. It is possible to apply five-color printing on the shell.

Figure 30 – Four-sling soft containers with sewn-in slings

Figure 31 – Four-sling soft containers with overhead slings

Four-sling soft containers antistatic.

The soft container shell is made of single-layer polypropylene laminated UV-stabilized fabric with conductive threads. They are intended for bulk or granular materials that generate electrostatic discharges during filling or transportation of the container. Loading volume from 500 to 1200 l. Slings made of polypropylene tape are sewn into the corners.

It is possible to complete the package with polyethylene inserts, including those made in a design with formed necks, with a lower and upper shell hatch. The diameter of the loading and unloading hatches is from 30 to 60 cm. Five-color printing on the shell is possible.

Figure 32 – Four-sling soft antistatic containers

Protective inserts.

The protective wagon liner (VVZ) is designed to protect bulk cargo from adverse environmental impacts, maintain the marketable appearance of products in bags (soft containers), and protect the vehicle and road surface from spills and leaks of aggressive chemicals.

The VVZ is a soft box that follows the shape of a gondola car and is equipped with end and side covers with loops and ties for fastening. It is made in various combinations from polypropylene fabric in accordance with the dimensions of the vehicle (gondola car) and the functional purpose of the VVZ.

Figure 33 – Protective inserts

Table 21. Characteristics of defects of disposable soft containers

Type of defect	Characteristic
1	2
Knotting	a fabric defect characterized by a disruption of the structure and integrity of the weave due to the entanglement of broken ends of the thread
White	a fabric defect characterized by the absence of one or more warp threads, the defect is expressed by the doubling of the threads. On the surface of the fabric it stands out as a compaction of color (a whiter stripe the width of 1 thread)
Massive break	simultaneous breaking of multiple threads, both warp and weft.
"Spreading" the warp threads	strips with a reduced base density.
"Prickly" surface of the fabric	"rough" surface of the fabric, expressed by splitting of the weft thread.
Oil stains, dirt stains	irremovable contamination
Nodes	simultaneous "slip" (end of thread on bobbin) of warp and weft threads. Multiple breakage of single warp threads per 1 running meter of fabric.
Undershoots	stripes across the entire width of the fabric, having a reduced density along the weft
Weld edge shear	tearing of the outer warp threads from the edge of the fabric, observed at the end of the roll.
Surface defect (horizontal "fold")	uneven tension of the fabric on the product shaft.
Flight	a fabric defect characterized by the absence of the weft thread across the width of the fabric (partially or completely).
Unburnt thread	the warp thread in some places is not intertwined with the weft threads and protrudes from the surface of the fabric, lying freely above the canvas
Thread "Different Tones" Defect	different intensity of colour obtained in dyeing or printing of printed and plain-dyed fabrics.
Extractor hood	non-perpendicular arrangement of weft threads to warp threads

Violation of the rules and regulations of the internal regulatory documentation of the enterprise OOO Don-Tex measurements leads to the production of defective products. Table 22 provides the distribution of responsibility for eliminating defects.

Table 22. Distribution of responsibility for defect elimination

Type of defect	Regulatory documentation	Responsible for defect elimination
1	2	3

Knotting	I.Sh.09.5-1.2015-02	Head of Production
White	I.Sh.10.23-1.2017-04	Head of Production
mass break	Pm.Sh.09.47-1.2009-11	Head of Production
"Spreading" the warp threads	I.Sh.09.5-1.2015-02	Head of Production
"Prickly" surface of the fabric	Pm.Sh.09.47-1.2009-11	Head of Production
Oil stains, dirt stains	I.Sh.10.23-1.2017-04	Head of Production
Nodes	I.Sh.10.23-1.2017-04	Head of Production
Undershoots		Head of Production
Weld edge shear	I.Sh.09.3-1.2015-02	Head of Production
Surface defect (horizontal "fold")	I.Sh.09.3-1.2015-02	Head of Production
Flight	I.Sh.13.2-1.2015-03	Head of Production
Unburnt thread	I.Sh.09.3-1.2015-02	Head of Production
Thread "Different Tones" Defect	I.Sh.09.3-1.2015-02	Head of Production
Extractor hood	I.Sh.13.2-1.2015-03	Head of Production

Underbraiding, warp thread "spacing", weld edge crumbling, horizontal "fold" surface defect, unpunched thread, "different tone" defect of threads. This list of defects is related to the violation of the standards of I.Sh.09.5-1.2015-02 "Production of Products". The products were not manufactured in accordance with the design documentation. The person responsible is the production manager. To solve this problem, it is necessary to strictly adhere to the rules in production in accordance with the design documentation.

Whiteness, oil stains, knots, undercuts. This list of defects is related to the violation of the standards of the process ISh 10.23 – 1.2017 – 04 “Procedure for quality control of containers manufactured using “seamless” technology by a quality controller”. Violations were observed during the production of products. Responsible: head of the design bureau. Measures to eliminate: improving the qualifications of personnel, more thorough verification of the developed design documentation by the quality control department.

The procedure IOT.Sh.22-2.18-1.2017-01 "Quality Control Organization" is responsible for quality control. In case of non-compliance with this procedure, design documentation that does not meet the required requirements is allowed into production.

The process I.Sh. 10.23 – 1.2017 – 04 “Procedure for quality control of containers manufactured using “seamless” technology by a quality controller” and the procedure I.Sh.09.5-1.2015-02 “Production of products” require strict adherence and revision to achieve the greatest production efficiency and minimize the amount of defective products manufactured by the enterprise.

Criteria for ensuring process effectiveness:

- development deadlines (in accordance with the annual plan);
- compliance with regulatory requirements;
- compliance of the prototype with the requirements of the technical specifications;
- absence of claims from consumers and the prototype (acceptance committee report).

The efficiency of product design and development depends not only on the equipment and software used, but also on the qualifications and professionalism of the employees in the production department.

It is necessary to implement information on how to minimize defects in production. To do this, it is necessary to follow the following algorithm:

- The first step is to make a table indicating all cases of defects at the enterprise. For indicative statistics, it is recommended to analyze data for at least a year.
- the second step is to combine similar causes of manufacturing defects into a common group. By identifying a group of similar causes of defects, it will be possible to calculate the number of cases for the period, as well as the losses from them.
- The third step is to conduct an analysis. Usually, after grouping, it turns out that only a few identical causes are regularly repeated, leading to the main share of production defects.
- The fourth step is to select the cause of defects at the enterprise with the maximum number of cases and the greatest losses.
- the fifth step is to reduce or eliminate the likelihood of repetition of common causes of manufacturing defects. To prevent manufacturing defects in the future, it is necessary to provide conditions where repetition of the defect is physically impossible, so that the employee does not have the opportunity to repeat the error, etc.
- The sixth step is the development and implementation of a personnel motivation system aimed at reducing production defects. Possible measures include a certain amount of employee bonus deduction for the release of each ton of defective goods or for errors made.
- The seventh step is to organize a continuous quality improvement process. Individual quality indicators should be defined for each employee. As a rule, 1-3 indicators are enough.

Incoming inspection. Each worker is required to assess the quality of the blanks that come to him for

work. If it is immediately obvious that it will not be possible to make a suitable part from this blank, he does not put it into work in order to reduce the cost of defects.

The employee himself must check the quality of soft containers. If a defect is found, he must report it, there will be no punishment.

Interoperational control. It is carried out by a controller, an employee of the Quality Control Department. The Quality Control Department (QCD) is an independent structural division of the plant, subordinate only to the director of the enterprise. The main tasks of the QCD are to prevent the release and supply of products to the enterprise that do not meet the requirements of standards and technical conditions, approved standards, design and technological documentation, delivery conditions and contracts in terms of quality or established requirements. Quality control of products carried out by the QCD does not relieve personnel and shop managers from responsibility for the release of products that do not meet certain standards.

The Quality Control Department interacts with other departments and services to exchange information and obtain the necessary measuring and control tools. The department receives information on the results of accounting for losses from defects from the accounting department, providing in turn conclusions on the acceptance of claims, acts on defects and calculations of losses from the elimination of defects. The Quality Control Department receives technical documentation, testing instructions, calculations necessary to determine the quality of products from the technical and design departments, and from the quality management department – standards, norms, instructions and other technical documentation. The Quality Control Department notifies the former of violations of the technological process and deficiencies in technology, proposes measures to improve the technology and quality of products, and the latter – of proposals on documentation issues. The chief mechanic and chief power engineer departments supply the department with the necessary control tools and components and materials required for the repair and operation of equipment. The Sales and Marketing Department gives permission to final close boxes, containers or wagons. The department provides accompanying documents for incoming materials and components, copies of contracts with suppliers, receiving from the quality control department laboratory conclusions on the quality of incoming products, permission for their use or non-use in production.

Together with the tool shop, the QC carries out quality control of the production of ordered tools and equipment for the plant's shops. The main and auxiliary production shops provide the QC with premises for the quality control bureau, control points and defect isolators, provides equipment, tools for control, and accompanying documentation.

Punishment not for defects, but for negligence. Despite all the loyalty, the enterprise OOO Don-Tex still has certain sanctions in relation to employees. If an employee presented a batch as suitable, and the controller found a defect, punishment awaits. But the enterprise has a penalty not for the defect itself, but for the lack of proper quality control of the products, negligent attitude to work. In this case, we withhold the cost of the workpiece and the costs of the previous stages of processing from the manufacturer.

To solve all sorts of problems related to the appearance of defects, equipment malfunctions, an increase in the time from the release of products to their sale, the presence of unsold products in the warehouse, and the receipt of complaints, the Pareto diagram is used.

The Pareto diagram allows you to distribute efforts to resolve emerging problems and establish the main factors from which you need to start acting in order to overcome emerging problems. There are two types of Pareto diagrams.

Tables 23 and 24 present data for constructing Pareto charts for 2024 and 2025, respectively.

Table 23. Data for constructing a Pareto chart for 2024

Defect	Number of defects	Accumulated share of defects	Cumulative percentage
1	2	3	4
Knotting	100	12.90%	12.90%
Flight	89	11.50%	24.40%
Extractor hood	87	11%	35.60%
White	81	10.50%	46.10%
Massive break	77	9.90%	56%
"Spreading" the warp threads	74	9.60%	65.60%
"Prickly" surface	63	8.10%	73.70%
Oil stains	61	7.90%	81.60%

Nodes	43	5.50%	87.10%
Undershoots	36	4.60%	91.70%
Edge fraying	34	4.40%	96.10%
Other defects	30	3.90%	100%
Total	775	100.00%	

Table 24. Data for constructing a product defect chart for 2025 (expected)

Defect	Number of defects	Accumulated share of defects	Cumulative percentage
Knotting	37	16.20%	16.20%
Flight	30	13.10%	29.30%
Extractor hood	27	12%	41.10%
White	20	8.70%	49.80%
Massive break	20	8.70%	59%
"Spreading" the warp threads	19	8.30%	66.80%
"Prickly" surface	17	7.40%	74.20%
Oil stains	15	6.50%	80.70%
Nodes	13	5.70%	86.40%
Undershoots	12	5.20%	91.60%
Edge fraying	10	4.40%	96.00%
Other defects	9	3.90%	100.00%
Total	229	100.00%	

According to the diagram, in 2024 the most frequently encountered defects in manufactured products were defects in the underlay and spans.

OnFigures 59 and 60 showdiagrams by defect typesmanufactured products for 2024 and 2025, respectively.

In 2025, the number of defective products decreased, but the most difficult to eliminate defects were the underlayment and spans, which remained the same.

As can be seen, in 2025, as a result of the measures developed within the QMS, it was possible to reduce the percentage of products, its quantity has noticeably decreased and has a tendency to decrease the number of defects taken.

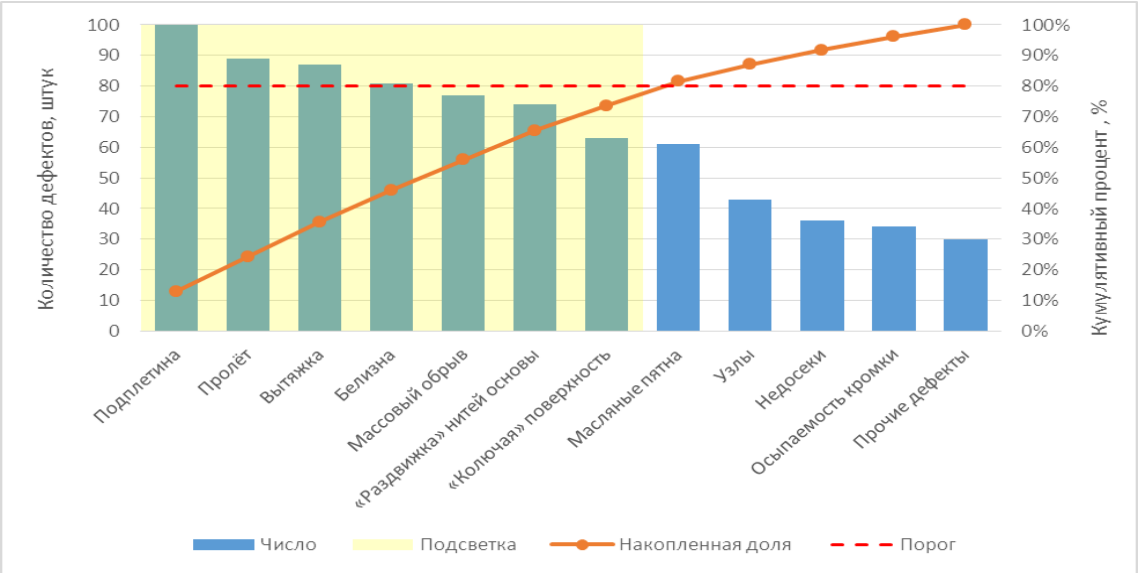

Figure 34 – Diagram of product defects manufactured by Don-Tex LLC for 2024.

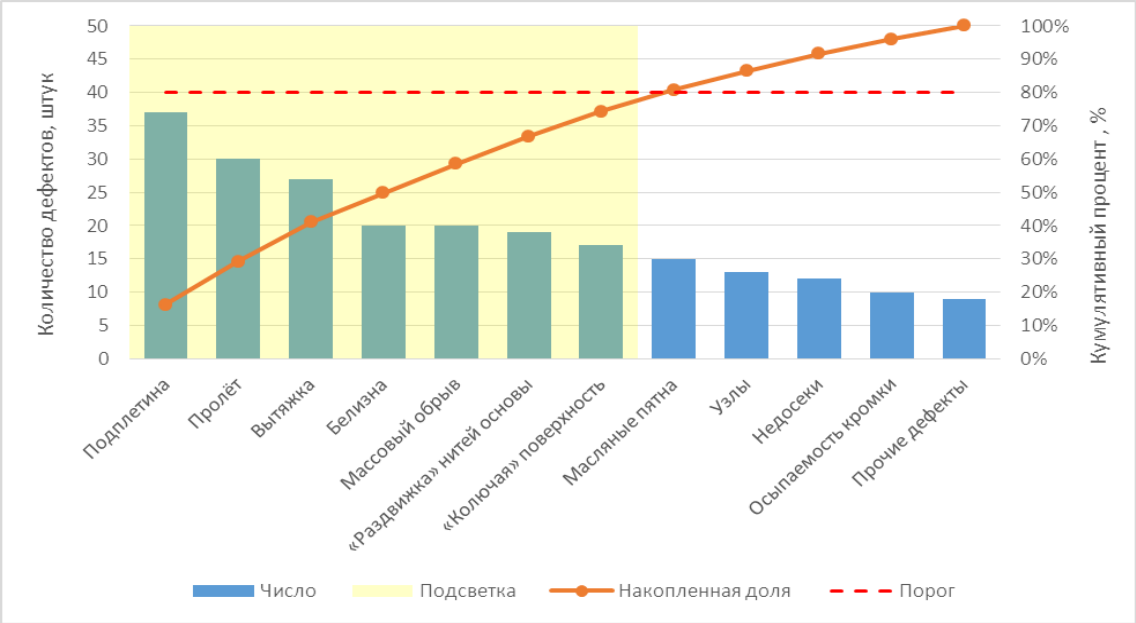

Figure 35 – Diagram of defects in products manufactured by Don-Tex LLC for 2025 (expected).

Financial and economic activities of the enterprise LLC "Metal - Construction" is a set of economic relations that arise during the formation, distribution and use of the enterprise's monetary resources.

For any enterprise, obtaining a financial result means recognition by society (the market) of the results of its activities or obtaining results from the sale of the product produced by the enterprise in the form of products, works and services.

Costs of production and sales of products take the form of cost price. Cost price of products (performance of works, provision of services) should be understood as the cost estimate of natural resources, raw materials, materials, fuel, energy, fixed assets, labor resources and other costs used in the process of production of products (performance of works, provision of services).

In order for an enterprise to obtain a financial result, it is necessary to constantly improve metrological support by introducing new measuring instruments and replacing old equipment with new, modern equipment.

The main source of the formation of the economic effect is the reduction of losses in the production system, ensured by the creation of legal, regulatory, organizational, technical and economic conditions necessary for solving the problems of obtaining this very economic efficiency.

The economic effect of conformity confirmation is an indicator expressed in physical or monetary equivalent, showing the savings in production costs as a result of product certification.

The economic effect of product certification is determined by the comparative economic efficiency method. The sources of savings, costs of developing and implementing certificates, the annual economic effect or the economic efficiency coefficient of the certificate are determined.

When confirming the technical and economic justification for improving the quality of the rack profile, when assessing the economic efficiency and analyzing certification work in accordance with current legislation, it is necessary to calculate the economic efficiency of certification work for this product.

Sources of savings can be identified at all stages of the product life cycle.

The consumer can make claims regarding the quality of the product to both the manufacturer and the certification body that issued the certificate.

Payment for certification services is made by the applicant (organization, individual who has submitted an application for the product certification procedure) using their own funds, in accordance with the Federal Law "On Technical Regulation".

In the conditions of a market economy, the issue of financing certification bodies and testing laboratories is important. Therefore, determining the cost of certification work is a pressing task for both the applicant and the certification bodies.

Types of services subject to payment when declaring conformity:

- performance of work by the certification body such as conducting an examination of documents, organizational processes, and drawing up a declaration of conformity;
- carrying out work on product testing;
- certification of the production system under a certain certification scheme for services;

• work on implementing inspection control over compliance with product quality;

• license to use the conformity mark.

The applicant's costs for declaring products (rack profile) are determined by formula 3.

$$C = Co.c. + Cu.л. + Cpc. + Cu.к. + Cd.c. \quad (3)$$

where: Co.c. – cost of work carried out by the organization for product certification, rubles;

S.l. – cost of product testing in an accredited testing laboratory, rub.;

Cpc. – costs of packaging, storage, disposal, loading and unloading operations and transportation of samples to the testing site, rubles;

S.k. – cost of inspection control over the compliance of the rack profile with the requirements of regulatory documents, rub.;

Сд.с. – cost of registering a declaration of conformity with a certification body, RUB.

The costs of the certification body for declaring the conformity of the rack profile are determined by formula 4

$$C_{O.C.} = to.c.i. \cdot T \cdot (1 + \frac{Кн.з. + Кн.р.}{100}) \cdot (1 + \frac{P}{100}), \quad (4)$$

where to.c.i is the labor intensity of confirming the conformity of products according to a certain certification scheme, man-days;

T - average daily rate of the expert, rub.;

Kn.z. - standard for accruals on wages established by current legislation, %;

Kn.r. - overhead cost coefficient, %;

P - profitability level, %.

The cost of work performed by the certification body directly depends on the labor intensity of the work and the average daily rate of the expert.

When calculating the cost of declaration work, the formula includes only those elements that correspond to the composition of the work being performed.

Let's calculate the cost of declaring a rack profile for Shakhtinsky Profile LLC, given the following data:

The cost of registering a declaration of conformity with the certification body NP "RCS "Dontest" is Sd.s. - 45,600 rubles.

The average daily rate for a certification expert is RUB 1,000.

The standard for accruals to wages established by current legislation (Book of Laws) is 30%.

Overhead cost ratio (OCR) – 250%.

Profitability level (P) – 30%.

Costs for packaging, storage, disposal, loading and unloading operations and transportation of samples to the testing site (Srs.) – 9000 RUB.

The cost of testing products in the accredited testing laboratory of Nika-K LLC is (Sil.l.) – 30,000 rubles.

The labor intensity of inspection control over the condition of products that have undergone the conformity confirmation procedure will be 15 man-days.

The total labor intensity of quality inspection control of products that have undergone the conformity confirmation procedure will be 30 man-days.

The calculation of the cost of work carried out by the certification body is determined by formula 2.

$$Co.c. = 30 \cdot 1000 \cdot \left(1 + \frac{30 + 250}{100}\right) \cdot \left(1 + \frac{30}{100}\right) = 148200 \text{ rub.}$$

Calculation of the cost of inspection control S.k, rubles for compliance of the rack profile with the requirements of regulatory documents is determined by formula 5

$$Cu.к. = Ca.q + Cu.л. \quad (5)$$

where Ca.q. is the cost of work on collecting and analyzing data on the state production, rub;

S.l. – cost of product testing in an accredited testing laboratory, RUB.

The results of the inspection calculation will be:

S.k. = 148200 + 30000 = 178200 rubles.

The total costs of the applicant for declaring the rack profile will be:

C = 148200+30000+9000+178200+45600 = 411000 rubles.

In accordance with the fact that OOO Shakhtinsky Profil has passed the declaration procedure for the rack profile, the quality of the manufactured products will be guaranteed to increase. Consequently, this will lead to a decrease in losses from defects in products, defects and complaints.

OOO Shakhtinsky Profil sells rack profiles for

the amount of 1,827,408.00 thousand rubles, the cost of one piece of rack profile is 22.00 rubles, annual output is 83,064 pieces.

If defects are found, the consumer returns the product 3%, when selling such products, the average price of one rack profile is 15.00 rubles. After declaring the rack profile, the return due to poor quality products decreased to 1.1%.

Savings from reducing defective products, RUB, amount to RUB 36,466.30 thousand.

Economic effect Ef, rub. is calculated using formula 1.6:

$$Ef = Eb - Ztek, \quad (6)$$

where Eobsh is the savings from reducing defects, rubles;

Зтек – current costs, rub.

The economic effect will be:

Ef = 411000 = 36466.30 = 374533.70 rubles.

Analyzing the obtained results, the feasibility and effectiveness of declaring the conformity of the rack profile for Shakhtinsky Profile LLC was confirmed.

Measurement information with maximum accuracy and reliability, as well as making decisions based on this measurement information.

The main objective of the economic efficiency of new measuring instruments is to improve product quality, reduce losses, and reduce operating and repair costs.

To improve measurements, testing and control, it was proposed:

- replace the outdated caliper ШЦ-П-250-0.05 with a new digital caliper ADA Mechanic 150;
- replace outdated testing machines for checking reinforcing profile bending with more modern analogs of testing machines;
- improve the qualifications of employees.

The costs of replacing obsolete testing and measuring instruments will be:

- digital caliper ADA Mechanic 150, costing 2500 rubles;
- testing machine – 250,000 rubles;
- Conducting advanced training for employees will require 14,000 rubles.

With the equipment upgrade, the quality of the reinforcing profile at Shakhtinsky Profile LLC will increase, and the number of defective and faulty profiles will decrease.

OOO Shakhtinsky Profil sells reinforcing profile for the amount of 4,600,950 rubles, the cost of one piece of reinforcing profile is 65.00 rubles, annual output is 70,783 pieces.

The consumer returned a reinforcing profile that had defects or marriage, which amounted to 2.8% of losses from low-quality products.

Implementation of recommendations for equipment replacement will reduce losses from defects and marriage to 1.1%, which will have a positive effect on the economic condition of the enterprise E, rubles, which is calculated using formula 7.

$$Э = \frac{a_1 - a_2}{100} \cdot O_p, \quad (7)$$

where α1 is the loss from defects before the implementation of measures in %;

α2 – losses from defects after the implementation of measures in %.

The reduction in losses from defects and marriage will be:

$$Э = \frac{2{,}8 - 1{,}1}{100} \cdot 4600950 = 78216{,}15 \text{ rub.}$$

Capital expenditures Zkap, rubles, for testing the reinforcing profile amount to 36,800 rubles.

Operating costs Z1 tech, rubles are 14,000 rubles,

Advanced training Z2tek, rub. – 14,000 rub.

Current costs are calculated using formula 1.8

$$Z\ tek = Z1\ tek + Z2tek. \quad (8)$$

Current costs will be:

Z tek = 14,000+ 14,000 = 28,000 rub.

The difference between savings and current costs is called the economic effect Ef, rub. and is calculated using formula 9.

$$Ef = E - Ztek \quad (1.9)$$

The economic effect will be:

Ef = 78216.15 – 28000 = 50216.15 rub.

The payback period of the capital expenditures is calculated according to the formula 10

$$Current = Cap / Eph. \quad (10)$$

The payback period will be:

Current = 36800 / 50216.15 = 0.73 years.

Annual economic efficiency Eg, rub., is calculated using formula 11

$$E\ g = Ef - En \cdot Zcap, \quad (11)$$

where En is the standard coefficient of annual

efficiency (En=0.1);

3 cap – capital expenditures.

Annual economic efficiency will be:

Eg = 50216.15 – 0.1 · 46800 = 45536.15 rub.

Conclusion

Having conducted an analysis of the annual economic efficiency, we confirmed the feasibility and justification of the proposed measures for Shakhtinsky Profile LLC to improve technical and economic indicators, namely, when implementing the recommendation to improve measurements, testing and control, production costs were reduced, the economic effect from reducing losses due to defects increased, the competitiveness of products increased, which allowed the enterprise to establish itself in the market as a reliable manufacturer of high-quality products.

Their experience of using statistical methods of quality control using the Pareto diagram has confirmed their effectiveness for developing measures by enterprises to significantly improve the quality of their products, guaranteeing their consumers safety and demand for them.

The software developed by the authors for processing the results of statistical quality control methods using the Pareto diagram creates the basis for their reliability and guarantees that enterprises can provide import substitution with their products.

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