MACHINE BUILDING
МАШИНОСТРОЕНИЕ

Original Empirical Research

Methodology for Determining the Classification Group of Jib Cranes of Foreign Companies when Assessing Their Technical Condition during Current Sanctions

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Abstract

Introduction. Currently, more than 7,000 legal entities and individual entrepreneurs in the Russian Federation operate hazardous production facilities (HPFs) and over 90,000 lifting facilities, including cranes, hoists, and elevators. Periodically, serious accidents leading to injuries and deaths are recorded at these facilities, emphasizing the importance of ensuring safety on lifting cranes. However, sanctions against imported cranes installed in ports make it difficult to ensure their safe operation, as many of these cranes exceed or approach the end of their service life. According to the regulatory legal acts of the Russian Federation, an industrial safety inspection is required for further operation of these cranes. The existing studies on the assessment of technical condition of lifting machines primarily focus on issues related to residual life. However, the analysis reveals that the features of evaluating the condition of cranes manufactured by foreign companies, in particular, their actual loads as determined by FEM[1], have not been thoroughly investigated. This discrepancy between actual and specified loading leads to increased risk of accidents. The aim of this research is to develop a methodology for determining the actual classification group of jib cranes produced by foreign companies, which will allow for an objective assessment of their technical condition during the industrial safety inspections, as well as verifying the developed methodology through a specific example.

Materials and Methods. The assessment was based on statistical data collected over the past 27 years. The study was conducted through a systematization of typical damages to cranes identified during industrial safety inspections. Statistical data on the number of cranes and accidents were collected from open sources. During the observation period, there were 254,250 cranes, and the average number of accidents was 42.29, which allowed us to calculate a background probability of accidents of $1.66 \cdot 10^{-4}$. This allowed us to identify an excess in the permissible destruction probability, which was 2×10^{-3}, compared to the established regulatory level of 10^{-4}. Based on this, we analyzed the technical condition of cranes and refined the risk assessment methodology. The direct analysis of the technical condition of cranes was based on the study of loading functions, which depended on the weight of the load and the boom outreach, considered as random variables. For this purpose, we collected and processed primary information in the form of histograms of the distribution of transported cargo masses and boom outreach of the tested cranes. We used these data to calculate the remaining fatigue life of the resource-determining component of the metal structure and the probability of structural failure. Statistical data processing techniques were used to formalize conclusions about the risk level of crane operation based on specific numerical values of accident and damage probabilities, taking into account economic and social factors.

Results. To assess the technical condition of jib cranes manufactured by foreign companies, a methodology was developed to determine the actual classification group. The methodology included calculating the load distribution coefficient (K_p) through load moments, estimating the residual resource by a characteristic number, calculating fatigue stresses for a resource-determining unit, determining the probability of structural failure, and assessing the risk of an

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[1] F.E.M. 1.001–1998. *Rules for the Design of Hoisting Appliances.* VBOOK.PUB. URL: https://vbook.pub/documents/fem-1001-3-edition-revised-19981041-rules-for-the-design-of-hoisting-appliances-5wglvlzj78o7 (accessed: 24.02.2025).

accident. The article provides an example of the application of this technique to a specific jib crane. For a crane with design $K_p = 0.30$ (group A6) and a standard characteristic number of 125,000, the actual characteristic number was 179,323, indicating that service life had been exhausted. Verification calculation of fatigue stresses in the reference contour showed close proximity to the ultimate strength. The value of the probability of destruction, considering the statistical data on the crane load, exceeded the permissible value.

Discussion and Conclusion. The analysis of the results, using a specific example, showed that exceeding the passport classification of the crane's operating mode, and as a result, exceeding the assigned resources of its structural components, led to a significant increase in the risk of accidents. Based on the examination, it was found that the actual classification group of the crane's operating mode exceeded the passport value and amounts to A6 instead of A5. The developed methodology for assessing the actual classification group of the operating mode of jib cranes from foreign manufacturers allows for a significant reduction in the likelihood of structural failure and accident rate during industrial safety inspections. At the same time, it is recommended to use the background probability of a lifting crane accident of $1.66 \cdot 10^{-4}$ and the average value of material damage of 73.2 million rubles in calculations.

Keywords: jib cranes, industrial safety inspection, probability of destruction, classification group, service life

Оригинальное эмпирическое исследование

Методика определения группы классификации стреловых кранов зарубежных фирм при оценке их технического состояния в период действующих санкций

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Аннотация

Введение. На текущий момент в Российской Федерации более 7 000 юридических лиц и индивидуальных предпринимателей эксплуатируют опасные производственные объекты (ОПО) и свыше 90 тысяч подъемных сооружений, включая грузоподъемные краны, подъемники и лифты. Периодически на этих сооружениях регистрируются серьезные аварии, приводящие к несчастным случаям и гибели людей, что подчеркивает значимость вопроса обеспечения безопасности на грузоподъемных кранах. При этом санкции, введенные зарубежными компаниями — производителями импортных кранов, установленных в портах, усложняют их дальнейшую безопасную эксплуатацию, поскольку многие из них превышают или приближаются к предельному сроку службы. В соответствии с нормативными правовыми актами Российской Федерации, для их дальнейшей эксплуатации необходимо проведение экспертизы промышленной безопасности. Существующие исследования, посвященные оценке технического состояния грузоподъемных машин, в основном затрагивают вопросы остаточного ресурса. Однако анализ показывает, что особенности оценки состояния кранов зарубежных производителей, включая их фактические нагрузки в соответствии с FEM[2], остаются недостаточно исследованы. Это приводит к несоответствию фактической и паспортной загрузки, что создает повышенные риски аварийных ситуаций. Цель данного исследования заключается в разработке методики определения фактической группы классификации (режима) стреловых кранов зарубежных компаний. Эта методика позволит произвести объективную оценку технического состояния кранов в процессе экспертизы промышленной безопасности. Также в рамках работы будет проведена проверка разработанной методики на конкретном примере.

Материалы и методы. Оценка базировалась на статистических данных, собранных последние 27 лет. Исследование проводилось на основе систематизации типовых повреждений кранов, выявленных в ходе экспертизы промышленной безопасности. Использовались статистические данные о количестве кранов и авариях, собранные из открытых источников. Количество кранов за период наблюдения составило 254 250 единиц, а среднее число аварий — 42,29. Это дало возможность рассчитать фоновую вероятность аварий, равную

1,66·10⁻⁴, что позволило выявить превышение допустимого значения вероятности разрушения, которое составило $2 \cdot 10^{-3}$ против установленного нормативного уровня 10^{-4}. Данные результаты стали основанием для проведения анализа технического состояния кранов и доработки методики оценки рисков. Непосредственно анализ технического состояния кранов основывался на исследовании функций загрузки, которые зависят от массы груза и вылета стрелы, рассматриваемых как случайные величины. Для этого был произведен сбор и обработка первичной информации в форме гистограмм распределения перемещаемых масс грузов и вылетов стрелы испытуемых кранов. Эти данные использовались для расчета остаточного ресурса по наработке на усталость ресурсоопределяющего узла металлоконструкции и вероятности разрушения конструкции. При статистической обработке данных применялись методики, позволяющие формализовать выводы об уровне риска эксплуатации кранов, основанные на конкретных численных значениях вероятности аварий и величины ущерба, учитывающие экономические и социальные аспекты.

Результаты исследования. Для оценки технического состояния стреловых кранов зарубежных фирм разработана методика, позволяющая определить фактическую группу классификации (режим). Методика включает расчет коэффициента распределения нагрузок ($K_р$) через грузовые моменты, оценку остаточного ресурса по характеристическому числу, расчет напряжений на усталость для ресурсоопределяющего узла, определение вероятности разрушения конструкции, а также оценку уровня риска аварии. В статье представлен пример применения данной методики на конкретном стреловом кране. Для крана с расчетным $K_р = 0{,}30$ (группа А6) и нормативным характеристическим числом равным 125 000, фактическое характеристическое число составляет 179 323, что указывает на исчерпание ресурса. Проверочный расчет напряжений на усталость опорного контура показал близость к пределу прочности. Значение вероятности разрушения с учетом статистических данных о загруженности крана превысило допустимое значение.

Обсуждение и заключение. Анализ результатов на конкретном примере показал, что превышение паспортной группы классификации режима работы крана и, как следствие, превышение назначенного ресурса его конструктивных элементов приводит к значительному увеличению риска аварий. В результате экспертизы установлено, что фактическая группа классификации режима работы крана превышает паспортное значение и составляет А6 вместо А5. Разработанная методика оценки фактической группы классификации режима работы стреловых кранов зарубежных производителей позволит существенно снизить вероятность разрушения конструкций и уровень аварийности в процессе экспертизы промышленной безопасности. При этом рекомендуется при расчетах использовать фоновое значение вероятности аварии грузоподъемного крана 1,66·10⁻⁴ и среднее значение материального ущерба 73,2 млн рублей.

Ключевые слова: стреловые краны, экспертиза промышленной безопасности, вероятность разрушения, группа классификации, ресурс

Introduction. Currently, there are 51,670 hazardous production facilities registered in the Russian Federation that operate more than 284,000 lifting devices, including 224,363 cranes. It's worth noting that 51.2% of these lifting devices have already reached the end of their standard service life.

In 2023, there were 30 recorded accidents at lifting facilities. The analysis of causes of accidents over the past few years has revealed that the main contributing factors are: poor production control [1], operation of faulty lifting structures, and inadequate organization of inspections, maintenance, and scheduled repairs for lifting structures [2].

The sanctions imposed by producing countries have affected foreign lifting cranes that are mainly used in sea and river ports. For many imported lifting cranes, their service life has reached a critical point or exceeded the established standard [3]. To ensure the safe operation of these devices in accordance with the regulatory legal acts of the Russian Federation, an industrial safety inspection is required. This mandatory step ensures the reliability and safety of crane operation and compliance with applicable standards and regulations. The classification groups, classes of use, and loading modes for these cranes are based on the international European standard FEM 1.001-1998[3] "Rules for the

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[3] F.E.M. 1.001–1998. *Rules for the Design of Hoisting Appliances.* VBOOK.PUB. URL: https://vbook.pub/documents/fem-1001-3-edition-revised-1998101-rules-for-the-design-of-hoisting-appliances-5wglvlzj78o7 (accessed: 24.02.2025).

Design of Hoisting Appliances", which is equivalent to the Russian standard GOST 34-017-2016[4]. A comparative analysis of these regulatory documents has shown that, according to FEM[5], the crane loading is indicated as Q2 in the certificate, while the actual load corresponds to Q3. This results in an excess of the classification group value and increased risk of accidents.

The main challenge of operating such cranes in the context of sanctions imposed by manufacturing countries is the termination or severe restriction of the supply of equipment, spare parts, and assemblies for these cranes, as well as disruption of contact for consulting services related to their operation. Additionally, there has been a cessation of equipment maintenance by specialists from supplier companies, as well as remote monitoring of equipment status and updates to software products that ensure the safe operation of the cranes.

Jib cranes, in accordance with the legislation of the Russian Federation No. 116 FZ[6], belong to potentially dangerous objects of hazard class IV, and must comply with standard safety requirements, such as reliability, durability, maintainability, and safety [4, 5].

During the scheduled expert inspections of cranes, the presence of separate resource-determining (resource-limiting) components and elements of metal structures was established [6]. Damage (resource depletion) of such components can lead to the complete destruction of the structure. For example, there have been accidents related to: the destruction of the rail attachment unit of the boom outreach mechanism for an Albatross type portal jib crane (Fig. 1), the destruction of the outrigger attachment unit for a tower crane (Fig. 2), the destruction of the lifting mechanism for a portal jib crane (Fig. 3).

a)

b)

Fig. 1. Accident of an Albatross type portal jib crane due to the destruction of the rail attachment unit of the boom departure:
a — general view; *b* — place of destruction
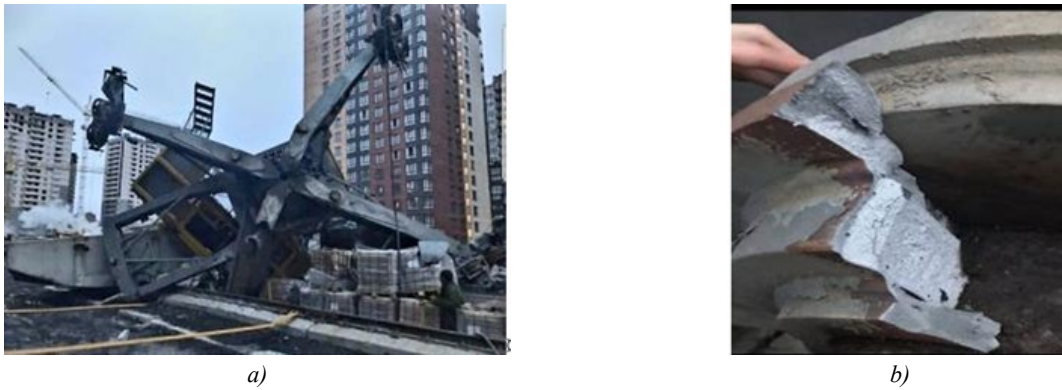
a)   *b)*

Fig. 2. Accident of a tower crane due to the destruction of the attachment point of the outriggers of the carriage frame:
a — general view; *b* — place of destruction

a)   *b)*

Fig. 3. An accident of a portal jib crane due to the destruction of the lifting mechanism:
a — before the accident; *b* — after the accident

The described accidents have a common cause, which is exceeding the crane's classification group (mode) of the specified value in the passport, which in turn leads to exceeding the service life for the crane as a whole and the resource-determining components of the crane specifically.

The task of conducting an objective assessment of the technical condition of jib cranes during the process of industrial safety inspection is essential. Therefore, the aim of this work was to develop a methodology for determining the actual classification group (mode) of jib cranes of foreign companies and to test the developed methodology using a specific example.

Materials and Methods. Gottwald type cranes have an A5 or A6 crane operating mode classification group with recommended parameters according to International European standards FEM 1.001–1998[7] [8]:

− crane classification group A;
− mechanism classification group M;
− other components classification group E;
− usage class U for each group;
− loading mode Q for each group.

With these parameters, the expected lifetime of the components and mechanisms [9] of the crane must be achieved, expressed in operating hours (Table 1).

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[7] F.E.M. 1.001–1998. *Rules for the Design of Hoisting Appliances.* VBOOK.PUB. URL: https://vbook.pub/documents/fem-1001-3-edition-revised-1998101-rules-for-the-design-of-hoisting-appliances-5wglvlzj78o7 (accessed: 24.02.2025).

Table 1

Service life diagram for HMK, HSK type cranes

Components	Hours in service	Service life of components								
		5,000	10,000	15,000	20,000	25,000	30,000	40,000 Q2	45,000	50,000 Q3
Metal structure	Check every 5000 hours	■								
Diesel unit	Overhaul				■			■		
	Generator Clutch				■			■		
Swing mechanism	Reduction unit									■
	Engine				■			■		
	Rotation crown gear Brake				■			■		
Axes	Axis									■
	Brake									■
Undercarriage	Hydraulic motors Valves									■
Hydraulic system	Pump			■			■		■	
	Seals			■			■		■	
Electrical system	Drive					■				■
	Control system									
Lifting mechanism	Reduction unit Brake				■			■		
	Blocks		■							
	Engine				■			■		
	Ropes 6000 hours	■	■							
Outrigger support system	Cylinders					■				
Derricking mechanism	Cylinders					■				
Undercarriage on rails					■			■		
Undercarriage on tires	Axis									■
	Engine				■			■		
	Brake									■
	Reduction unit									■
Components	Hours in service	5,000	10,000	15,000	20,000	25,000	30,000	40,000	45,000	50,000

This table determines the recommended service life in operating hours for the bearing metal structures of cranes, as well as for the main components of the crane — lifting, rotating, chassis, electrical, and hydraulic equipment — under a specific loading mode Q. For instance, the service life of a crane's metal structure under loading mode Q2 was 40,000 operating hours.

According to FEM[8], Q2 load mode is recommended for imported cranes. However, when we analyzed the actual load on several cranes that were surveyed, we found that the current load mode corresponded to Q3 level, which exceeded the passport values for the crane's classification group [10].

[8] F.E.M. 1.001–1998. *Rules for the Design of Hoisting Appliances.* VBOOK.PUB. URL: https://vbook.pub/documents/fem-1001-3-edition-revised-1998101-rules-for-the-design-of-hoisting-appliances-5wglvlzj78o7 (accessed: 24.02.2025).

Machine Building

When conducting an industrial safety inspection, it is essential to collect data on the actual loading of the crane [11]. However, it is not always possible to use parameter recorders, as they may not be operational. Therefore, in such situations, it was decided to use statistical data on the actual loading of cranes.

Loading of jib cranes is a function of at least two parameters — the load weight and the boom outreach, the product of which determines the load moment. In general, these parameters can be random values [12]; they should be taken into account when determining the crane load.

Therefore, the key task of determining the classification group (mode) of the crane is to gather initial data and construct histograms of the distribution of transported cargo masses and boom outreach of the crane under test. The distribution of random variables (the mass of the transported goods and the boom outreach of the crane) is characterized by such quantities as the average value (mathematical expectation) and the standard deviation (variance).

Let us take the random values distribution law (the mass of the transported goods and the boom outreach of the crane) as normal, which will greatly simplify calculations in the future [13]. The accepted assumptions are supported by studies of the boom outreach and angle of inclination of portal jib crane presented in [7, 8].

Results. In order to obtain more objective information to make an informed decision on further operation of jib cranes of foreign companies, a methodology has been developed for assessing the actual classification group (mode) for conducting an industrial safety inspection. The process included several stages. The first step was to determine the actual value of the load distribution coefficient K_p through the load moments and compare it with the passport value. The second stage included an assessment of the remaining operating life and its comparison with the standard value. Then, the maximum fatigue stresses of the resource-determining unit of the metal structure were calculated, followed by a comparison of the obtained value with the limit value. The probability of structural failure was also calculated and compared with the acceptable value. An important element of the assessment was the analysis of the accident risk level.

As an example, we considered a specific case where the actual classification group (mode) of a jib crane was determined and it was recommended for decommissioning. At the first stage, the load distribution coefficient K_p was determined in terms of load moments from the expression:

$$K_p = \sum_i \left[\frac{C_i}{C_T}\right]\left(\frac{M_{(xy)}}{M_n}\right)^3, \tag{1}$$

where C_i/C_T — ratio of the number of operating cycles of a crane with an average load torque to the total number of cycles (we assumed 1 in calculations); $M_{(xy)}$ — mathematical expectation of the load moment; M_n — maximum load moment of the crane specified in its certificate; $M_{xy} = 28 \times 40 = 1{,}120$ t·m; $M_n = 33.4 \times 50 = 1{,}670$ t·m (40 and 50 — average and highest outreach value in the hook mode; 28.0 and 33.4 — average and highest lifting capacity of the crane in the hook mode according to cargo characteristics).

$$K_p = 1 \cdot \left(\frac{1\,120}{1\,670}\right)^3 \cdot 3 = 0{,}30. \tag{2}$$

According to [5, 6, 9], the crane classification group (mode) is generally determined depending on the class of use (U0 – U9), characterized by the maximum number of cycles per service life, and the loading mode (Q1–Q4). Calculated value of the load distribution coefficient Kp = 0.30 corresponded to A6 classification group (mode) of the crane as a whole, but was higher than A5 nominal value [14].

At the second stage, the residual life of the crane was estimated based on the current value of the characteristic number, which was a measure of the crane's life, and was determined taking into account the load distribution coefficient of the crane for the corresponding loading mode and the number of operating cycles [15].

The limiting condition of the crane in terms of operating time occurred if the current characteristic number was equal or higher than the standard value. The residual life was calculated using the following equation:

$$C_{\text{ост}} = (N_н - N_T) \cdot \left(\frac{M_n}{M_{xy}}\right)^3, \tag{3}$$

where $N_н$ — standard value of the characteristic number, which was determined by the crane's classification group and operating mode according to [9, 10]; $N_т$ — current value of the characteristic number.

$$N_T = C \cdot \left(\frac{M_{xy}}{M_n}\right)^3. \tag{4}$$

For the example discussed earlier, the additional conditions were as follows:

$N_{\text{н}}$ = 125,000 — standard value of the characteristic number for A5 crane classification group (mode);

C = 596,228 — estimated number of working cycles;

Then the current value of the characteristic number was:

$N_{\text{т}}$ = 596,228×0.67³ =179,323;

179,323 > 125,000;

$N_{\text{т}} > N_{\text{н}}$.

Conclusion: the resource was exhausted**.**

At the next stage, a verification calculation of the resource-determining assembly of the metal structure [11] for fatigue resistance was performed according to the formula.

$$\sigma_{max} = \alpha_V \cdot R_v \cdot \gamma_v \cdot \gamma_c, \tag{5}$$

where σ_{max} — maximum stress; α_v — coefficient of the operating mode of the element; R_V — calculated fatigue resistance calculated considering time resistance, steel, and the group of elements' joints, taking into account the degree of stress concentration; γ_v — coefficient that took into account the type of stress state and the asymmetry of operating stresses;

γ_c — coefficient of operating conditions.

The value of operating mode coefficient α_v was determined based on the crane's operating mode group and the level of stress concentration. The value γ_v was calculated based on the type of stress state and the stress asymmetry coefficient:

$$\rho = \frac{\sigma_{max}}{\sigma_{min}}, \tag{6}$$

where σ_{min} and σ_{max} — maximum and minimum absolute stresses in the calculated element.

As an example, we calculated the reference contour of the rotary device on a portal jib crane. The results of this calculation can be found in Table 5, which shows the fatigue resistance.

Table 5

Fatigue resistance calculation results

Parameter	Value
Maximum compressive stress, σ_{max}	65 MPa
Maximum tensile stress, σ_{min}	55 MPa
Coefficient of the operating mode of the element α_v	1.5
Calculated R_v fatigue resistance for the 6th group of elements in terms of stress concentration	60 MPa
Coefficient of the operating mode of the element, α_v	1.5
Coefficient that takes into account the type of stress state and the asymmetry of the acting stresses, γ_v	1.08
Coefficient of operation conditions, γ_c	0.7
Fatigue resistance strength condition	65 MPa not more than 68 MPa

The verification calculation of the reference contour of the portal jib crane's rotary device for fatigue resistance indicated that the maximum stress values calculated were close to the limiting value.

Based on the statistical data on the load of the jib crane, we could determine the probability of destruction of the resource-determining element of the metal structure using the following expression:

$$P_{\text{разр}} = \left[\frac{1}{2} - \Phi\left(\frac{\sigma_{\text{К}} - \sigma_{v\text{ср}}}{\sigma_{\text{Н}}}\right)\right]\left[\frac{1}{2} + \Phi\left(\frac{\sigma_{\text{К}} - \sigma_{\text{Пср}}}{\sigma_{\text{Н}}}\right)\right], \tag{7}$$

where $\Phi(\text{x})$ — Laplace function; $\sigma_{\text{Н}}$ — average square deviation of stresses in the distribution of the load factor; $\sigma_{\text{П}}$ — average square deviation of stresses in the distribution of the strength factor; $\sigma_{v\text{ср}}$ — average calculated stress in the structure; $\sigma_{\text{Пср}}$ — average value of the fatigue limit of the structural material, taking into account the cycle asymmetry; $\sigma_{\text{К}}$ — calculated stress value at the intersection point of the alternating stresses distribution of and the distribution of fatigue limits, which could be obtained from solving the equality of load and strength distribution equations. Table 6 provides the calculation results.

Table 6

The results of calculating the probability of destruction of the resource-determining element of a metal structure

Parameter	Value
σ_{vcp}	58 MPa
$\sigma_{н}$	2.5 MPa
$X(н)$	1.6
$\Phi(н)$	0.4452
$\sigma_{пcp}$	68 MPa
$\sigma_{п}$	3.3 MPa
$\sigma_{к}$	62 MPa
$X(п)$	1.81
$\Phi(п)$	0.4649
Estimated value of the probability of destruction $P = (0.5 - 0.4452) \times (0.5 - 0.4649) = 0.0548 \times 0.0351$	2×10^{-3}
Acceptable probability value	$1.0 - 0.9999 = 0.0001\ (10^{-4})$

The safety condition was not fulfilled, because the calculated value of the probability of destruction equal to 2×10^{-3} exceeded the permissible value of 10^{-4}.

For comparison, Table 7 shows the failure probabilities of jib-type crane elements.

Table 7

Probability of failure of jib-type crane elements

Name	Event	Probability
Brake	Failure	$3.5 \times 10^{-5} - 3.3 \times 10^{-7}$
Rope	Wire breakage	3.6×10^{-4}
	Wear and tear	3.8×10^{-5}
Blocks	Failure	$2.7 \times 10^{-3} - 5.6 \times 10^{-4}$
Engine	Failure	$1.28 \times 10^{-4} - 6.2 \times 10^{-7}$
Metal structure	Damage	2.5×10^{-5}
Starting-and-control devices	Failure	9.5×10^{-4}
Running wheels	Wear and tear	9.9×10^{-6}
Electrical wiring	Failure	1.9×10^{-4}
Reducer	Failure	8.7×10^{-6}

At the final stage, based on regulatory and technical documentation, a risk assessment was conducted to determine the level of safety for further operation of the jib crane. The background risk of accidents for lifting cranes was calculated using statistical data from the last 27 years:

– average number of cranes during the observation period— 254,250 units;

– average number of accidents — 42.29;

– background probability of an accident — $42.29/254,250 = 0.000166 = 1.66 \cdot 10^{-4}$

Table 8 presents the damage from accidents at hazardous production facilities with lifting cranes, including direct losses, costs for localizing and mitigating the consequences, and economic losses based on statistical data from open press sources.

Table 8

Economic damage from accidents

Year	Economic damage, rub.	Year	Economic damage, rub.
2003	16,000,000	2014	50,000,000
2004	8,000,000	2015	78,000,000
2005	60,000,000	2021	150,000,000
2008	165,000,000	2022	73,778,191
2009	62,000,000	2023	70,648,042

For comparison, Table 9 provides information on the probability of events with other types of equipment operated at hazardous production facilities.

Table 9

Probabilities of events for various types of equipment

Type of equipment	Event	Probability
Pressure vessels	Depressurization	$4.0\times10^{-5} - 6.2\times10^{-6}$
	Total destruction	3.0×10^{-7}
Tanks for flammable liquids	Total destruction	5.0×10^{-6}
Fixed-roof tanks	Fire	9.0×10^{-5}
Industrial pipeline	Break	$1.4\times10^{-6} - 6.4\times10^{-9}$
Metallurgical workshop	Fire	1.9×10^{-5}
Road transport (USA)	Accident	3×10^{-4}
Road transport (Russian Federation)	Accident	2.7×10^{-4}
Water, air transport (USA)	Accident	9×10^{-6}
Water transport (Russia)	Accident	2.2×10^{-7}
Air transport (Russian Federation)	Accident	3.4×10^{-7}
Railway transport (USA)	Accident	4×10^{-6}
Railway transport (Russian Federation)	Accident	2×10^{-8}

Discussion and Conclusion. Using a specific example, the results showed that exceeding the crane's classification group (mode) and the assigned crane resources as a whole, including structural elements that determine the resource, will inevitably increase the risk of accidents involving jib cranes. Therefore, it was determined that the actual classification group of the crane was A6, which exceeds the passport value A5.

The developed methodology for assessing the actual classification group (mode) of jib cranes of foreign companies will significantly reduce the likelihood of structural failure of jib cranes and the level of accidents during industrial safety inspections. Currently, in Russia, the acceptable level of risk is determined qualitatively without specific numerical values for the probability of accidents or the amount of damage. The numerical values of the probability of accidents and the amount of damage are determined based on the economic and social development of society and may vary depending on the industry. Therefore, it is recommended to use the background probability of a lifting crane accident of $1.66 \cdot 10^{-4}$ and an average material damage value of 73.2 million rubles in calculations.

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