Ministry of Science and Higher Education of the Russian Federation Federal State Budgetary Educational Institution of Higher Education Irkutsk National Research Technical University
Institute of Subsurface Use
Department of Industrial Ecology and Life Safety

ASSESSMENT OF ENVIRONMENTAL RISKS OF METALLURGICAL PRODUCTION UNIT

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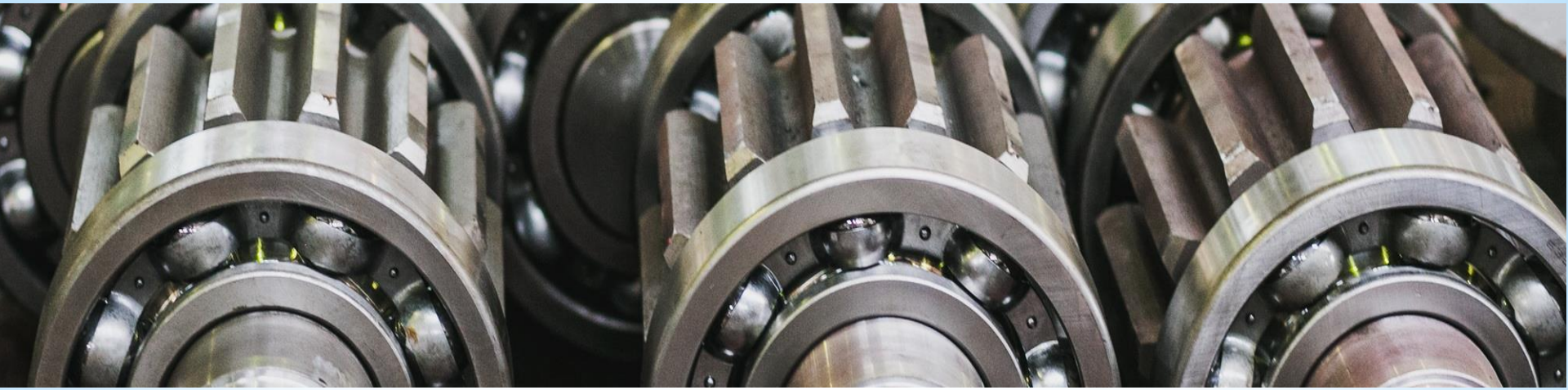
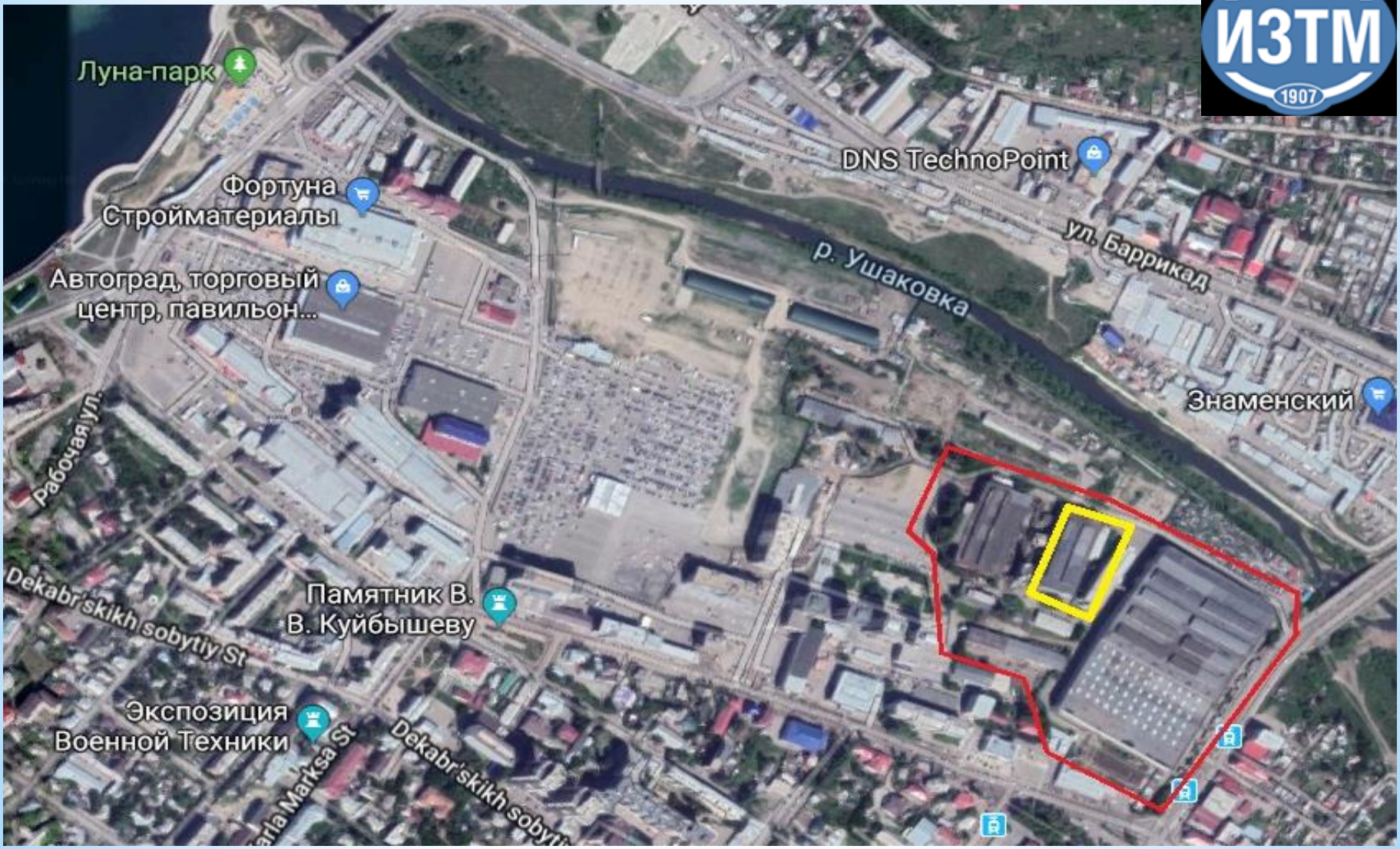
Object of research: division of the heavy industry enterpriseindustry, engaged in the production of steel and cast iron products of wide application

Subject of the study: environmental risk management system at IZTM-Engineering LLC (formerly Production Company LLC, formerly IZTM - Irkutsk Heavy Engineering Plant)



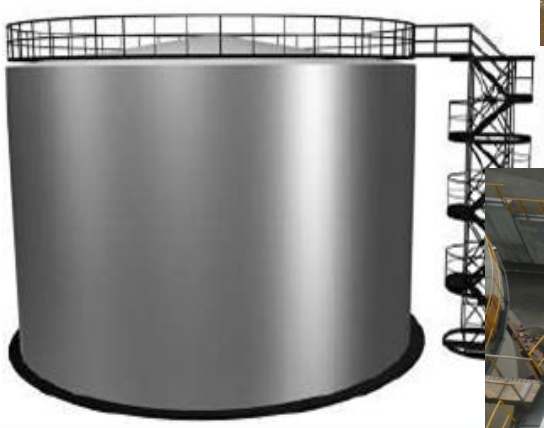
Relevance: around metallurgical plants, peculiar technogenic areas are formed in all surface formations of which (soil, snow, water, vegetation) contain a wide range of harmful substances, including such extremely dangerous ones as lead and mercury. The assessment of environmental risks makes it possible to identify and assess the probability of occurrence of events that have an adverse effect on the state of the environment, the health of the population and the activities of the enterprise.

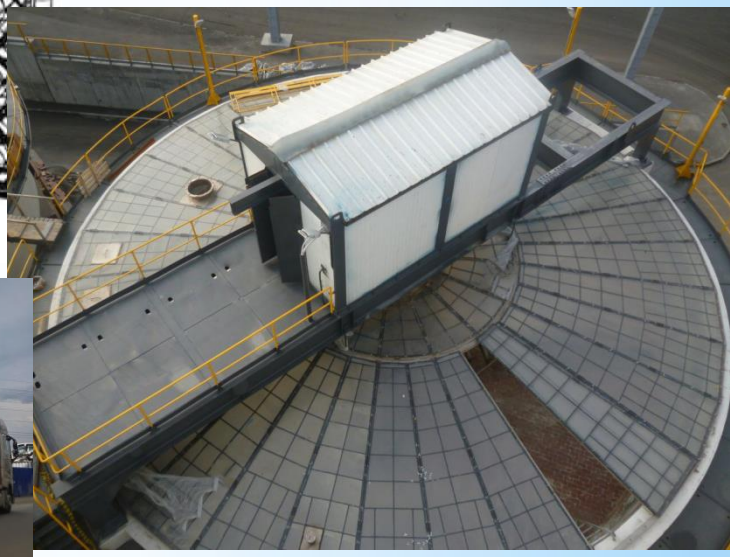
IZTM-Engineering LLC is a Russian engineering company that combines modern production capabilities and offers a range of technological solutions for the implementation of projects in the mining and processing, ferrous and non-ferrous metallurgy and related industries.



Manufactured products of the plant:

Road equipment
Washing equipment
DRO spare parts
Mining and processing equipment
Mining equipment
Equipment for ferrous metallurgy
Equipment for non-ferrous metallurgy
Equipment for coking chemical production
Drawing equipment
Non-standard equipment
Transport equipment
Metal structures and tanks
Engineering services





The concept of risk assessment

Environmental risk — the probability of an event having adverse consequences for the natural environment and caused by the negative impact of economic and other activities, natural and man-made emergencies [No. 7-FZ of January 10, 2002 "On Environmental Protection"].

Risk assessment is a process involving risk identification, analysis, and comparative assessment [GOST R ISO 31000-2019].

Environmental risk assessment is an integrated part of corrective research and studies of measures aimed at protecting the environment. Corrective studies consist of three parts:1) characteristics of the nature and degree of pollution;2) environmental risk assessment;3) assessment of the impact of pollution risk on human health [GOST R 54135-2010].

Regulatory framework for environmental risk assessment

№	Standard	Environmental management
1	G 2.1.10.1920-04	Guidelines for assessing public health risks from exposure to chemicals that pollute the environment
2	GOST G 14.09-2005	Guidelines for risk assessment in the field of environmental management
3	GOST G 54134-2010	Guidelines for the application of organizational security measures and risk assessment. Greenhouse gas emissions
4	GOST G 54135-2010 (переиздание)	Guidelines for the application of organizational security measures and risk assessment. Protection of ecological natural zones. General aspects and monitoring
5	GOST G 54139-2010	Guidelines for the application of organizational security measures and risk assessment. Climate change
6	GOST G IEC 62502 2014 Group T59	National standard of the Russian Federation. Risk management. Event Tree analysis

Regulatory framework for environmental risk assessment

№	Standard	Environmental management
7	GOST G ISO 31000-2019	National standard of the Russian Federation. Risk management. Principles and guidelines
8	GOST G 58771-2019	National standard of the Russian Federation. Risk management. Risk assessment technologies
9	GOST G ISO 14008-2019	Monetary assessment of the impact on the OS and related environmental aspects
10	Order No. 87 of 13.04.2009(as amended on August 26, 2015)	On approval of the Methodology for calculating the amount of damage caused to water bodies as a result of violation of water legislation
11	GOST G 56167-2014 Emissions of pollutants into the atmosphere(reissue October 2019)	Method of calculating damage from an industrial enterprise to environmental objects Methodology for calculating the amount of damage caused to atmospheric air as a component of the natural environment (approved by Order No. 59 of the Ministry of Natural Resources of the Russian Federation dated January 28, 2021)
12	Order No. 238 of8.07.2010 (as amended on 11 July 2018)	On approval of the Methodology for calculating the amount of damage caused to soils as an object of environmental protection

Approximate sequence of risk assessment

Stages:

1. **Primary hazard identification;**
2. **Description of the source of danger and related damage;**
3. **Risk assessment under normal operating conditions;**
4. **Risk assessment of possible hypothetical (moment of probability) industrial accidents;**
5. **The range of possible scenarios for the development of an accident;**
6. **Statistical estimates and probabilistic risk analysis;**
7. **Risk management.**

Risk assessment - a tool for decision-making

Block diagram of the technological process of the foundry

Preparation of materials for molding and core mixture

Preparation of the molding and core mixture

Molding of casting molds

production of casting rods

Installation and assembly of rods

Finishing (painting) of the casting

Preparation of charge materials

Metal melting

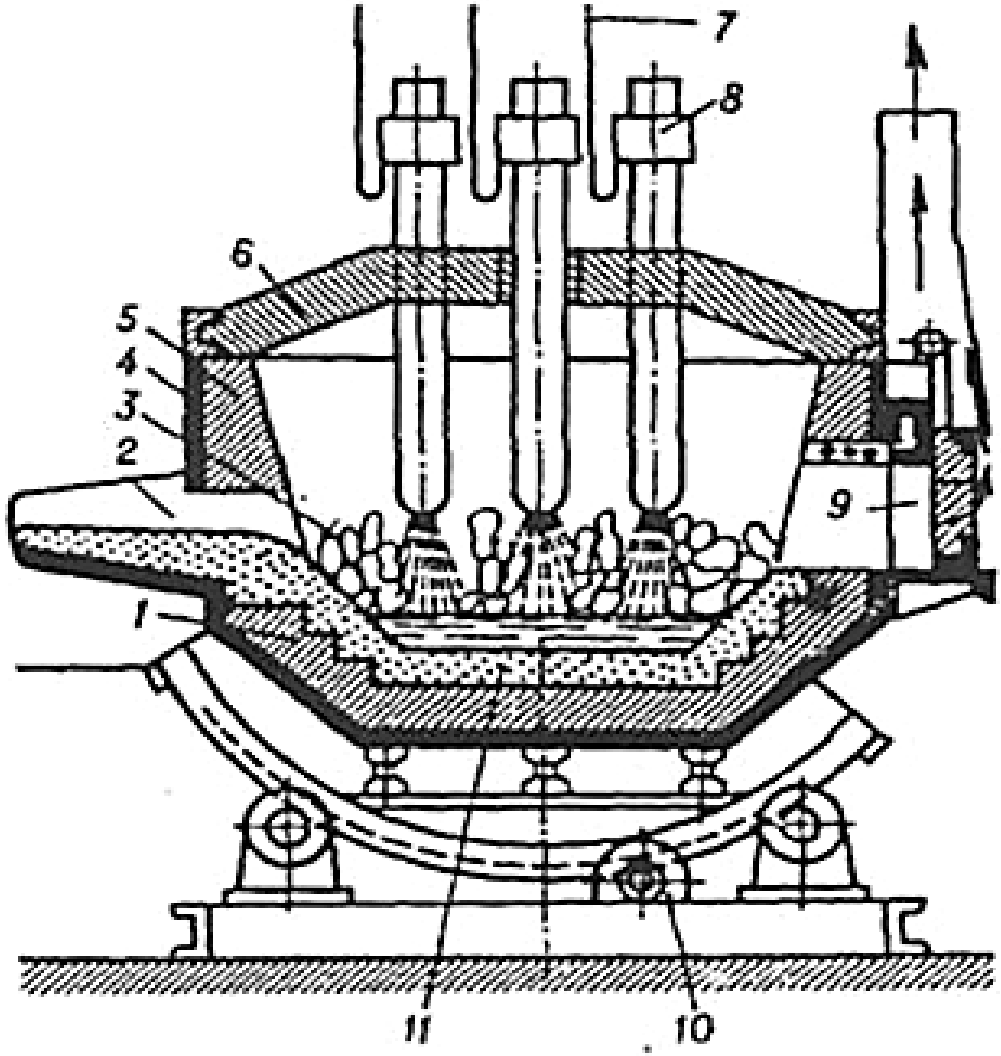
Filling the form

Casting embossing

Cleaning the casting

Heat treatment of castings

Electric arc furnace circuit diagram



1-spherical bottom;
2-outlet port;
3-metal bath;
4-casing;
5-furnace lining;
6-furnace arch;
7-copper tires;
8-electric holders and electrodes;
9-boot window;
10-device for tilting the oven;
11-under the furnace

The list of works of a technological nature with an indication of the degree of danger

1. **Technological process of steel smelting in the DSP−3 electric furnace**
2. **Bucket drying process using fuel oil burner**
3. **The technological process of pouring molds with hot metal is an increased danger**
4. **Obsolete and worn-out equipment**

Increased risk

Identification of the sources of environmental hazards of the foundry

Emissions of pollutants		Industrial waste water		Waste. Soil pollution	
source	**danger**	**source**	**danger**	**source**	**danger**
Steelmaking units	Emissions to the atmosphere CO2 SO2 CH4 H2 O2 Mn, Fe, Zn, Cu, Kd, Pb – containing dust, their oxides	Presence of mechanical impurities of organic origin, metal hydroxides, soluble toxic compounds	Violation of water balance and natural self-cleaning processes	Spent foundry sand containing metal waste, ceramics, scrap, refractories, paper and wood waste; 50% iron sludge	Accumulation on the temporary placement site for longer than the term
Embossed grilles					
Crushers, Sieves					
Furnace gas cleaning	fireand explosionhazard				It is stored in special containers and exported to special enterprises
Steel spill		Recycled water supply	----------		

Register of environmental negative factors of the foundry with ranking of consequences

№ п	Cause ofoccurrence	Name of the dangerous factor	Effects of exposure	Severity / Time of occurrence
1	Natural disasters; Terrorist acts ⇩ Corrosion of materials Leaky connections	Waste water leakage in the event of a break in the factory sewer	Pollution in the river aquifer. Regional distribution	Non-fatal (risk of disease)By time of manifestation-distant
2	The human factor. "Fatigue" wear and tear of electrical equipment.Explosion of the furnace due to a failure in the water cooling system	Fire in the foundry. Local or Global	Burns of various degrees, OScontamination by gorenje products, damage to equipment	Non-fatal (risk of injury, disease).The manifestation is immediate. Fatal (risk of death) - immediate.
3	Furnace gas cleaning and steel spilling	Emissions of pollutants into the atmosphere (inorganic metal compounds in dust)	Environmental pollution. Regional distribution.	Non-fatal Immediate
4	Storm drain failure	Leakage of untreated storm water and meltwater	Accumulation of untreated discharges. locally	Non-fatal Immediate

Risk assessment of possible hypothetical (moment of probability) accidents in the foundry

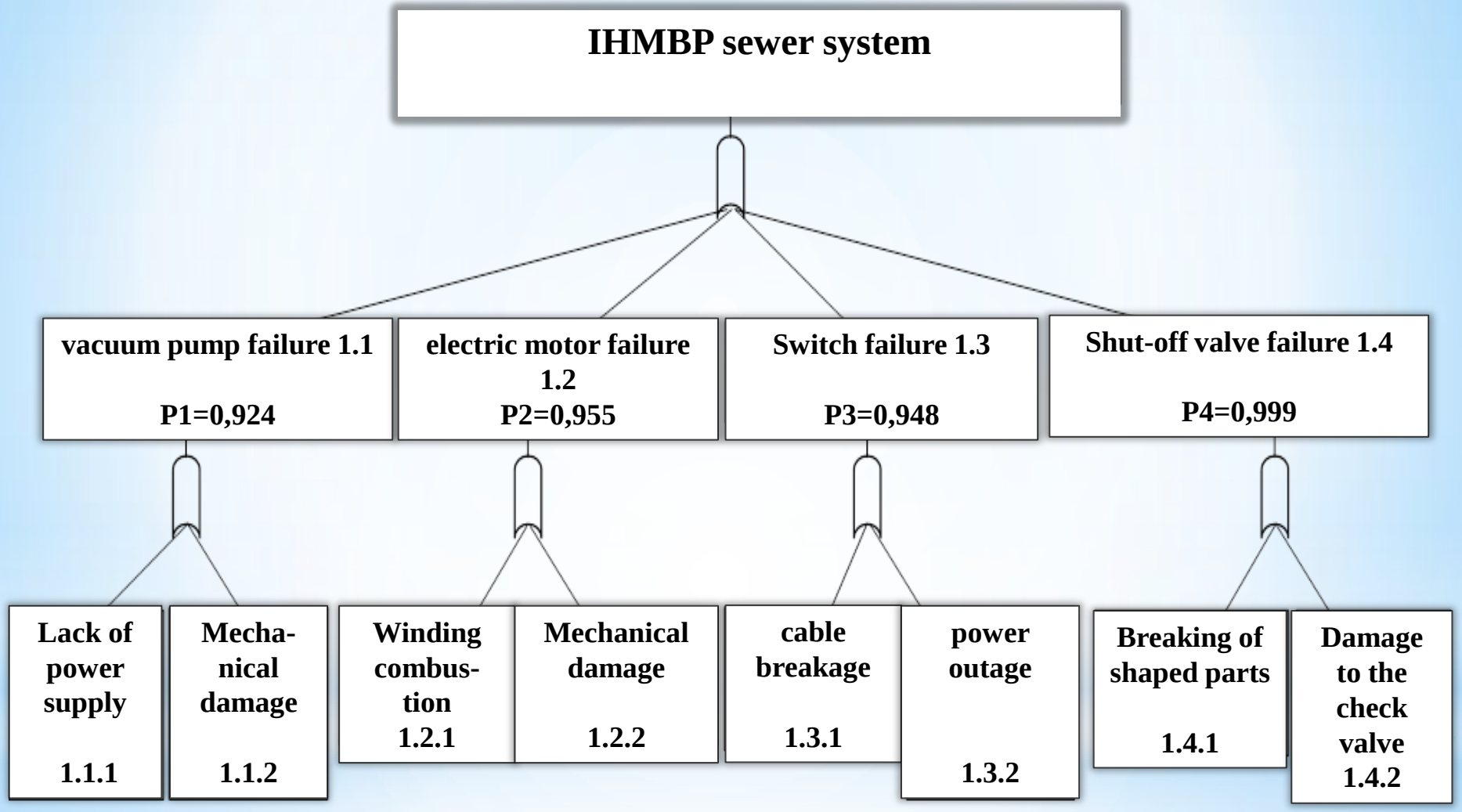
Scenario 1: emergency wastewater discharge in the Ushakovka river

Description: IZTM is located in the water protection zone of the Ushakovka River, which in turn flows into the Angaru River of the highest category of fisheries significance. Therefore, the most negative event, bearing significant environmental damage, will be the emergency discharge of wastewater into the Ushakovka river, which is listed in the State Fisheries Register as a watercourse of the first category.

Method: Analysis of types and consequences of failures (FMEA) and analysis of types, consequences and criticality of failures (FMECA), according to GOST G 58771-2019 Risk management. Risk assessment technologies.

Pros: applicable in human, technical systems, hardware, software, and procedures; identifies failure modes, their causes, and their impact on the system, and presents them in an easy-to-read format; avoids the need for costly hardware changes in maintenance by identifying problems early in the design process; provides input to maintenance and monitoring programs, highlighting the key functions that need to be monitored.

Failure tree in the enterprise sewer system



Probability of failure-free operation of the sewer: P(S) = P1 • P2 • P3 • P4 = 0,874

The amount of damage caused to water bodies as a result of violation of the water legislationof the design process;provides input to maintenance and monitoring programs, highlighting the key functions that need to be monitored

According To Paragraph 13 Of The Methodology:

У = Квг*Кв*Кин*Кдл*∑Hi,

where У - the amount of damage, million rubles;

Квг – coefficient that takes into account natural and climatic conditions depending on the time of year = 1,2;

Кв – coefficient that takes into account environmental factors=1.36;

Кин - indexation coefficient that takes into account the inflationary component of economic development = 1;

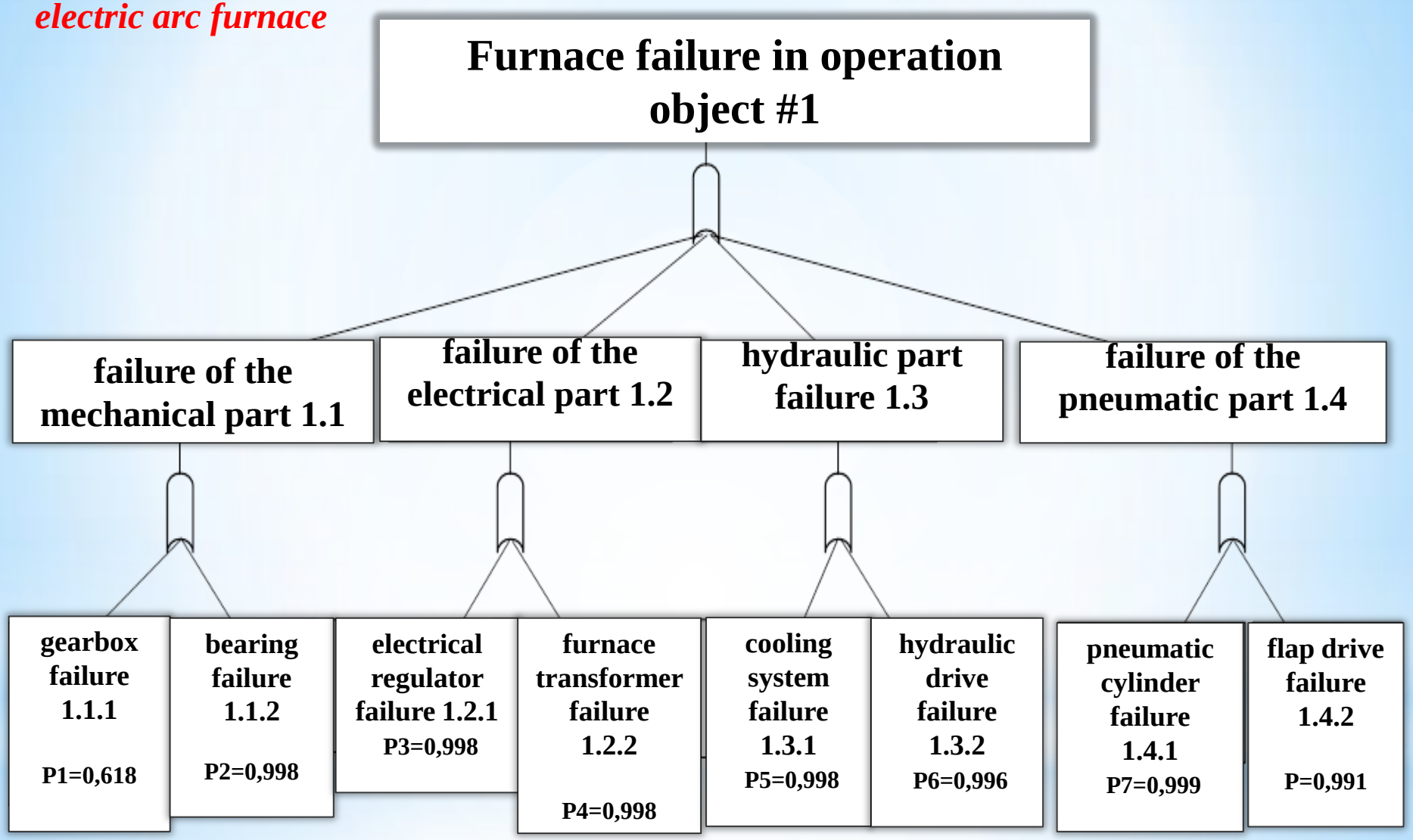
Кдл - coefficient that takes into account the duration of the negative impact of harmful (polluting) substances on a water body if no measures are taken to eliminate it = 5;

Hi - the tax for calculating the amount of damage caused by pollution of water bodies as a result of accidents with the i-m harmful (polluting) substance is determined depending on its mass (M).

Accepted M<0,1 т (organic+inorganic+petroleum products)

Total: У = 1,25*1,36*1*5*∑0,34+0,17+0,35=7,31 million rubles

Scenario 2. Emissions of pollutants into the atmosphere caused by an accident in an electric arc furnace



Probability of failure-free operation of the sewer: P(S) = P1 • P2 • P3 • P4 = 0,605
that is, the probability of failure of all elements is high, except for the gearbox

Scenario 3. Negative impact on soils

Chemical concentration coefficient values(heavy metals) in the sample of soil and soil, the total indicator загрязнения

Title	Surface sample up to 0.2 m, content of the i-th toxicant in the soil	Mid-regional background for Russia	Zci	Кз(i) - conversion factor	П - the amount of the damage fee, thousands of rubles
1	2	3	4	5	6
nickel	64±8	30	2,13	0,3	697,95
lead	33,0±2,7	15	2,20	0,3	697,95
copper	37±5	15	2,47	0,3	697,95
zinc	167±12	45	3,71	0,3	697,95
cadmium	3,97±0,04	0,12	33,08	1	2326,5
arsenic	19,6±0,6	2,2	8,91	0,6	1395,9
mercury	0,82±0,025	0,1 / 2,1	8,00	0,6	1395,9
total amount of payment for damage, thousands of rubles					7910,1

Extent of damage caused by land pollution: П = ∑(Нс*Si*Кв*Кзi*Кэi*Кг) , were П - the amount of payment for damage caused by land pollution by one or more (from 1 to n) chemicals (thousands of rubles);

Нс - standard value of land in the South Siberian mountain zone (705 thousands of rubles/hectare);

Кв - conversion factor depending on the time period for the restoration of contaminated agricultural land, equal to 2.5 if the land is restored in 3 years;

S(i) - the area of land contaminated with a chemical of the first type (he), equal to 1.2 he (the area of the foundry according to the public cadastral map);

Кз(i) - conversion factor depending on the degree of land contamination with a chemical of the i-th type;

Кэ(i) - coefficient of the ecological situation and ecological significance of the territory of the i-th economic district, equal to 1.1 for the East Siberian region;

Кг - conversion factor depending on the depth of land pollution.

Total П - the amount of payment for damage caused by land pollution with seven chemicals will be 7910,1 thousand rubles.

The ecological and economic risk will be (with the probability of a furnace accident Q=0,998).

R=7910100*0,998=7 894 279,8 rubles.

Corrective measures for the type of emergency failure of the sewer device

Type of refusal	Measures
1.1 - Vacuum pump failure	- Regular check-up - Ensuring optimal operating conditions of the equipment - Check the main reserve of equipment.- Replacement of worn-out equipment
1.2 - Electric motor failure	- Regular check-up - Timely implementation of planned preventive repairs.- Strict accounting and evaluation of the technical condition of the equipment - Check the reliability of the docking of all the connecting connectors of the contact terminals
1.3 - Switch failure	- Regular check-up - Check the reliability of the docking of all the connecting connectors of the contact terminals - Timely elimination of minor defects
1.4 - Shut-off valve failure	- Regular check-up - Ensuring optimal operating conditions of the equipment - Replacement of worn-out equipment

Managing the risk of an emergency furnace failure

Type of refusal	C	Corrective measures
1.3.1 Cooling system failure	420	- Diagnosis of the birth space after each melting - Installation of a pressure level indicator with an audible pressure drop signal - Strict compliance with the technological regime
1.2.2 Furnace transformer failure	120	- Frequent monitoring - Checking the transformer protection tripping settings - Decommissioning when the diagnostic characteristic reaches the limit value - Replacement planning
1.1.1 Gearbox failure	108	- Regular check of the gearbox - Timely elimination of minor defects
1.2.1 Electrical regulator failure	108	- Regular check of the electric controller - Check the reliability of the docking of all the connecting connectors of the contact terminals

impact assessment · failure probability assessment · detection probability

criticality of failure C

Thanks for your attention!