UIC Railway Asset Management
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Risk based decision making for Russian Railways

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The problem of managerial decision-making

Knight at the crossroads: Where should I go to?

Infrastructure and rolling stock facilities of JSC RZD

Infrastructure:

Length of operational tracks	85 200 km
Length of electrified lines	43 100 km
Lines equipped with signalling equipment	62 196 km
Railway stations	5 428
Traction substations	1 402
Service units (track divisions)	742

Rolling stock fleet:

Freight locomotives (electric and diesel)	11 191
Freight cars of all types and owners	1 600 000
Shunting engines (diesel)	6 016
Long-distance passenger cars	24 100
Commuter cars	15 600
Motive power and car depots	411

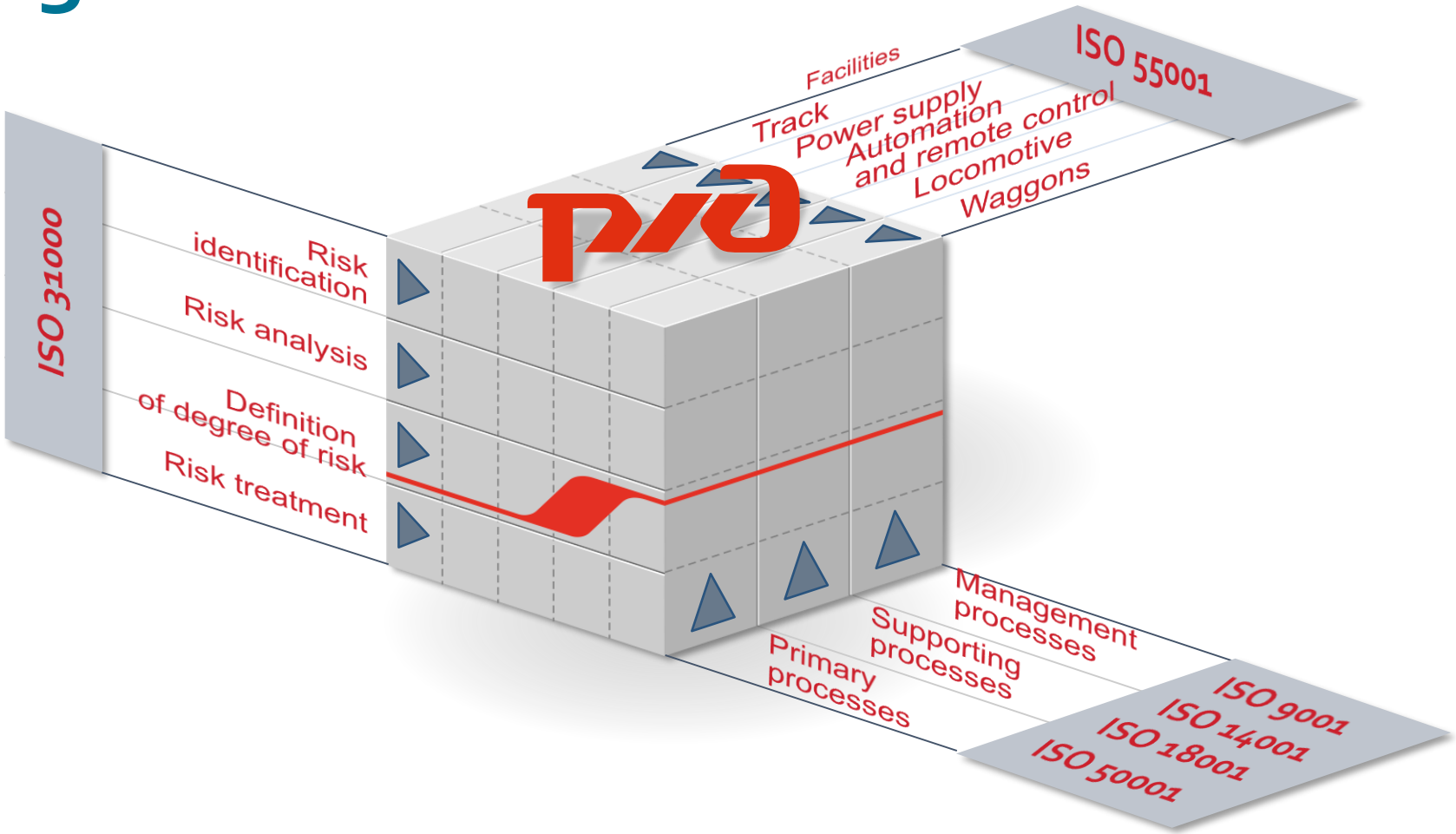
The role of the risk management system in the context of the ISO 55001 standard

"Understanding and managing risk is a universal requirement throughout ISO 55001. It is particularly prevalent in the definition and implementation of the overall Asset Management System, in planning what to do to the assets to manage risks, and in operations, i.e. doing things to the assets to manage risks."

Main principles of risk management as part of deployment of asset management system as per ISO 55001

- Risk identification should be undertaken on each component of the Asset Management Framework from the setting of organizational objectives to the execution of work and operation of the network
- A Corporate Risk Matrix describes the risk assessment criteria used to quantify and compare risks (usually probability and consequence)
- A risk register provides a structured format for recording risks. Each risk should be linked to one or more components of the Asset Management framework
- The level of detail undertaken in the risk assessment should be commensurate to the severity and complexity of the risk. Formal approaches are required for safety risks, and most sophisticated risk tools have been developed in this area e.g. bow-tie, fault and event tree analyses
- Risk actions should be prioritized to support achievement of the appropriate balance between costs, risks and performance

Correlation of ISO standards for asset and risk management in JSC RZD



Purpose of URRAN introduction:

increase of the efficiency of railway transport operation based on adaptive management under the conditions of scarce resources

OBJECTS OF TECHNICAL REGULATION

Track facilities

Facilities of electrification and power supply

Facilities of signaling and remote control

Telecommunication facilities

Locomotive facilities

BASIC PROCESES OF RAILWAY TRANSPORT TECHNICAL MAINTENANCE

- Technical maintenance of infrastructure facilities and rolling stock
- Modernization of infrastructure and rolling stock
- Procurement management
- Management of environmental, fire, industrial and labor safety

URRAN normative and methodological framework — 125 documents

Risk definition and Regulatory support of risk management in railway transportation

ГОСТ 33433-2015 Безопасность функциональная. Управление рисками на железнодорожном транспорте
Применяется с 01.09.2016 взамен ГОСТ Р 54505-2011

ГОСТ 33433-2015

МЕЖГОСУДАРСТВЕННЫЙ СТАНДАРТ

Безопасность функциональная

УПРАВЛЕНИЕ РИСКАМИ НА ЖЕЛЕЗНОДОРОЖНОМ ТРАНСПОРТЕ

Functional safety. Risk management on railway transport

МКС 03.220.30

Дата введения 2016-09-01

Предисловие

Цели, основные принципы и основной порядок проведения работ по межгосударственной стандартизации установлены ГОСТ 1.0-92 "Межгосударственная система стандартизации. Основные положения" и ГОСТ 1.2-2009 "Межгосударственная система стандартизации. Стандарты межгосударственные, правила и рекомендации по межгосударственной стандартизации. Правила разработки, принятия, применения, обновления и отмены"

Сведения о стандарте

1 ПОДГОТОВЛЕН Федеральным государственным унитарным предприятием "Всероссийский научно-исследовательский институт стандартизации и сертификации в машиностроении" (ВНИИНМАШ) и Закрытым акционерным обществом "ИБТранс" (ЗАО "ИБТранс")

2 ВНЕСЕН Межгосударственным техническим комитетом по стандартизации МТК 524 "Железнодорожный транспорт"

3 ПРИНЯТ Межгосударственным советом по стандартизации, метрологии и сертификации (протокол от 27 августа 2015 г. N 79-П)

За принятие проголосовали:

Краткое наименование страны по МК (ИСО 3166) 004-97	Код страны по МК (ИСО 3166) 004-97	Сокращенное наименование национального органа по стандартизации
Азербайджан	AZ	Азстандарт
Армения	AM	Минэкономики Республики Армения
Беларусь	BY	Госстандарт Республики Беларусь
Киргизия	KG	Кыргызстандарт
Россия	RU	Росстандарт
Таджикистан	TJ	Таджикстандарт

4 Приказом Федерального агентства по техническому регулированию и метрологии от 4 декабря 2015 г. N 2108-ст межгосударственный стандарт ГОСТ 33433-2015 введен в действие в качестве национального стандарта Российской Федерации с 1 сентября 2016 г.

According to GOST 33433 International standard. Functional safety. Risk management in railway transportation:

Risk is the combination of the probability and consequences of an event.

This standard sets forth the approach and general rules of risk management in railway transportation in terms of functional safety of infrastructure facilities and rolling stock.

JSC RZD risk types classification

URRAN documents 2011-2016

JSC RZD Regulations for risk management	1
International standard (GOST)	2
National standard (GOST R)	6
JSC RZD standard (STO RZD)	19
Concept	2
Regulatory and guidance documentation (methodologies, guidebooks, recommendations, classifications, norms, etc.)	121

2017-2018

International standard (GOST)	2
National standard (GOST R)	1
JSC RZD standard (STO RZD)	4
Regulatory and guidance documentation (methodologies, guidebooks, recommendations, classifications, norms, etc.)	29

URRAN Single Corporate Platform (EKP URRAN)

Federal law On the protection of the environment dated 10.01.2002 No. 7-F3

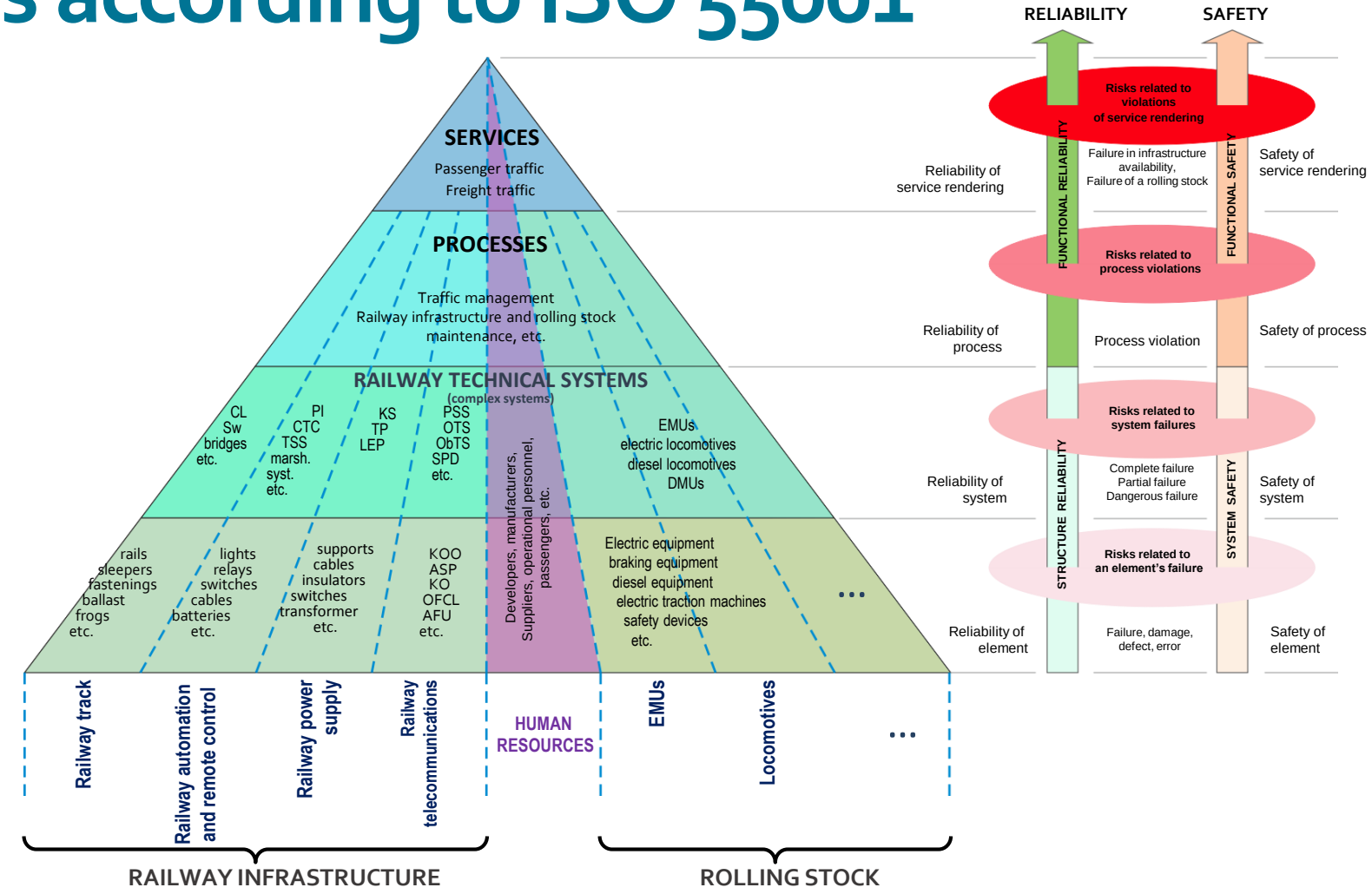
Federal law On industrial safety of hazardous industrial facilities dated 21.07.1997 No. 116-F3

TR CU 001/2011 On the safety of railway rolling stock
TR CU 002/2011 On the safety of high speed railway transportation
TR CU 003/2011 On the safety of railway infrastructure

Labor code of the Russian Federation

FL No. 123-FZ Technical regulations on fire safety requirements

Object and functional system hierarchy of Russian railways according to ISO 55001



Risk assessment principles

MEM PRINCIPLE

MEM - Minimum Endogenous Mortality: “Hazard related to a new system shall not increase the level of minimum endogenous mortality for a person”.

GAMAB PRINCIPLE

GAMAB (Globalement Au Moins Aussi Bon (France): “All new systems shall in total perform globally at least as good as any compared existing system”.

ALARP PRINCIPLE

ALARP (As Low As Reasonably Practicable): “Acceptable risk level is such a level of risk that cannot be reduced further and so, expenditures spent to reach it are economically beneficial”.

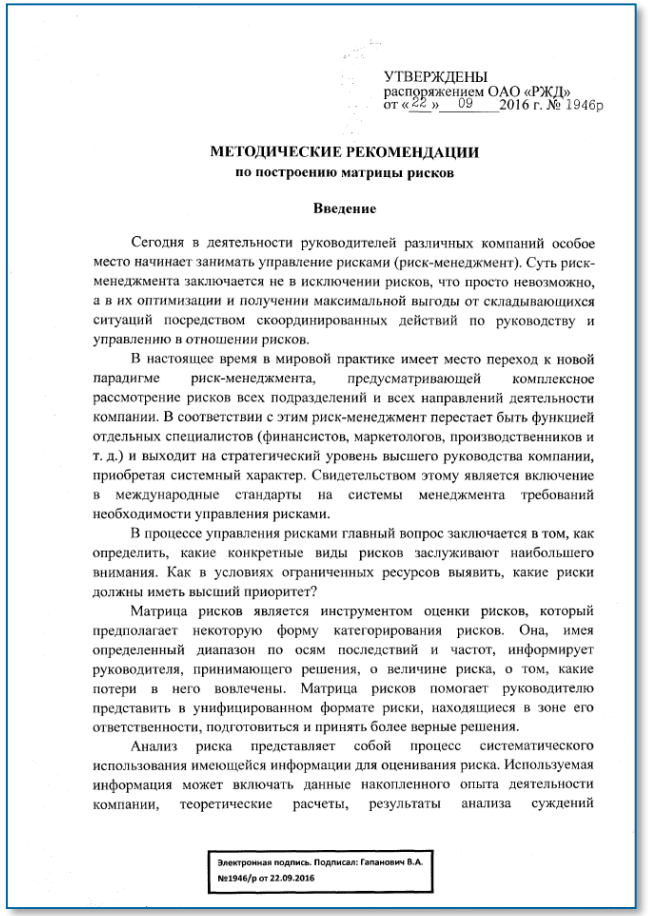
Typical levels of event rates

Rate	Event frequency per year, *f*	Description
Frequent	$f > 10^{-3}$	Can occur frequently. Continuous hazard
Probable	$5 \times 10^{-4} \leq f < 10^{-3}$	Repeated occurrence. Frequent occurrence of hazard is anticipated.
Occasional	$10^{-4} \leq f < 5 \times 10^{-4}$	Probability of repeated occurrence. Repeated occurrence of hazard is anticipated.
Remote	$5 \times 10^{-5} \leq f < 10^{-4}$	Probability of the event occurring sometimes during the life cycle of a facility. Grounded expectation of hazard occurrence.
Improbable	$10^{-5} \leq f < 5 \times 10^{-5}$	Probability of occurrence is unlikely but possible. Hazard can presumably occur in extraordinary cases.
Incredible	$f \leq 10^{-6}$	Probability of occurrence is very unlikely. Hazard cannot presumably occur.

Typical levels of consequences severity

Catastrophic	1 or more dead, or 5 or more railway employees critically injured or Train damaged to the point of being put out of the fleet park or Damage to infrastructure facility in the size of over 5000 MW	1 or more dead, or 5 or more railway employees critically injured or Threat to environment caused emergency of federal or interregional scale
Critical	Up to 5 railway employees critically injured or 1 dead, or 1 or more people critically injured as a result of deliberate or careless actions of the victim or other persons who are not railway employees or Damage to rolling stock requiring to do capital repair for its operation recovery or Damage to infrastructure facility in the size of 1500 to 5000 MW or Total loss of goods	Up to 5 railway employees critically injured. 1 dead, or 1 or more people critically injured as a result of deliberate or careless actions of the victim or other persons who are not railway employees. or Threat to environment caused emergency of regional or intermunicipal scale
Marginal	Mid-size damage to health or Damage to rolling stock requiring to do mid-size or depot repair for its operation recovery or Damage to infrastructure facility in the size of from 500 to 1500 MW or Partial loss of goods	Mid-size damage to health or Threat to environment caused emergency of local or municipal scale
Insignificant	Minor damage to health or Damage to rolling stock requiring to do running repair for its operation recovery or Damage to infrastructure facility in the size of less than 500 MW	Minor damage to health or Insignificant threat to environment

Guidelines for construction of corporate risk matrix



УТВЕРЖДЕНЫ
распоряжением ОАО «РЖД»
от «22» 09 2016 г. № 1946р

МЕТОДИЧЕСКИЕ РЕКОМЕНДАЦИИ
по построению матрицы рисков

Введение

Сегодня в деятельности руководителей различных компаний особое место начинает занимать управление рисками (риск-менеджмент). Суть риск-менеджмента заключается не в исключении рисков, что просто невозможно, а в их оптимизации и получении максимальной выгоды от складывающихся ситуаций посредством скоординированных действий по руководству и управлению в отношении рисков.

В настоящее время в мировой практике имеет место переход к новой парадигме риск-менеджмента, предусматривающей комплексное рассмотрение рисков всех подразделений и всех направлений деятельности компании. В соответствии с этим риск-менеджмент перестает быть функцией отдельных специалистов (финансистов, маркетологов, производственников и т. д.) и выходит на стратегический уровень высшего руководства компании, приобретая системный характер. Свидетельством этому является включение в международные стандарты на системы менеджмента требований необходимости управления рисками.

В процессе управления рисками главный вопрос заключается в том, как определить, какие конкретные виды рисков заслуживают наибольшего внимания. Как в условиях ограниченных ресурсов выявить, какие риски должны иметь высший приоритет?

Матрица рисков является инструментом оценки рисков, который предполагает некоторую форму категорирования рисков. Она, имея определенный диапазон по осям последствий и частот, информирует руководителя, принимающего решения, о величине риска, о том, какие потери в него вовлечены. Матрица рисков помогает руководителю представить в унифицированном формате риски, находящиеся в зоне его ответственности, подготовиться и принять более верные решения.

Анализ риска представляет собой процесс систематического использования имеющейся информации для оценивания риска. Используемая информация может включать данные накопленного опыта деятельности компании, теоретические расчеты, результаты анализа суждений

Электронная подпись. Подписал: Гапанович В.А.
№1946/р от 22.09.2016

Guidelines for construction of corporate risk matrix were developed for the purpose of creating a single method for representation of risk evaluation results as regards railway infrastructure facilities and rolling stock operation.

Risk evaluation

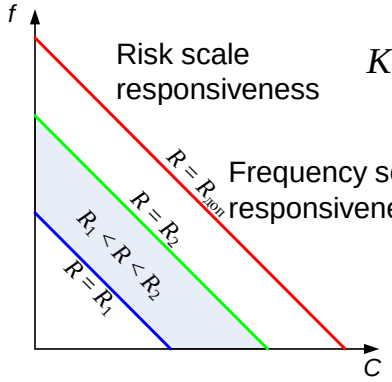
undesirable

Risks are tolerated if the costs for their reduction are obviously disproportionate to the achievable profit

tolerable

Risk are tolerated if the costs for their reduction exceed the achievable improvements

HAZARD RATE	ESTIMATION OF RISK DEGREE			
FREQUENT	Undesirable	Intolerable	Intolerable	Intolerable
PROBABLE	Tolerable	Undesirable	Intolerable	Intolerable
OCCASIONAL	Tolerable	Undesirable	Undesirable	Intolerable
REMOTE	Negligible	Tolerable	Undesirable	Undesirable
IMPROBABLE	Negligible	Negligible	Tolerable	Tolerable
INCREDIBLE	Negligible	Negligible	Negligible	Negligible
	INSIGNIFICANT	*MARGINAL*	*CRITICAL*	*CATASTROPHIC*
	SEVERITY LEVELS OF HAZARD CONSEQUENCES			



Risk scale responsiveness $K = \sqrt{\frac{R_{tol}}{R_{neg}}}$ $K = k_f \cdot k_c$

Frequency scale responsiveness $Kf = \sqrt{\frac{F_{max}}{F_{min}}}$

Damage scale responsiveness

$$A = \frac{a_{max} \cdot a_{min} \cdot F_{max}}{F_{min}}$$ **a required frequency range**

a_{max}, a_{min} **- safety factors for the upper and the lower limits of a frequency range**

$$A_0 = \sqrt{\frac{a_{max} \cdot F_{max} \cdot F_{min}}{a_{min}}}$$ **frequency range center**

$$B = \frac{b_{max} \cdot b_{min} \cdot C_{max}}{C_{min}}$$ **a required damage range**

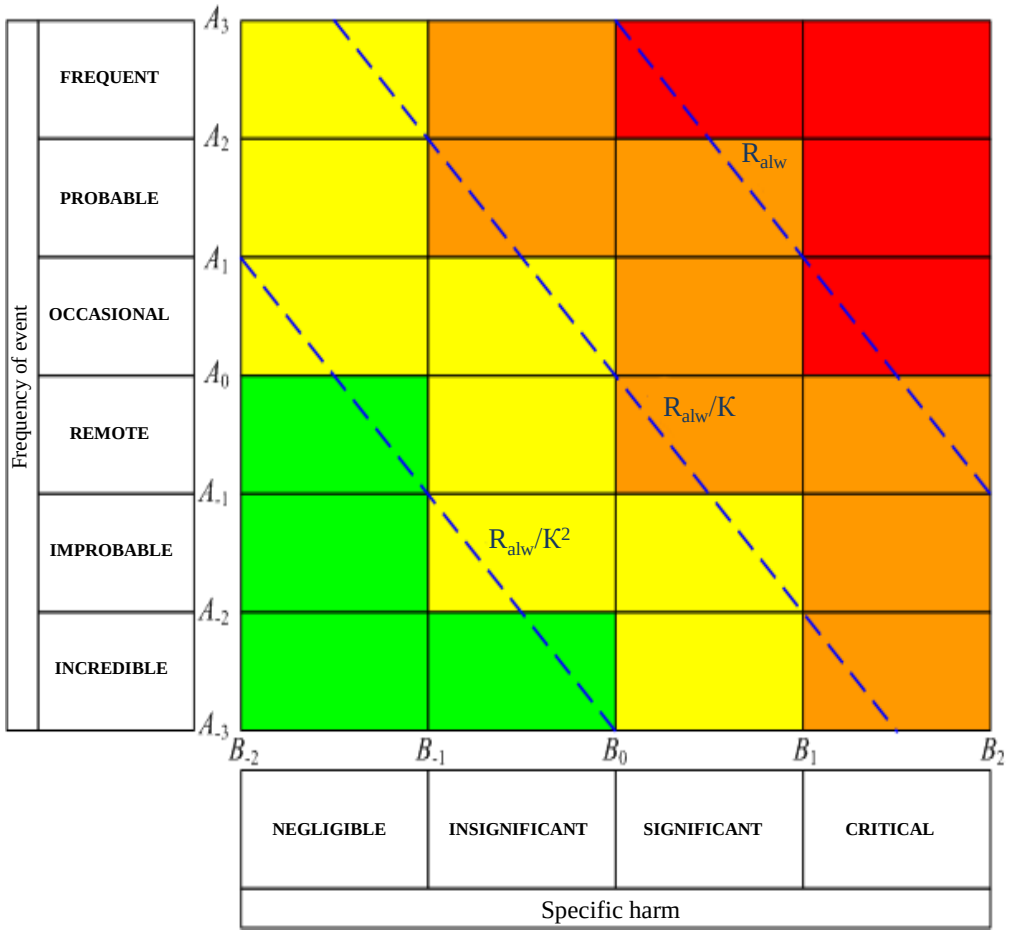
$$B_0 = \sqrt{\frac{b_{max} \cdot C_{max} \cdot C_{min}}{b_{min}}}$$ **damage range center**

b_{max}, b_{min} **- safety factors for the upper and the lower limits of a damage range**

Decision criteria

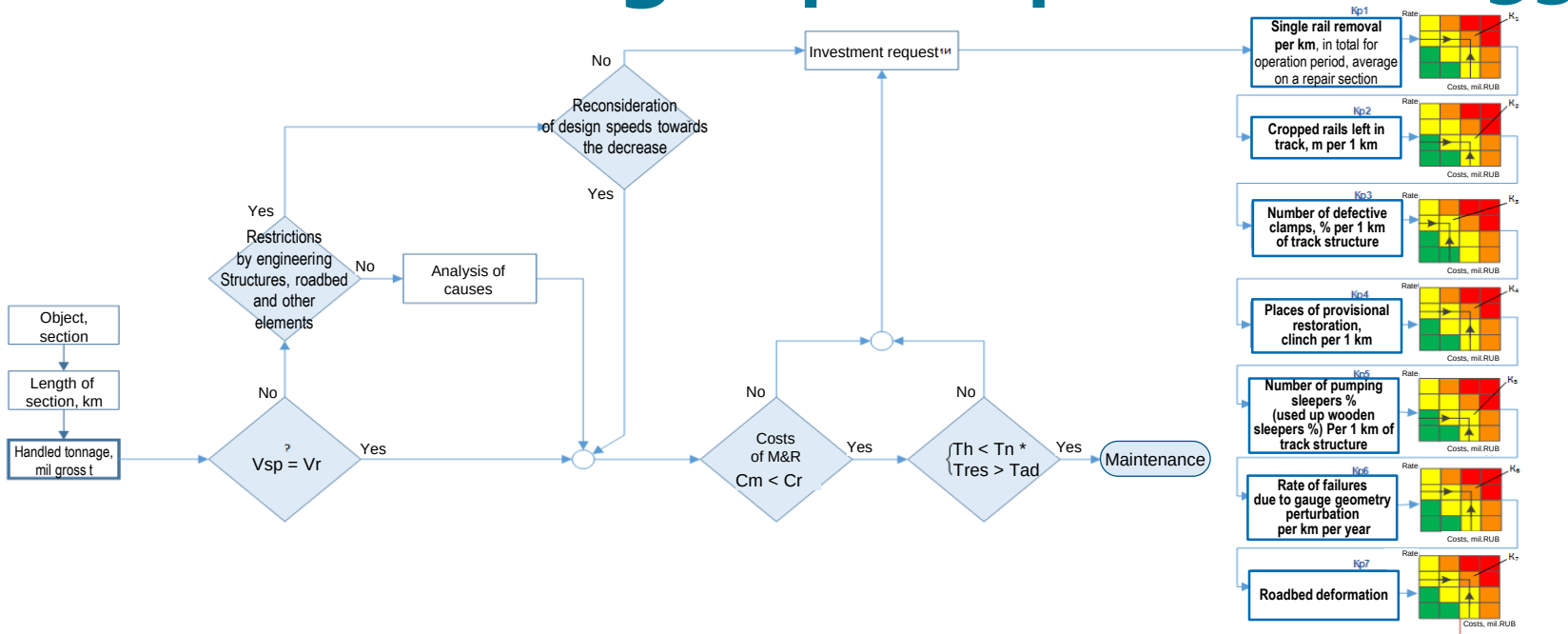
Risk level	Value range
Intolerable	$R > R_{tol}$
Undesirable	$0{,}1 \cdot R_{tol} \leq R < R_{tol}$
Tolerable	$0{,}01 \cdot R_{tol} \leq R < 0{,}1 \cdot R_{tol}$
Negligible	$R < 0{,}01 \cdot R_{tol}$

Presentation of risk assessment results in the form of risk matrix



- m=6 is the number of frequency scale levels; n=4 is the number of consequence scale levels (if m and n are even numbers, the cell field is centrally symmetrical); A-3, A-2,… , A3 are the threshold levels of frequency scale; B-2, B-1, …, B2 are threshold levels of consequence scale; K is the relative spacing of risk scale; R*alw* is the allowable risk level.
- The purpose of the risk matrix is to identify the numeric values of the threshold levels of the frequency and consequence scales based on the specified R*alw* and available statistical data on the frequency and consequences of the considered undesirable (risk) event.

Algorithm of works on maintenance of railway track section according to principles of ISO 55001



Legend

– Process

– Criterion

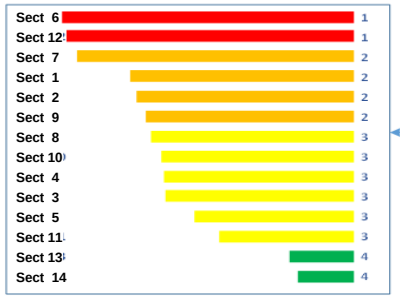
M – maintenance
Vr – real speed
Vsp – specified speed
Th – handled tonnage
Tn – normative tonnage
Tn (concrete steel) =700 mil.gross t.; Tn (wood) = 600 mil.gross t.

Vpas – speed of passenger train
Vfr – speed of freight train
CR – cropped rails
DR – defective rails

* Opposite system of logical inequations corresponding to "NO"

$\begin{cases} Th>Tn \\ Tres<Tad \end{cases}$ and $\begin{cases} Th>Tn \\ Tres>Tad \end{cases}$ and $\begin{cases} Th<Tn \\ Tres<Tad \end{cases}$

Forming of ranking list of sections

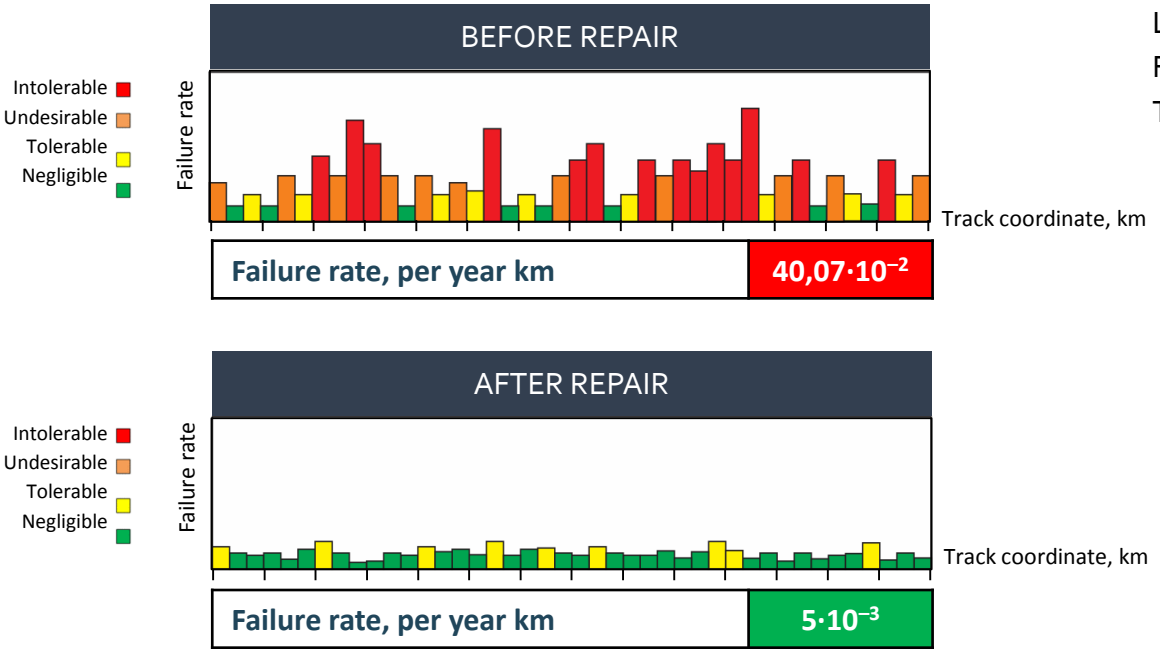


	Section 1	Section 2	Section…	Section M
Roadbed deformation	0,13	0,53	0,13	0,07
Single rail removal	0,53	0,13	0,13	0,07
Cropped rails	0,07	0,27	0,07	0,13
Number of defective clamps	0,13	0,27	0,27	0,07
Number of pumping sleepers	0,27	0,53	0,13	0,07
Perturbation of gauge geometry	0,27	0,13	0,07	0,07
Places of provisional restoration	0,07	0,53	0,13	0,07
TOTAL	0,45	0,64	0,25	0,14
Section priority	2	1	3	3

Efficiency of URRAN in generation of track maintenance planning

This line was included into the maintenance plan based on URRAN methodology, which was executed in 2014.

Karymskaya — Tarskaya line



Technical characteristics

Length : **8,731** km
Freight traffic : **129,9** mil gross t
Tonnage handled : **991,22** mil gross t

EFFECTS

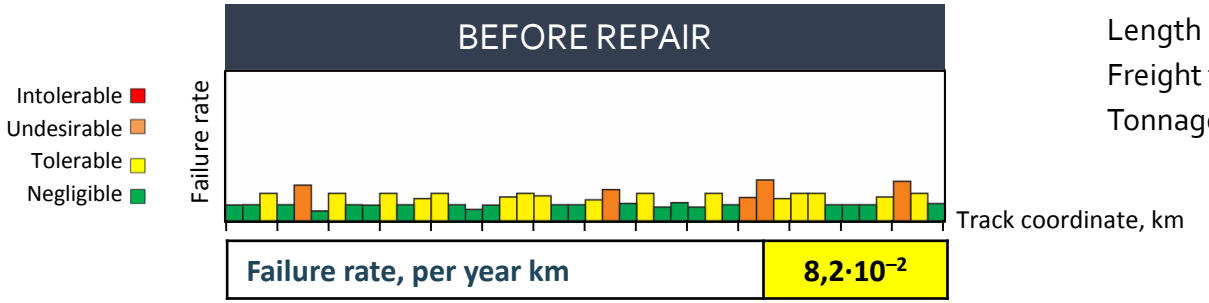
Technical
Reduction of failure rate by **$4{,}02 \cdot 10^{-2}$** per year km

Economic
Reduction of maintenance cost by **13,1** mil RUB

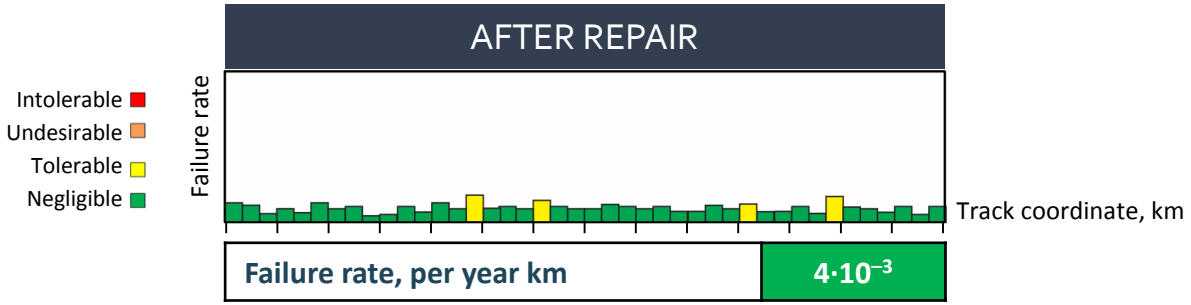
Efficiency of URRAN in generation of track maintenance planning

This line was not recommended by URRAN to be included into the rank, but repair was performed in 2014.

Zudyra — Ulyakan line



Scheduled for maintenance based on URRAN methodology in **2018**.
Overhaul performed in **2014**.



Technical characteristics

Length : **9,974** km
Freight traffic : **37,5** mil gross t
Tonnage handled : **599,87** mil gross t

EFFECTS

Technical

Reduction of failure rate by **4,2·10⁻²** per year km

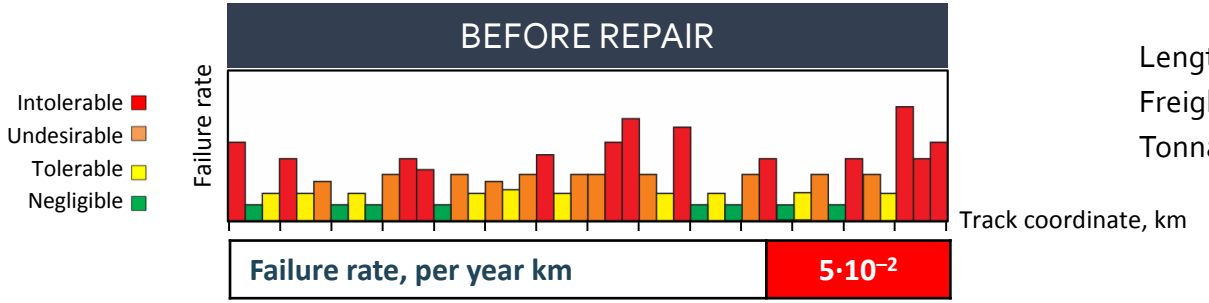
Economic

Contingent losses:
maintenance cost **129,61** mil RUB

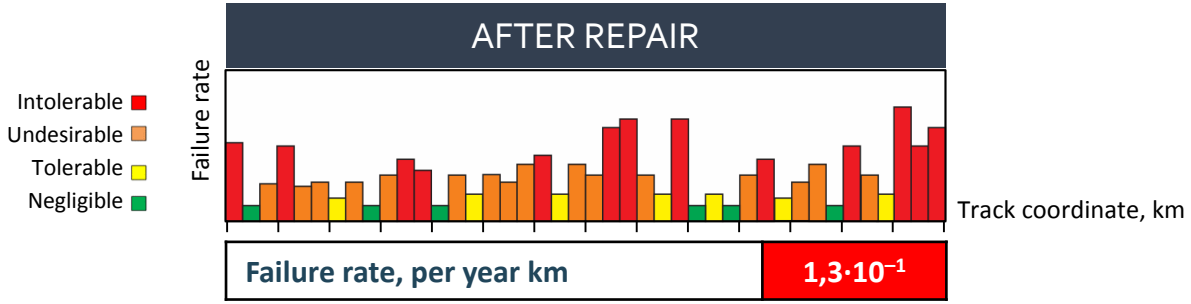
Efficiency of URRAN in generation of track maintenance planning

Track line that should have been repaired based on URRAN methodology, but repair eventually was not performed

St.Punkt 151km — Tahtair line



Recommended for repair based on URRAN in **2014**.
Residual operation — **241,8** mil gross t



Technical characteristics

Length : **13,114** km
Freight traffic : **45** mil gross t
Tonnage handled : **1000,7** mil gross t

EFFECTS

Technical

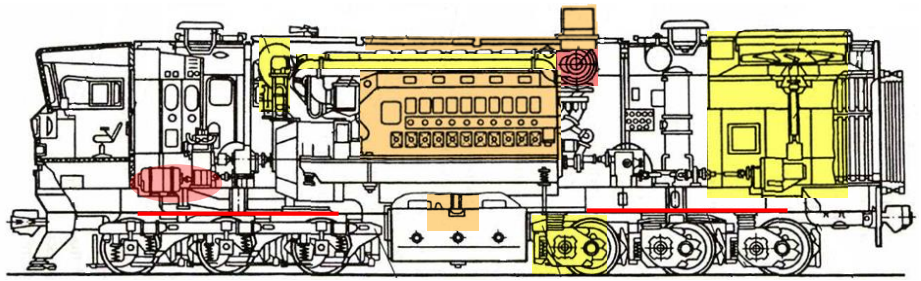
Increase of failure rate by **8·10⁻²** per year km

Economic

Increase of costs for running maintenance of the line by **5,86** mil RUB

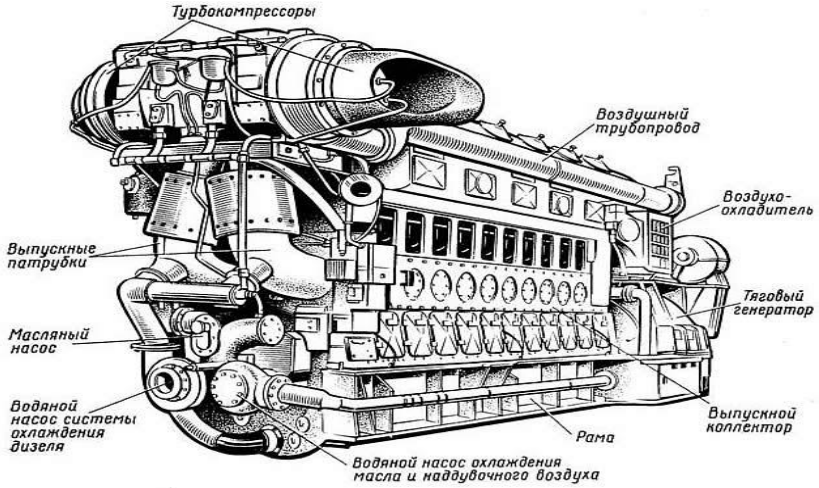
Fire-related risks at traction rolling stock

2ТЭ10



Systems and components of a diesel locomotive	Fire frequency/ per section a year
Diesel exhaust system	$5 \cdot 10^{-4}$
Diesel (other)	$3 \cdot 10^{-4}$
Diesel drainage system	$1 \cdot 10^{-4}$
Cooling system	$1 \cdot 10^{-4}$
Diesel lubricant system	$5 \cdot 10^{-4}$
Diesel fuel system	$5 \cdot 10^{-4}$
Turbo charger	$1 \cdot 10^{-3}$
Traction motor	$8 \cdot 10^{-4}$
Electrical system and equipment	$1 \cdot 10^{-3}$

3ТЭ10



Systems and components of a diesel locomotive	Fire frequency/ per section a year
Diesel exhaust system	$2 \cdot 10^{-3}$
Diesel (other)	$3 \cdot 10^{-4}$
Diesel drainage system	0
Cooling system	$3{,}5 \cdot 10^{-4}$
Diesel lubricant system	$3 \cdot 10^{-4}$
Diesel fuel system	$2 \cdot 10^{-3}$
Turbo charger	$1 \cdot 10^{-3}$

Primary tasks of the situation center

- Safety monitoring of railway infrastructure and rolling stock in operation
- Forecasting the risk of traffic incidents and other events, development of preventive measures
- Quick response to traffic incidents and emergencies, recovery operations
- Reporting to JSC RZD top management of traffic, operations, transportation and fire safety at JSC RZD infrastructure facilities
- About 2 000 messages as regards traffic safety are processed daily by operational shift dispatchers
- About 1 000 000 messages as regards traffic safety are processed monthly by analysis unit specialists

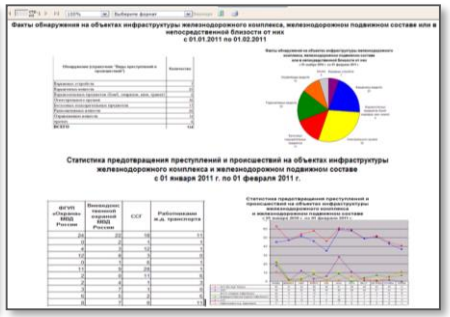
Functions of the situation center

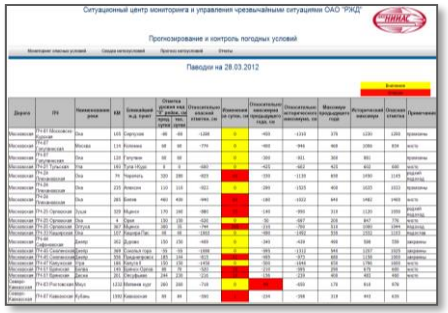
Traffic safety

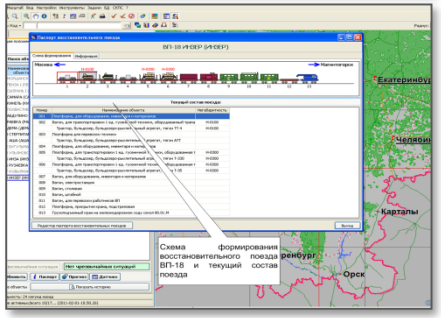
Transportation Safety

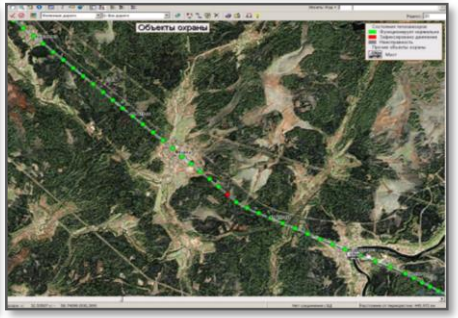
Fire Safety

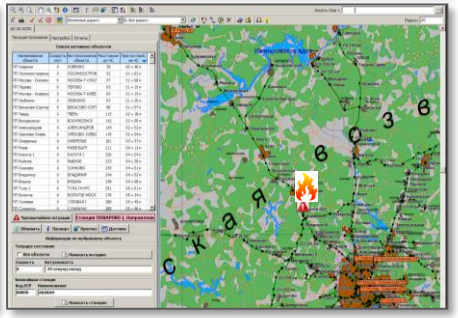
Monitoring of weather conditions











Dispatcher WS Functionality

Automation of data search using key parameters: time, place, site

Real-time automated access to industry-specific systems (over 20 ACSs and WSs)

Custom interface with capability to interface with new resources

Shared panel of situation center duty shift

Single industrial platform

to support dependability and safety of business processes based on risk estimation results of Russian railways in compliance with ISO 55000:2014

I. System for comprehensive management of operational assets at all lifecycle stages

Intended for increased efficiency of company operations based on adaptive management under conditions of limited resources.

- Improvement of work productivity
- Intensification of company infrastructure utilization
- Reduction of industrial disaster risk
- Improvement of capital investment and operational costs efficiency
- Decision-making based on asset condition evaluation
- Improvement of condition and failure prediction accuracy
- Risk, income, costs management at all lifecycle stages of an asset

1.1. Integrated automated system for recording, investigation and analysis of technical failures (KAS ANT)

- Reduction of the number of technical failures
- Improvement of the quality of products acquired from suppliers
- Reduction of downtime at mass production enterprises

1.2. Integrated automated system for recording, investigation and analysis of process violations (KASAT)

- Improvement of the quality of business processes
- Reduction of non-production losses
- Improvement of work productivity and personnel motivation

1.3. Corporate automated system for employee workplace and fire safety knowledge monitoring

- Reduction of labor effort of organization, holding and documentation of training
- Elimination of the human factor in employee rating
- Improvement of technical training planning efficiency

1.4. Integrated automated system for investment projects performance monitoring

- Improvement of timeliness and efficiency of investment projects implementation
- Improvement of accuracy and efficiency of information exchange among project managers, customers, supervisors, asset holders and contractors

Single indsutrial platform

to support dependability and safety of business processes based on risk estimation results of Russian railways in compliance with ISO 55000:2014

II. Innovative technologies of supervision and control of technical safety

Intended for condition monitoring of fire, industrial and environmental safety, analysis and planning of related activities.

- Improvement of fire, industrial and environmental safety
- Reduction of charged penalties
- Optimization of insurance expenditures
- Improvement of the efficiency of capital and operational expenditures related to the above safety activities

2.1. Automated systems for industrial safety management of dangerous manufacturing facilities

- Reduction of charged penalties related to industrial safety violations
- Optimization of insurance of dangerous manufacturing facilities
- Electronic delivery of information on operational supervision of dangerous manufacturing facilities
  to the Federal Environmental, Industrial and Nuclear Supervision Service of Russia
- Ensuring accuracy and immediacy of information on dangerous manufacturing facilities
- Improvement of industrial safety

2.2. Automated system for fire safety management of protected facilities

- Improvement of efficiency of fire safety supervision of protected facilities
- Improvement of efficiency of fire prevention activities
- Reduction of charged penalties related to fire safety violations
- Improvement of efficiency of fire safety activities implementation through objective evaluation of fire risks

2.3. Automated system for environmental safety and nature protection activities management

- Improvement of efficiency of natural resources management supervision
- Improvement of the accuracy and immediacy of accountancy through automated document management
- Reduction of costs related to submission of reporting documentation to national executive authorities through electronic reporting
- Improvement of objectivity of natural resources management analysis
- Insurance of efficiency of environmental protection activities planning
- Insurance of efficiency of environmental protection activities
- Reduction of charged penalties related to environment protection legislation
- Reduction of natural resources management payments to the minimum possible level

Single indsutrial platform

to support dependability and safety of business processes based on risk estimation results of Russian railways in compliance with ISO 55000:2014

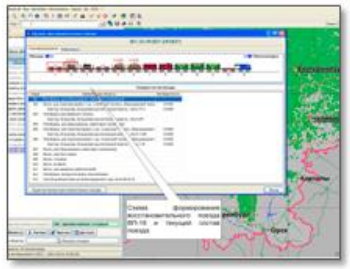
III. Situation Center

Intended for reduction of harm caused by incidents, accidents, emergencies, industrial disasters through monitoring of infrastructure facilities operation and support of recovery of reference operating modes.

The technology is designed for large factories, retail chains, industrial facilities for business process safety monitoring and immediate incident recovery.

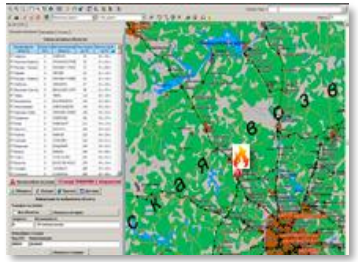
- Reduction of harm caused by incidents, accidents, emergencies, industrial disasters.
- Improvement of manageability and interaction under emergency conditions through integration of major Russian enterprises into the national control system of Emergency and Defense Ministries situation centers.

Traffic safety

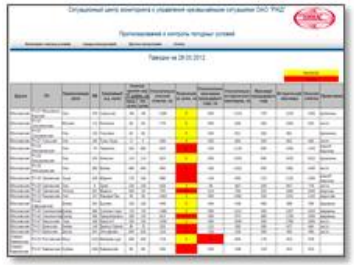


Transportation security

Fire safety



Monitoring of weather conditions



There is no limit for perfection,
once started you should continue…