UIC Railway Asset Management
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ISO 55001 compliant risk management system for railways

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Quotes

— Certainly, riding a motorcycle has its risks: in case of an accident the chance of grave injuries is higher that when driving a car. On the other hand, you constantly think of it and become more careful in all senses. People sometime fall asleep while driving, but never doze on a motorcycle.

— ***Malcolm Forbes***,
publisher of Forbes magazine

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

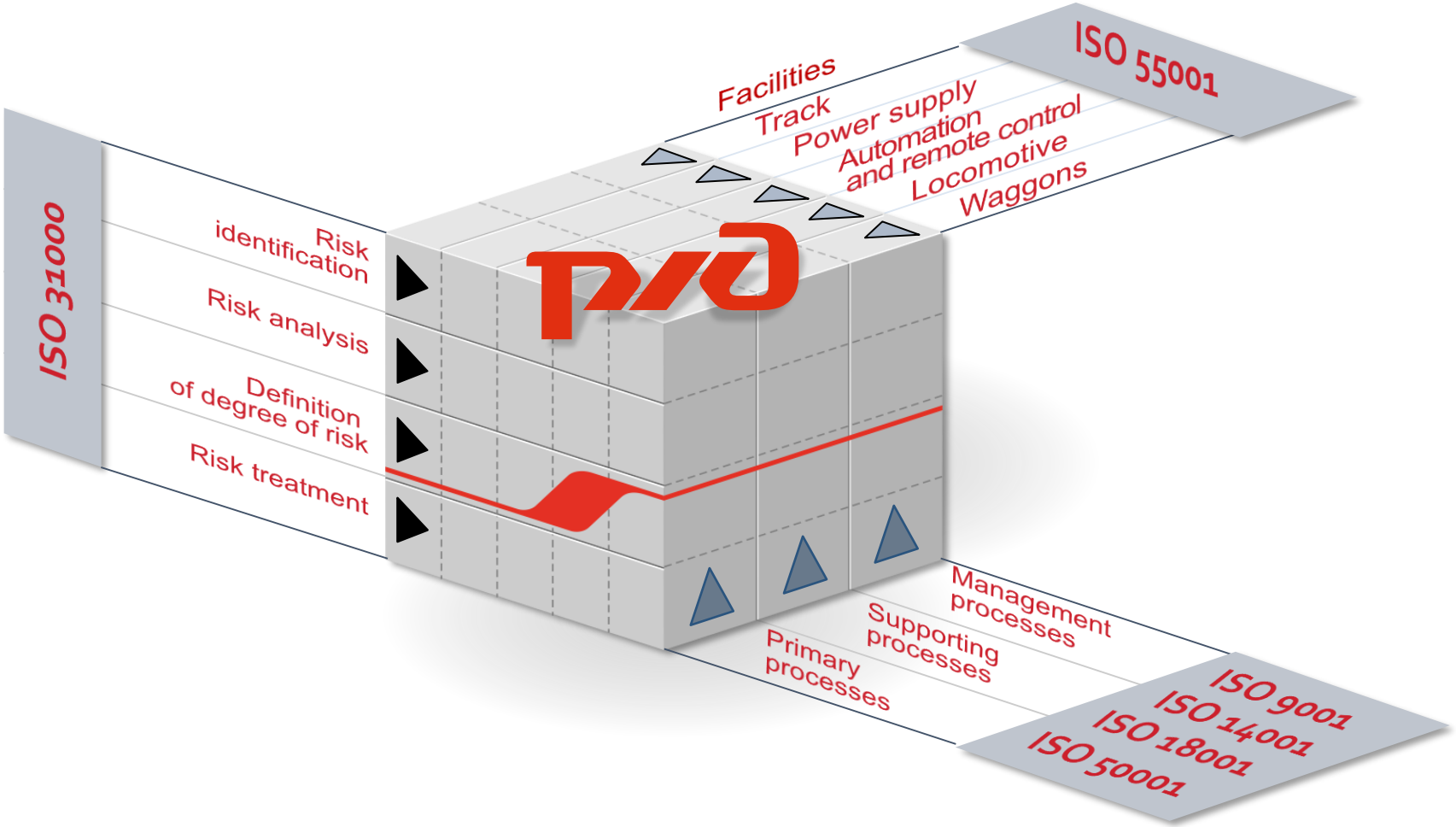
«Understanding and managing risk is a universal requirement throughout ISO 55001. It is particularly prevalent in the definition and implementation of the overall Asset Management System, in planning what to do to the assets to manage risks, and in operations, i.e. doing things to the assets to manage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

(ISO 55001, item 1.5.3 The treatment of risk)

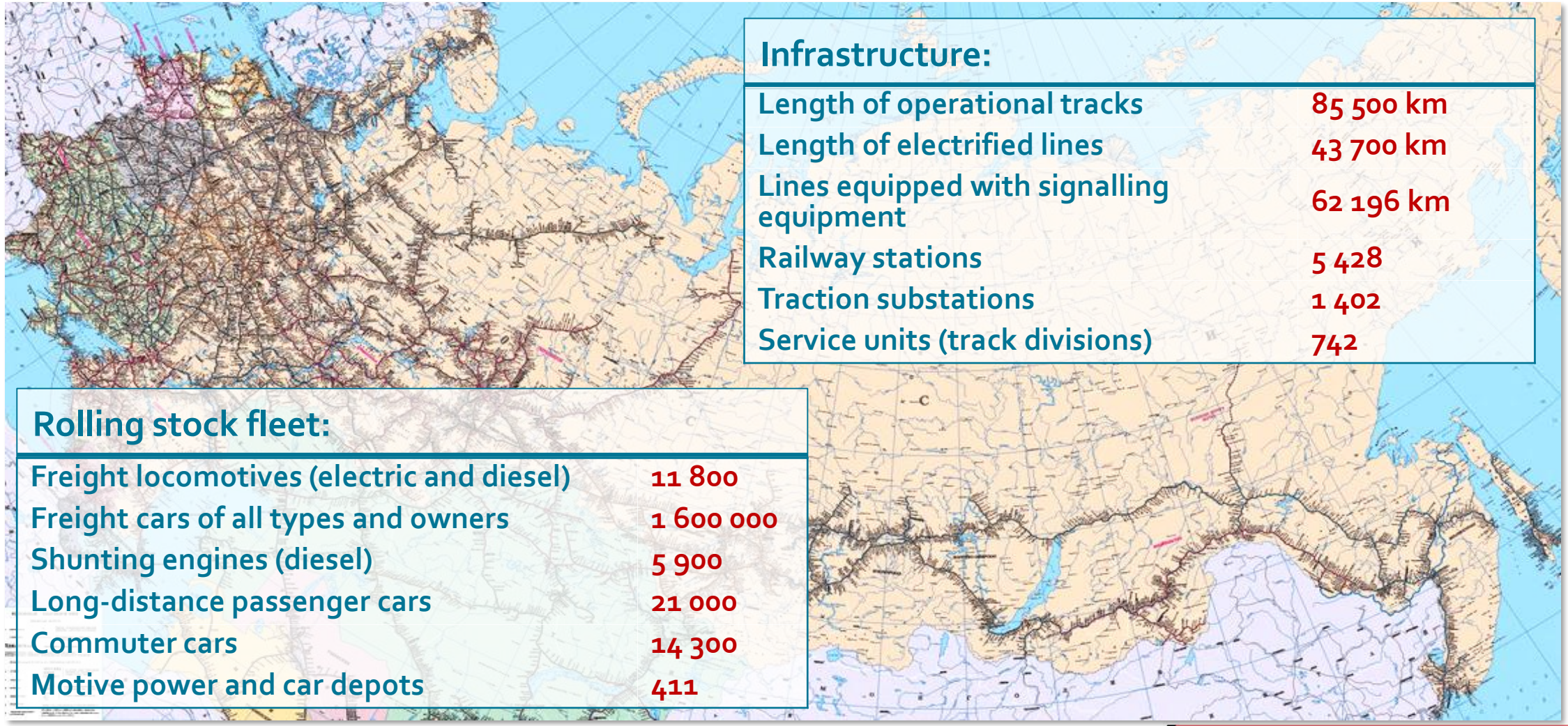
Main principles of risk management as part of deployment of asset management system as per iso 55001

- 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



Infrastructure and rolling stock facilities of JSC RZD



Infrastructure:

Length of operational tracks	85 500 km
Length of electrified lines	43 700 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)	11 800
Freight cars of all types and owners	1 600 000
Shunting engines (diesel)	5 900
Long-distance passenger cars	21 000
Commuter cars	14 300
Motive power and car depots	411

URRAN (asset management project)

– set of standards, methods and guidelines used for management of life-cycle processes of the Russian railways according to ISO 55001

OBJECTS OF TECHNICAL REGULATION

Track facilities

Facilities of electrification and power supply

Facilities of signaling and remote control

Telecommunication facilities

Locomotive facilities

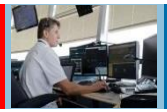
BASIC PROCESES OF RAILWAY TRANSPORT TECHNICAL MAINTENANCE

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

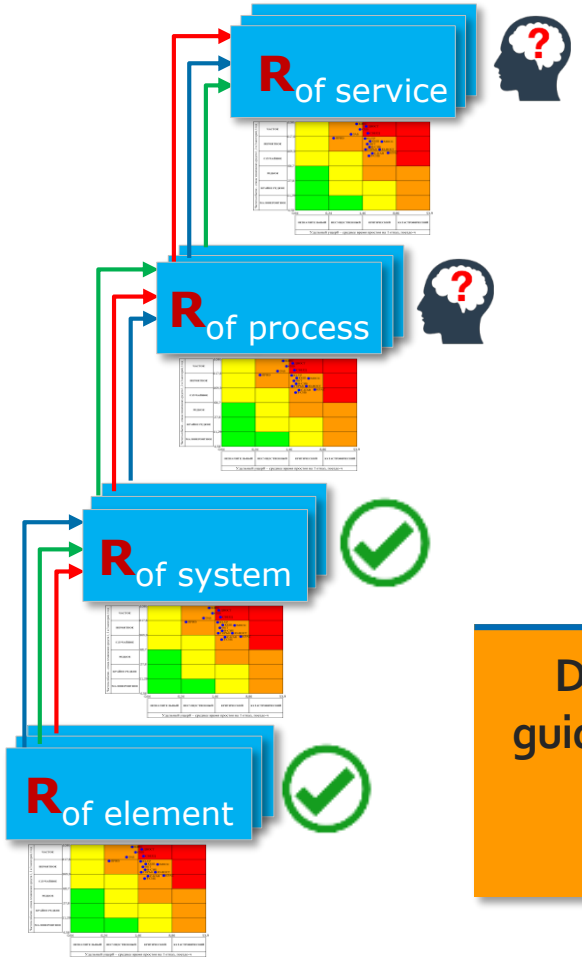
URRAN normative and methodological framework — 125 documents

Purpose of URRAN introduction: increase of the efficiency of railway transport operation based on adaptive management under the conditions of scarce resources

URRAN functions

1		Real-time assessment and prediction of dependability and safety indicators of infrastructure facilities and rolling stock
2		Risk management
3		Assessment of wear, residual operating life and limit state of infrastructure facilities and rolling stock
4		Prediction of infrastructure facilities condition, prediction of track prefailures
5		Assessment of life cycle cost of infrastructure facilities and rolling stock
6		Assessment of RZD units activities based on the actual dependability and safety indicators of operated infrastructure facilities and rolling stock
7		Management of resources directed towards the maintenance of infrastructure facilities and rolling stock
8		Managerial decision support using URRAN single corporate platform

Development of risk management system in JSC RZD

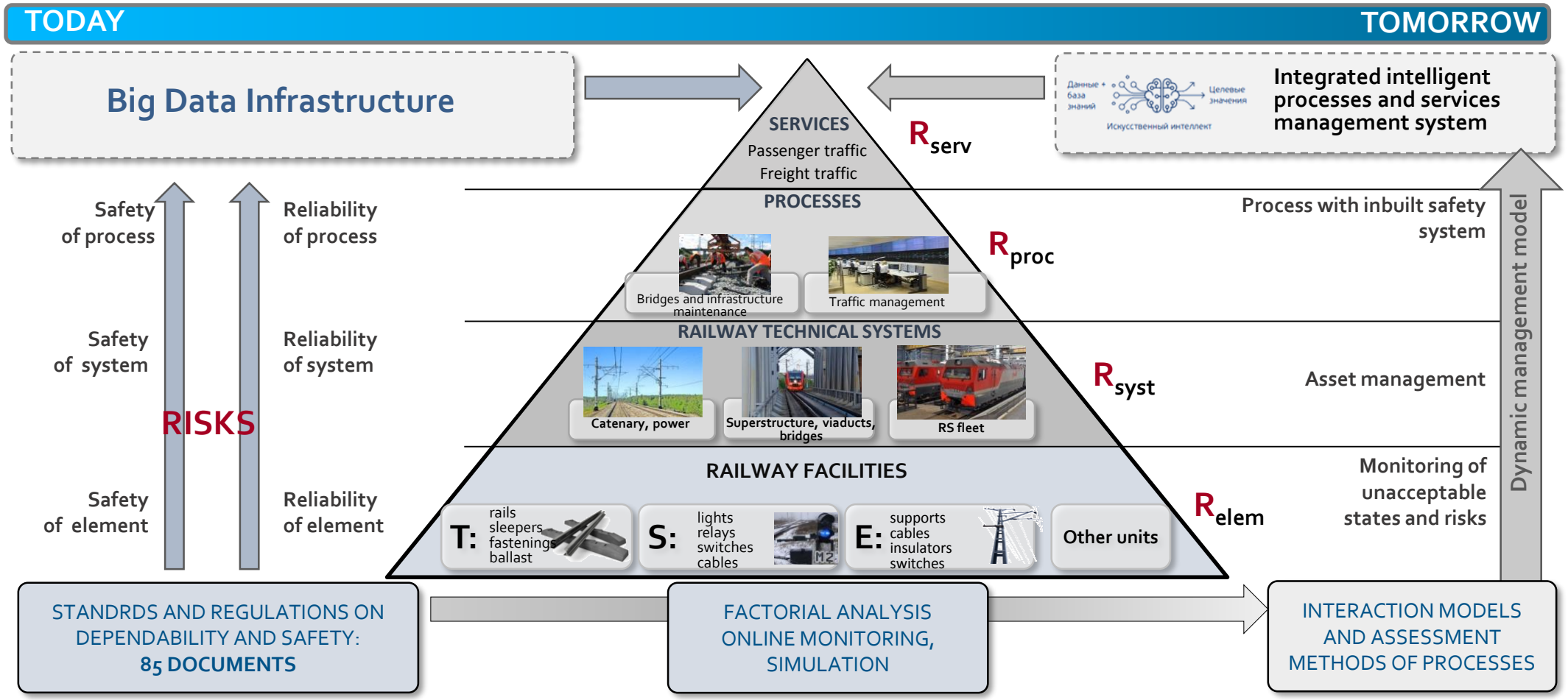


Development of company's risk management system based on crossfunctional interaction of business units using SCP URRAN

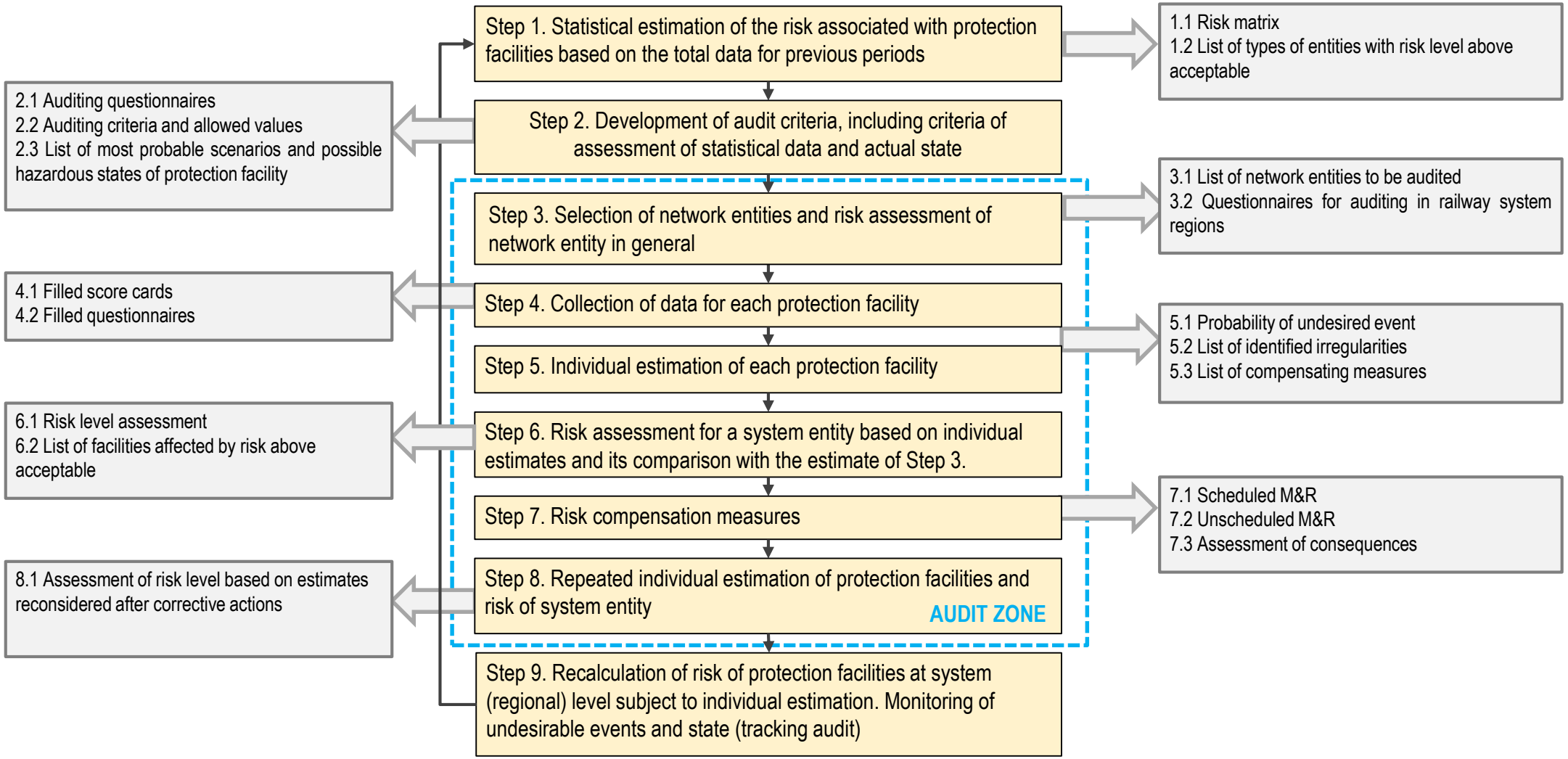
Development and implementation of algorithms: aggregation of risks, estimation of integral risks, evaluation of the risks of processes, decision-making

Development and implementation of standards and guidelines, as well as tools to assets the item-related risk (standards, methods, recommendations for risk matrix construction)

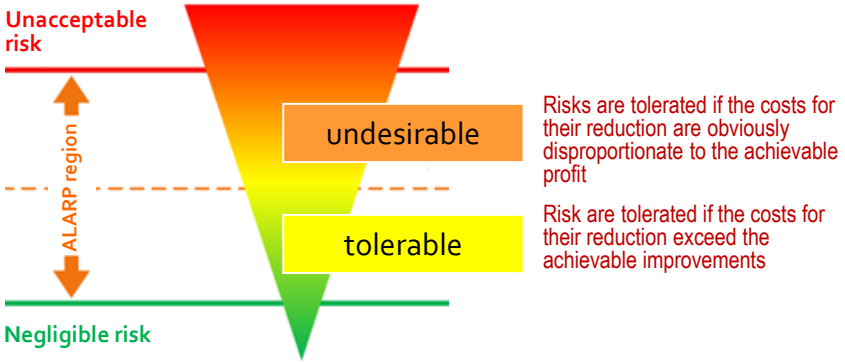
Items and functions hierarchy of asset management in railway transportation

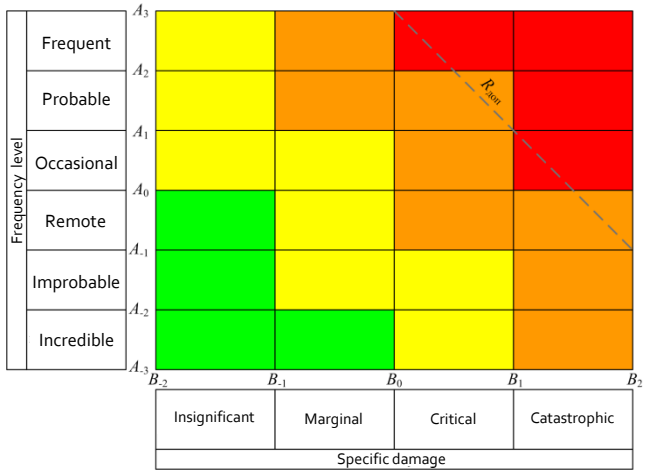


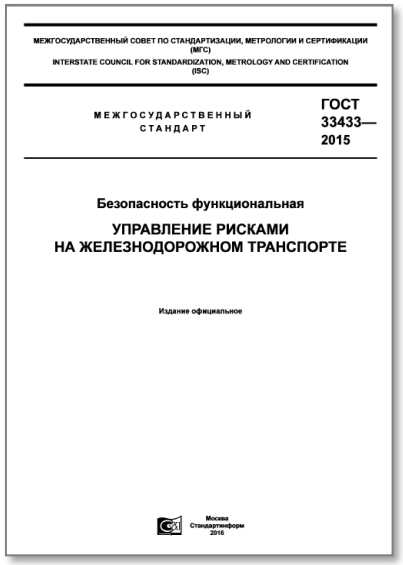
General risk management algorithm (9 steps)



Standardization of risk management and risk matrix construction in URRAN







МЕЖГОСУДАРСТВЕННЫЙ СОВЕТ ПО СТАНДАРТИЗАЦИИ, МЕТРОЛОГИИ И СЕРТИФИКАЦИИ (МГС)
INTERSTATE COUNCIL FOR STANDARDIZATION, METROLOGY AND CERTIFICATION (ISC)

МЕЖГОСУДАРСТВЕННЫЙ СТАНДАРТ

ГОСТ 33433—2015

Безопасность функциональная

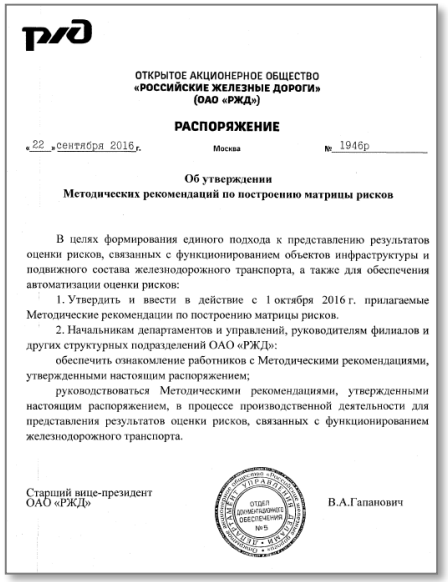
УПРАВЛЕНИЕ РИСКАМИ НА ЖЕЛЕЗНОДОРОЖНОМ ТРАНСПОРТЕ

Издание официальное

Москва Стандартинформ 2016

- 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.

- The guidelines formalize the risk matrix construction procedure and improve the reliability of data through correct generation of risk matrix parameters that are associated with actual statistical data



ОТКРЫТОЕ АКЦИОНЕРНОЕ ОБЩЕСТВО «РОССИЙСКИЕ ЖЕЛЕЗНЫЕ ДОРОГИ» (ОАО «РЖД»)

РАСПОРЯЖЕНИЕ

«22» сентября 2016 г. Москва № 1946р

Об утверждении Методических рекомендаций по построению матрицы рисков

В целях формирования единого подхода к представлению результатов оценки рисков, связанных с функционированием объектов инфраструктуры и подвижного состава железнодорожного транспорта, а также для обеспечения автоматизации оценки рисков:

1. Утвердить и ввести в действие с 1 октября 2016 г. прилагаемые Методические рекомендации по построению матрицы рисков.

2. Начальникам департаментов и управлений, руководителям филиалов и других структурных подразделений ОАО «РЖД»:

обеспечить ознакомление работников с Методическими рекомендациями, утвержденными настоящим распоряжением;

руководствоваться Методическими рекомендациями, утвержденными настоящим распоряжением, в процессе производственной деятельности для представления результатов оценки рисков, связанных с функционированием железнодорожного транспорта.

Старший вице-президент ОАО «РЖД» В.А.Гапанович

Risk-oriented model of occupational safety management. Algorithm of risk assessment and compensating measures

Step 1. System-wide risk assessment based on event statistics. Generation of the list of hazardous occupations

Step 2. Selection of the directorate, in which state-based risk assessment will be performed

AUDIT

Step 3. Audit of the management system and processes implemented in a division

Step 4. Individual assessment of the hazard of identified states and risks by means of score cards

Step 5. Risk compensation measures

Step 6. Reconsideration of individual assessments of employees' occupational risks. Safety reporting

Step 7. Recalculation of occupational risks at system (regional) level subject to individual assessments.

Risk assessment based on statistical criteria

Risk matrix and base risk levels based on statistics (at central and regional levels)

List of hazardous factors that cause injuries (heights, electric current, etc.)

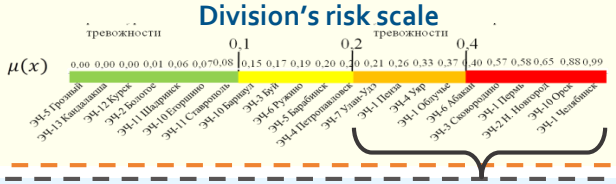
Audit of processes, whose realization affects the probability of injury

Hazardous factor: fall from heights
Criterion: number of wooden poles decayed beyond the allowed level

Hazardous factor: electric current
Criterion: provision of means of communication with power dispatchers

Score cards and questionnaires for auditing of processes

Division's risk scale



Increased duration of possession

Training

Provision of protective gear

Provision of tools

COMPENSATING MEASURES TO BLOCK HAZARDOUS FACTORS

Risk assessment subject to adopted measures

Rolling stock fire risks management system of JSC RZD

1 Identification of critical series (risk matrix)

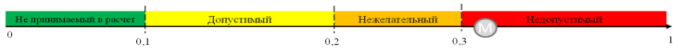
2 Development of score card for individual risk calculation

№	Часть узла	№	Пожароопасное состояние	Отметка о наличии		
1	Правый борт	1.3	Подтеки масла в соединениях трубопроводов	V	0,058	0,05
4	Полнопоточный фильтр (при наличии)	4.1	Крепление маслопроводов к фильтру ненадежно, подтеки масла	V	0,058	
		4.2	Наличие следов потертостей, не устраненных механических повреждений масляных трубопроводов	V	0,058	
5	Маслоперекачивающий насос	5.2	Следы утечки масла	V	0,058	
6	Левый борт	6.3	Подтеки масла в соединениях трубопроводов	V	0,058	
						0,29

3 Individual fire safety auditing of critical locomotive series (spring commission inspection)

Клицы повреждены	
Грязь и подтеки масла	V
Кабели ненадежно закреплены в клице	V

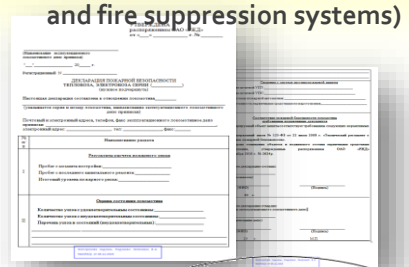
4 Assessment of the probability of fire in each locomotive

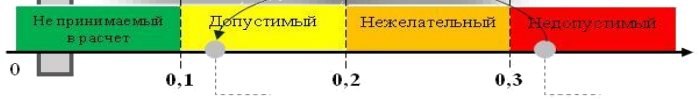


5 Planning of fire probability reduction measures

6 Selection of most efficient fire prevention measures

Declaration of compliance (with description of technical state and fire suppression systems)





- Performed in depot
- Performed by central and regional directorates

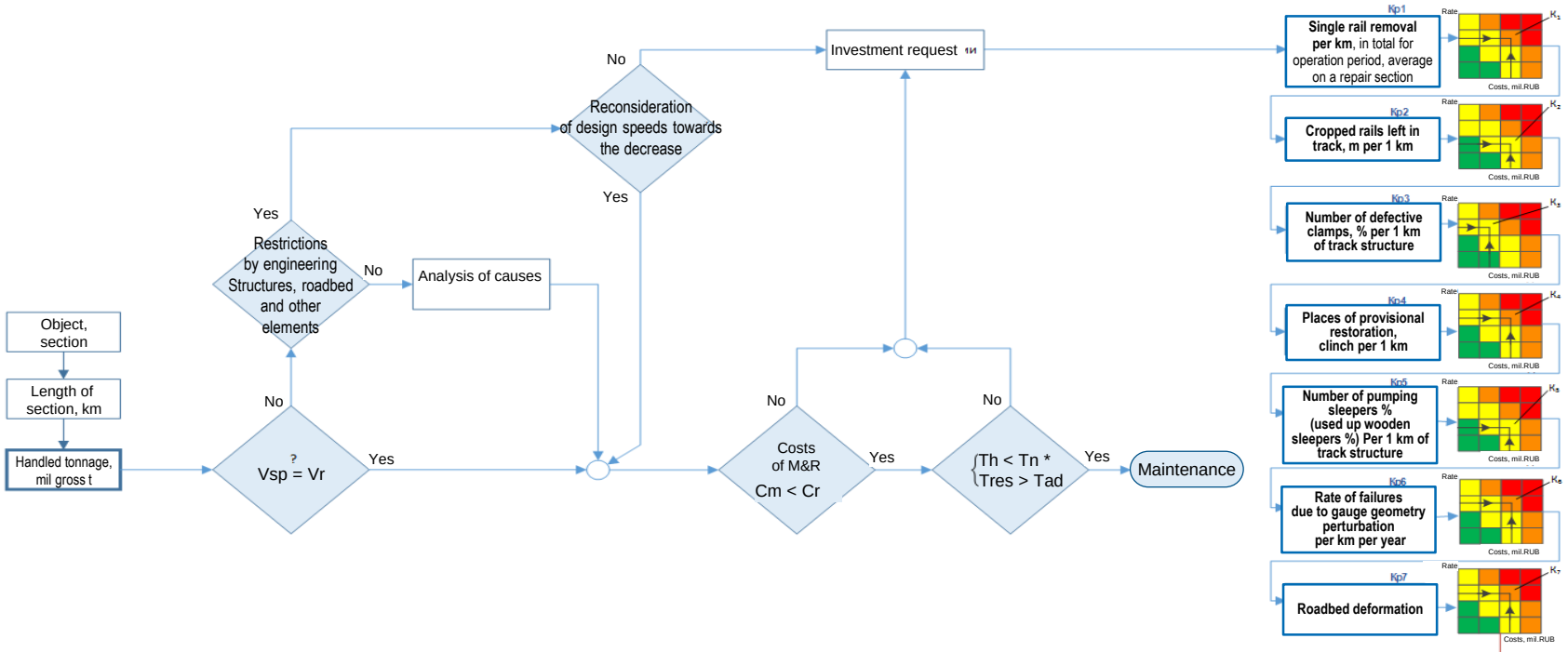
Primary metal elements of a railway bridges, whose state defines the level of risk

Estimates of the risk of corrosion of bridges and recommended year of corrosion protection activities

№	Value name	**Bridge no. 1** Gudermes - Samur line on the Azerbaijani border	**Bridge no. 2** Krymskaya - RZD line	**Bridge no. 3** Lozovaya - Rostov line	**Bridge no. 4** ETC 9 km - Timashevskaya line	**Bridge no. 5** Prokhladnaya - Gudermes line	**Bridge no. 6** Armavir - Minvody line
1	Risk of corrosion of metal bridge spans	Undesirable	Intolerable	Undesirable	Intolerable	Intolerable	Intolerable
2	Risk of corrosion of ties of main girders of metal spans	Negligible	Negligible	Intolerable	Negligible	Negligible	Negligible
3	Risk of corrosion of footpaths	Undesirable	Negligible	Undesirable	Negligible	Negligible	Negligible
4	Risk of corrosion of strings/ramps	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
5	Overdue* corrosion protection	Tolerable	Tolerable	Tolerable	Tolerable	Tolerable	Tolerable
6	Level of priority based on line class	Tolerable	Undesirable	Tolerable	Intolerable	Tolerable	Undesirable
7	Level of priority based on proximity of population	Tolerable	Tolerable	Tolerable	Tolerable	Tolerable	Tolerable
Integral risk figure		0,27	0,33	0,47	0,40	0,29	0,33
Integral level of risk		**Tolerable**	**Undesirable**	**Intolerable**	**Undesirable**	**Undesirable**	**Undesirable**
Recommended year of activities		**2021**	**2019**	**2018**	**2019**	**2019**	**2019**
Declared cost of activities, rubles		2 554 275,20	3 302 159,20	8 097 384,20	2 137 145,20	22 241 761,00	5 160 234,40

* Past due date is defined based on the assumption that a delay of up to 5 years is acceptable due to mass failure to meet the deadlines for railway bridges painting

Algorithm of track maintenance according to URRAN risk-oriented criteria



Legend

— Process

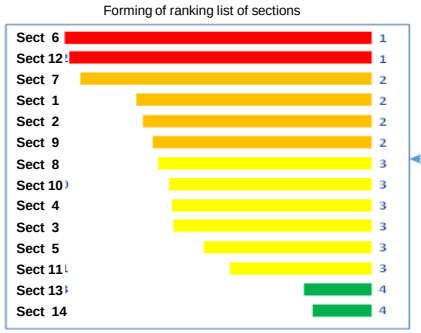
— Criterion

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"

{Th>Tn, Tres<Tad} and {Th>Tn, Tres>Tad} and {Th<Tn, Tres<Tad}

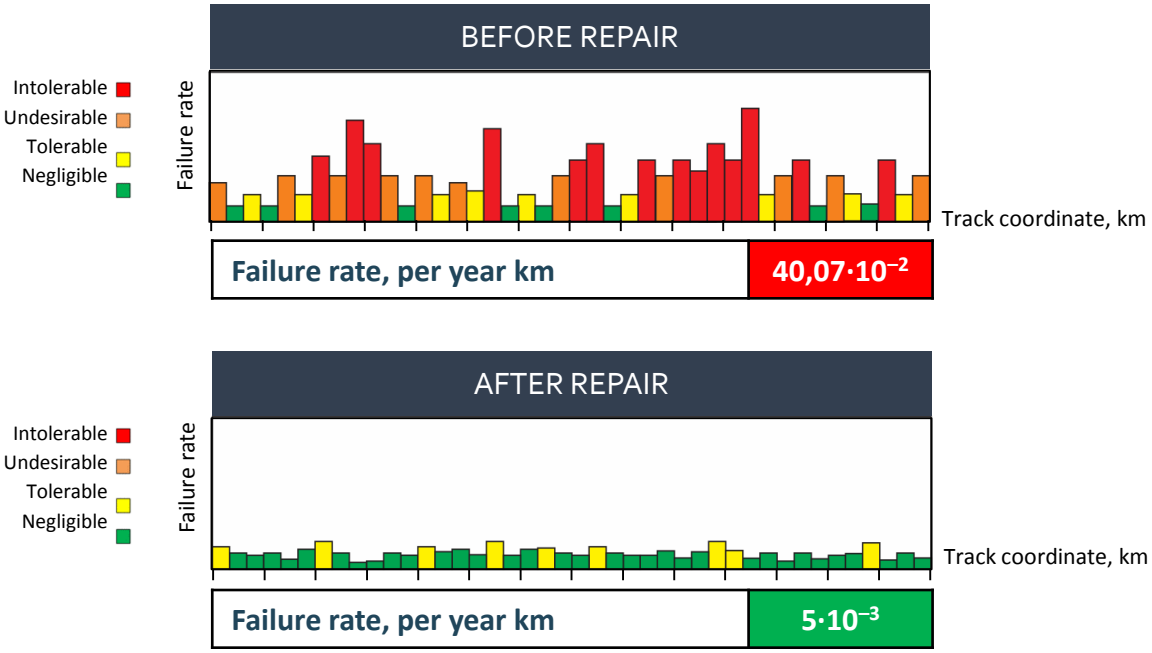


	Section 1	Section 2	Section…	Section M
Roadbed deformation	0,13	0,53	0,13	0,07
Single rail removal	0,53	0,13	0,13	0,07
Cropped rails	0,07	0,27	0,07	0,13
Number of defective clamps	0,13	0,27	0,27	0,07
Number of pumping sleepers	0,27	0,53	0,13	0,07
Perturbation of gauge geometry	0,27	0,13	0,07	0,07
Places 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.

KARYMSKAYA — TARSKAYA LINE



TECHNICAL CHARACTERISTICS

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

EFFECTS

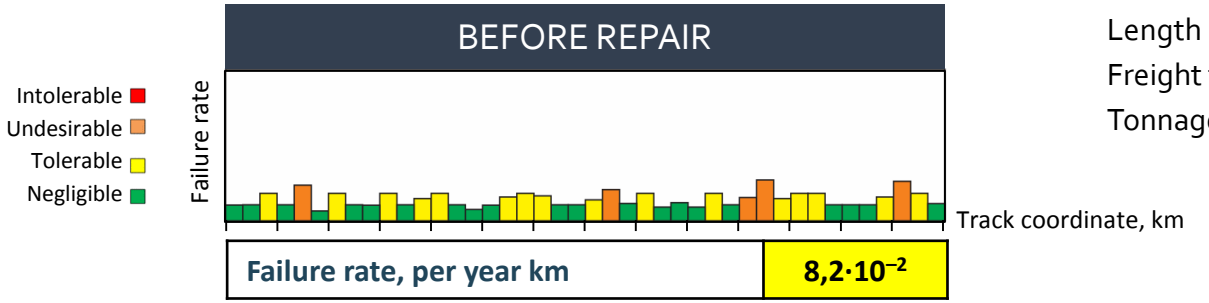
Technical
Reduction of failure rate by **4,02·10⁻²** per year km

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

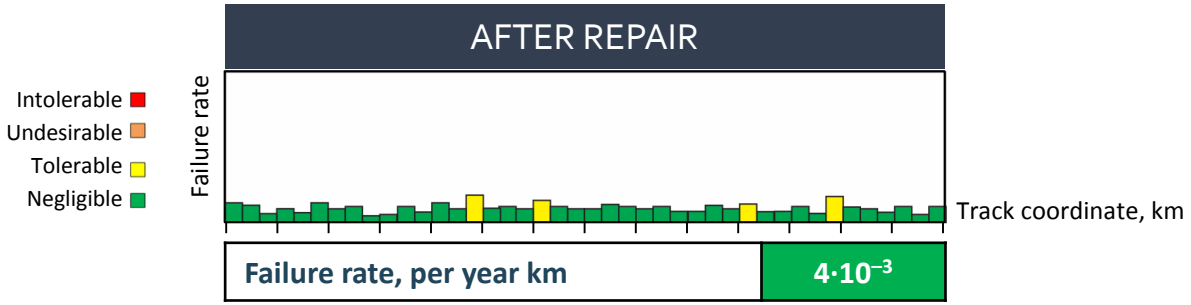
Efficiency of URRAN in generation of track maintenance planning

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

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

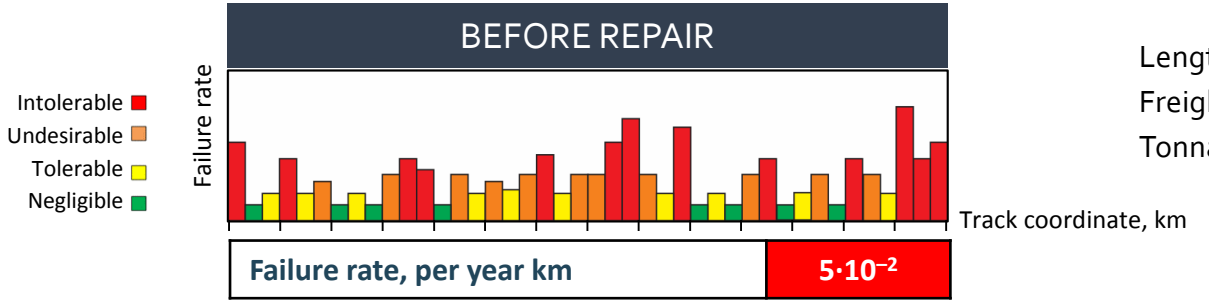
Economic

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

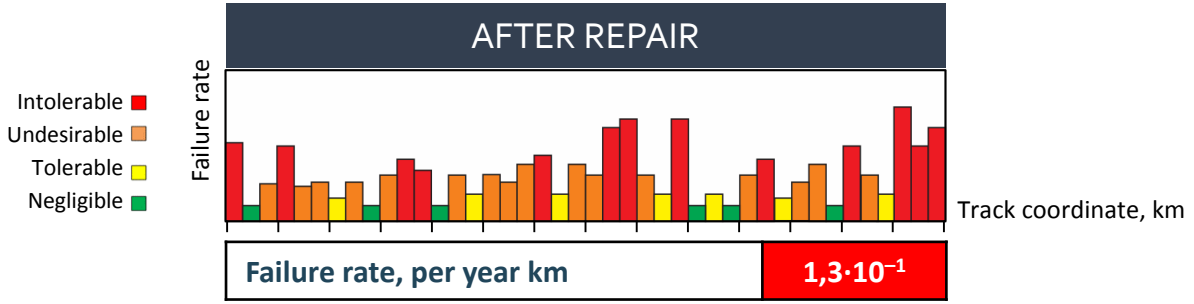
Efficiency of URRAN in generation of track maintenance planning

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

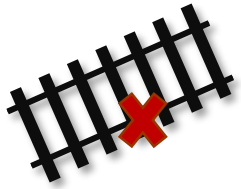
Technical

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

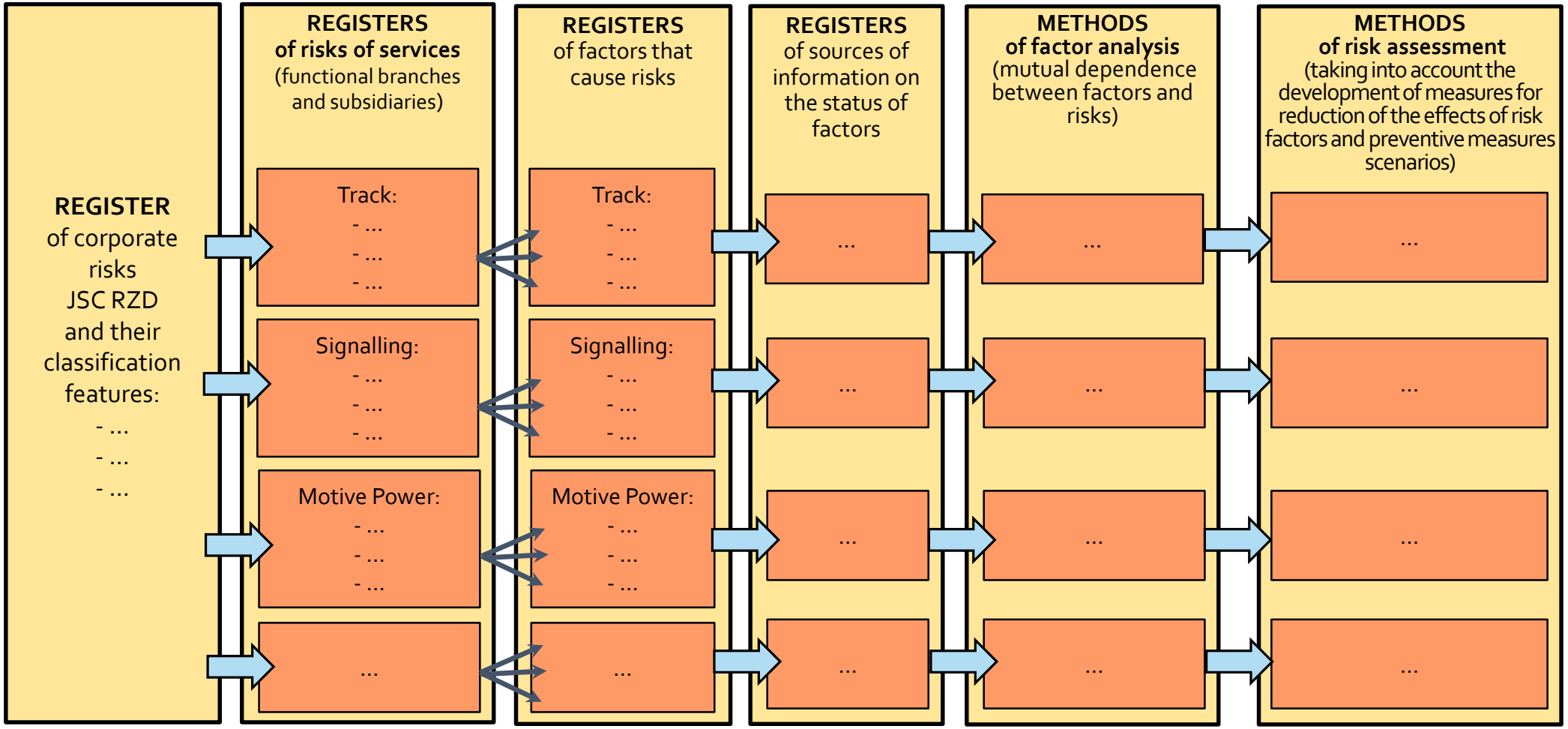
Practical results of risk management (1)

	**Risk of pedestrian injury at crossings** Recommendations for pedestrian crossings renovation	**Effect:** Improved pedestrian safety at crossings
	**Risk of rolling stock derailment due to broken bogie solebar** Recommendations for scheduled condition inspection of solebars to identify cracks and prevention of destruction	**Effect:** 15 % reduction of the number of broken solebars
	**Risk of corrosion of railway bridges** Recommendations for timing of painting	**Effect:** Yearly saving of 40 mln rub.
	**Risk of failure of railway track** Recommendations for maintenance assignment based on risk level	**Effect:** Yearly reduction of maintenance costs by 8 mln rub. per 1000 km.

Practical results of risk management (2)

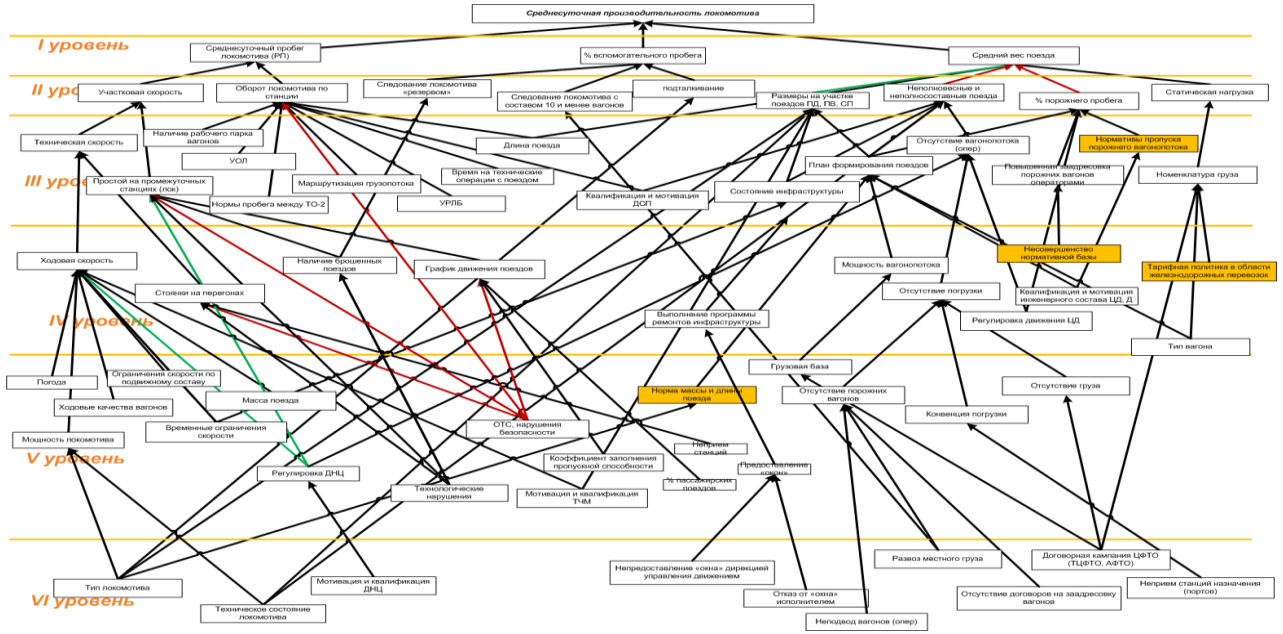
	**Fire risk** of locomotives (traction substations, computer centers) Recommendations for scheduled inspection of fire safety status of locomotives (traction substations, computer centers). Identification of fire hazard states	**Effect**: 40-60 % reduction of the number of fires. Economic effect of about 10 mln rub. per year
	**Professional risks** Recommendations for improved occupational safety	**Effect**: 10 % reduction of the number of incidents per year. Economic effect of 50 mln rub. per year
	**Environmental risks** Recommendations for measures to reduce environment pollution. Assessment of the economic efficiency of measures	**Effect**: 25 % reduction of water and air pollution. Economic effect of 88 mln rub. per year
	**Traffic safety risks** Recommendations for identification of flawed technical systems and human errors. Development of measures for improved train traffic safety	**Effect**: Improved train traffic safety

Structure diagram of risk management in railway transportation

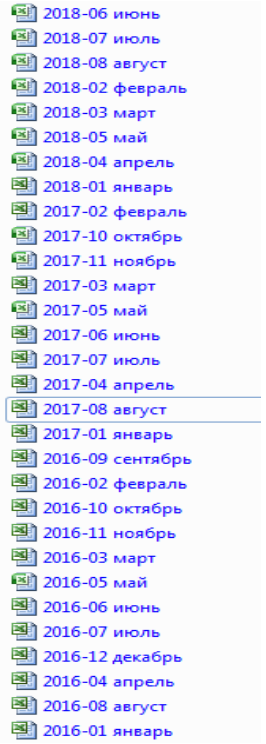


Intellectual statistics-based data analysis (with the example of the analysis of average daily performance of a locomotive)

1) Over 50 factors affecting the average daily performance of a locomotive



2) Statistics of each factor's values



3) Unknown are the values of a complete set of factors that would allow using classic formulas

A MODEL IS REQUIRED THAT WOULD SIMULTANEOUSLY TAKE INTO ACCOUNT A NUMBER OF FACTORS

URRAN single information environment

1 PARADIGM

Successful asset management requires reliable information and knowledge of assets conditions, productivity, risks and costs, as well as their interrelation.
(ISO 55000:2014)

2 GOAL

Provision of reliable, complete and timely information on company assets management

3 TRACK

Establishment of a single information environment for railway equipment developers, manufacturers and operators, as well as maintenance enterprises based on the Single Corporate Platform for Management of Resources, Risks and Dependability at Lifecycle Stages of Railway Facilities (EKP URRAN)

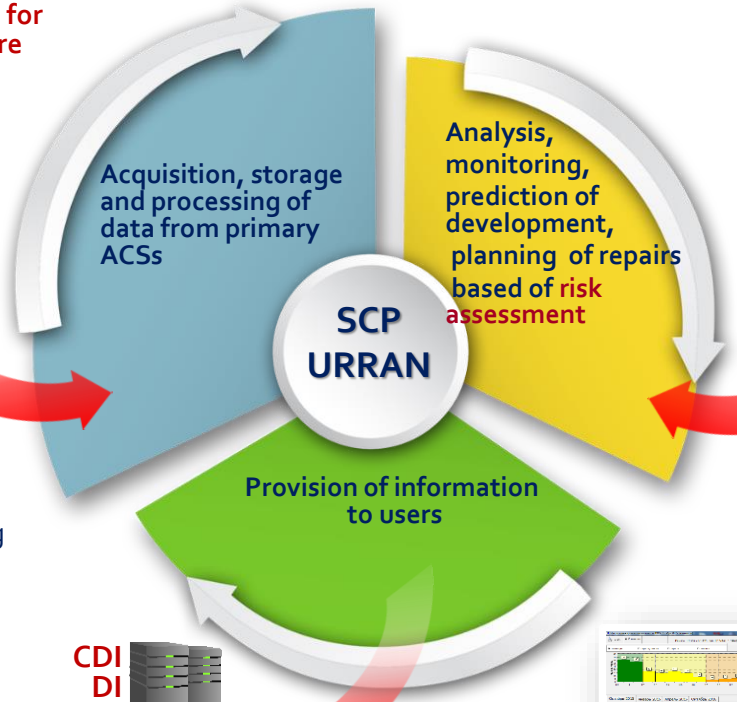
Integration of large amounts of raw data in SCP URRAN

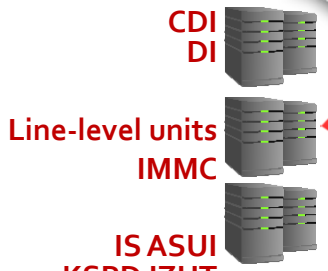
Collection and processing of large amounts of heterogeneous information, including raw data, for fullest possible list of parameters of infrastructure facilities obtained by means of diagnostics

Multidimensional non-linear statistical data analysis

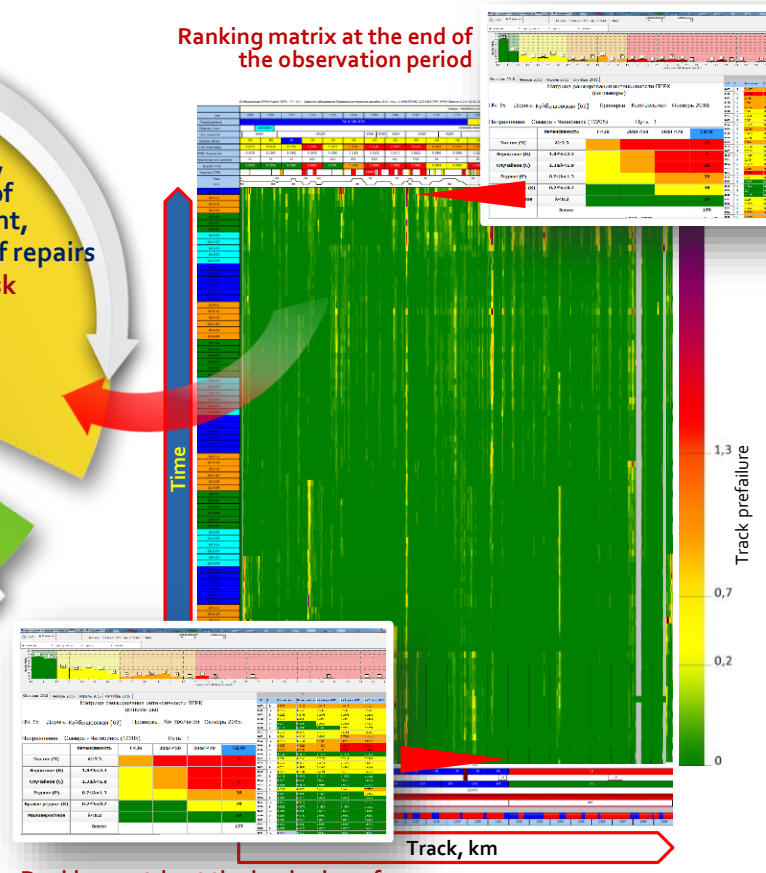
Functions:
- real-time operation of infrastructure and rolling stock
- maintenance
- monitoring, prediction of further development
- condition-based planning of repairs

Access of executives, engineers and experts to information from any **workstation connected to the JSC RZD Intranet**





Track condition map



Actions to address risks and opportunities for the asset management system (clause 6.1)

Recommended Evidence

- ✓ Risk management framework, processes and risk assesment criteria
- ✓ Risk management governance and escalation processes
- ✓ Corporate risk matrix (combines risk assesment criteria)
- ✓ Evidence of active use of risk management techniques and reliability engineering methods
- ✓ Risk registers at various levels of the organisation
- ▪ Alignment of risk assessments and risk registers
- ▪ Lifecycle cost models and outputs relating to costs, work volumes, performance and risk
- ▪ Process(es) for monitoring and assuring risk treatment actions and, where appropriate, closure of risks through appropriate planning and execution of work
- ▪ Traceability back to a common risk management approach and Asset Management decision making criteria (of which the risk assessment criteria are one example)

Thank you for your attantion!