PARIS 2 ► 7 OCTOBER 2016 ► Pullman Bercy Hotel

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Developing the Risk Management System

in the field of traffic safety on the infrastructure of Russian Railways

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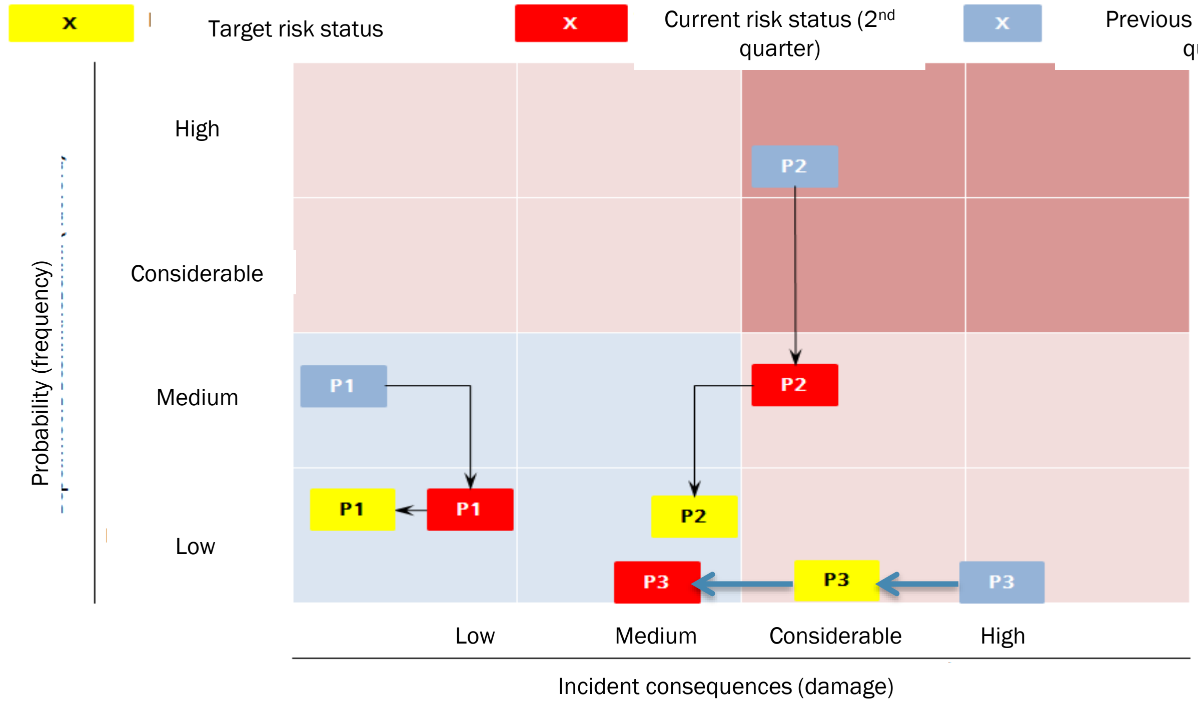
Risk Management Objectives &Tasks

The risk management objective is to reduce existing risks and to maintain them at an acceptable level.

Tasks:

- To form the regulatory and methodological framework for risk management;
- To distribute risk management powers and responsibilities between structural subdivisions and management levels;
- To regulate the risk management activities of employees and structural subdivisions;
- To develop a risk register and update it regularly;
- To identify, assess, monitor and review risks on a regular basis;
- To develop and implement risk processing measures;
- To develop and introduce procedures for risk monitoring and assessing the effectiveness of risk management measures;
- To develop and introduce procedures for keeping the management and stakeholders informed about current risks.

Key Risks For RZD Infrastructure



Transport incident risks

P1 – *Rolling stock collision at rail sections or stations during operation or shunting for the following reasons:*

violation of equipment operation

acts of unlawful interference, man-made and natural disasters

P2 – *Derailment of rolling stock at rail sections or stations during operation or shunting for the following reasons:*

violation of equipment operation

potentially hazardous products

technology violations during equipment repair and maintenance

- Collision of rolling stock with road vehicles at railway level-crossings for the following reasons:

Traffic rules violations by vehicle drivers

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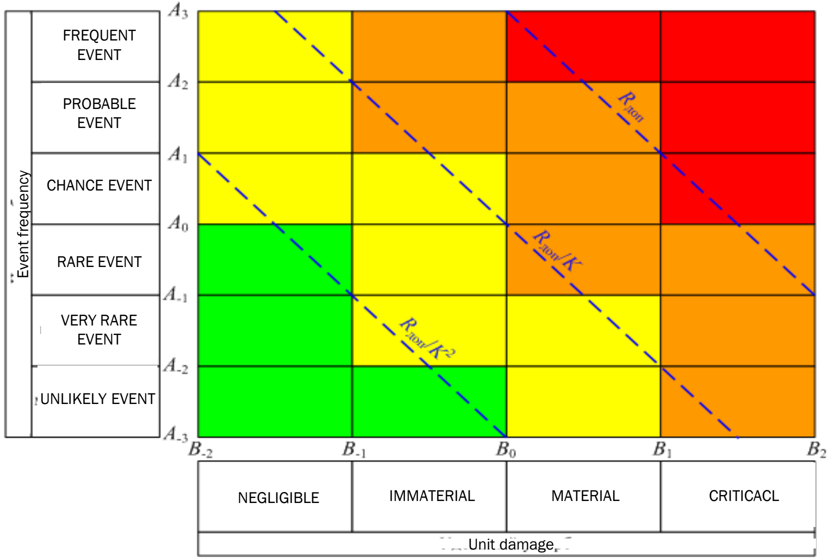
Presentation of Risk Assessment Results



- *m=6* –number of frequency scale levels; *n=4* – number of consequence scale levels (for even *m* and *n,* the box field is centrally symmetrical); A_{-3}, A_{-2},... , A_3 – frequency scale threshold levels; B_{-2}, B_{-1}, ..., B_2 – consequence scale threshold levels; *K* – risk scale pitch ratio; R_{perm} – permissible risk level.
- *The task pursued in constructing the risk matrix is to determine the numerical values of the threshold levels of the frequency and consequence scales on the basis of the set* R_{perm} *and available statistical data on the frequency and consequences of the undesirable (risk) event under consideration.*

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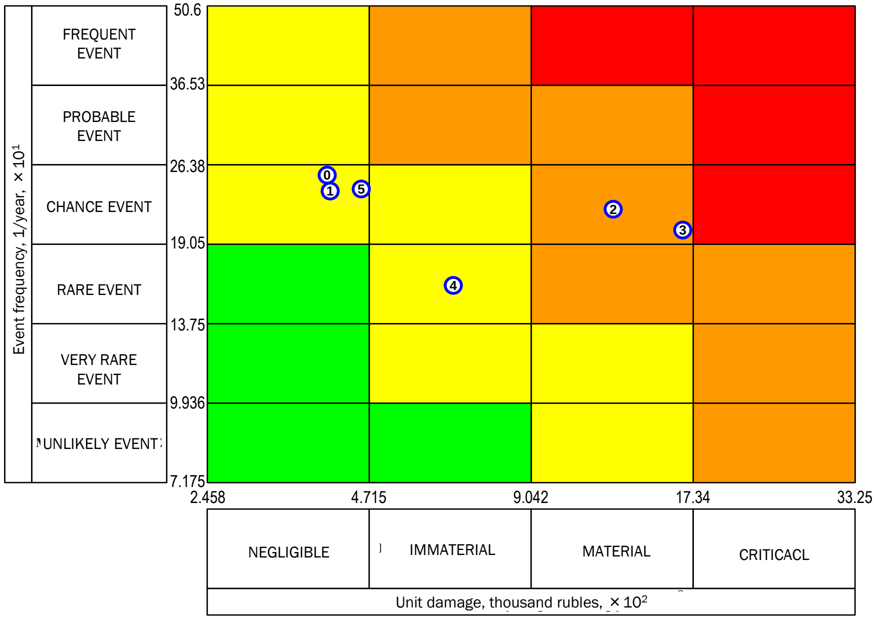
Risk Matrix Example



- A risk matrix for railway rolling stock crashes with one another, derailment during travel or manoeuvring, servicing or other movements not resulting in crashes or accidents (the figure means the observation year: 0-2010 , 1-2011, etc.)

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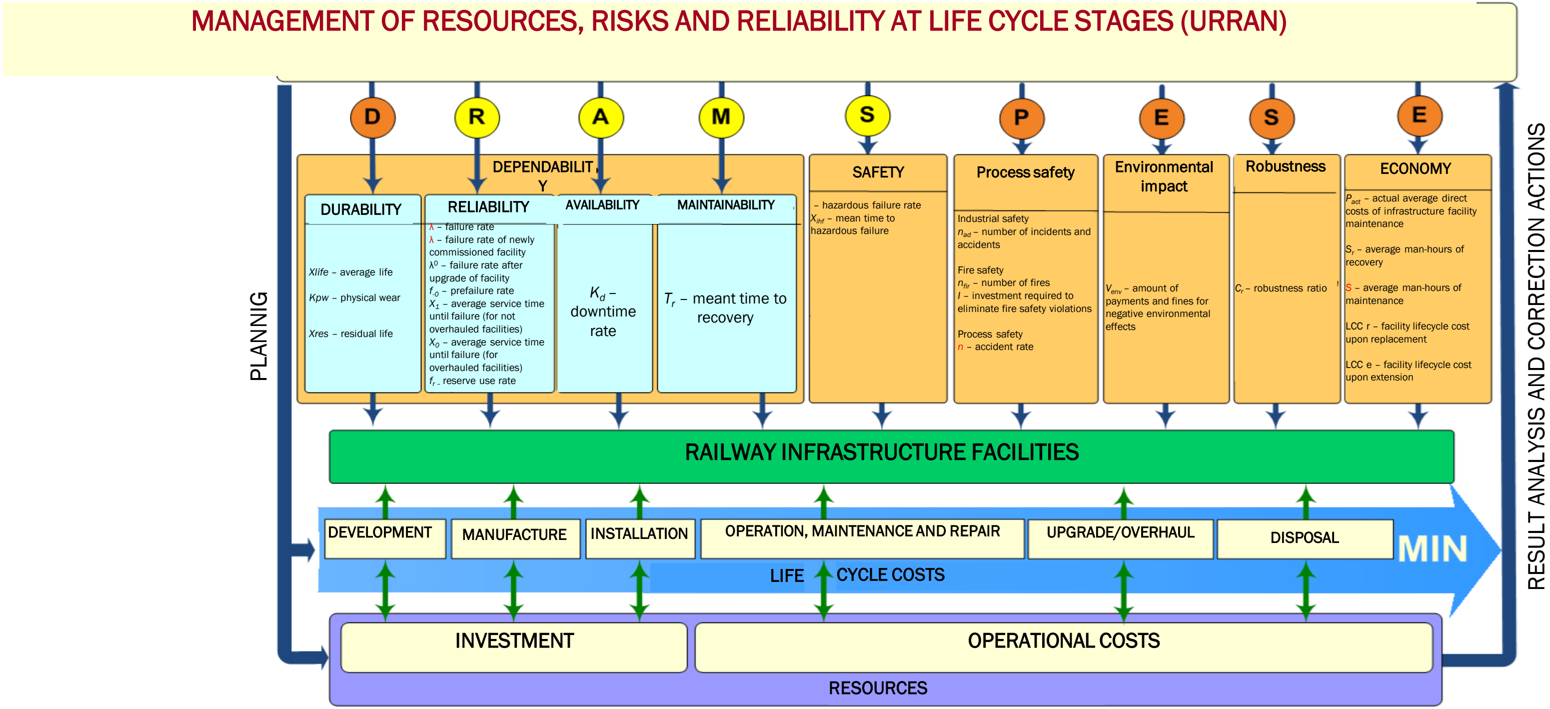
Comprehensive Management of Resources, Risks And Reliability at Life Cycle Stages



- Comprehensive management of resources, risks and reliability at life cycle stages (URRAN) is based on a system of indicators of reliability, functional safety, durability and cost of the life cycle and a risk-orientated approach to management decision-making.

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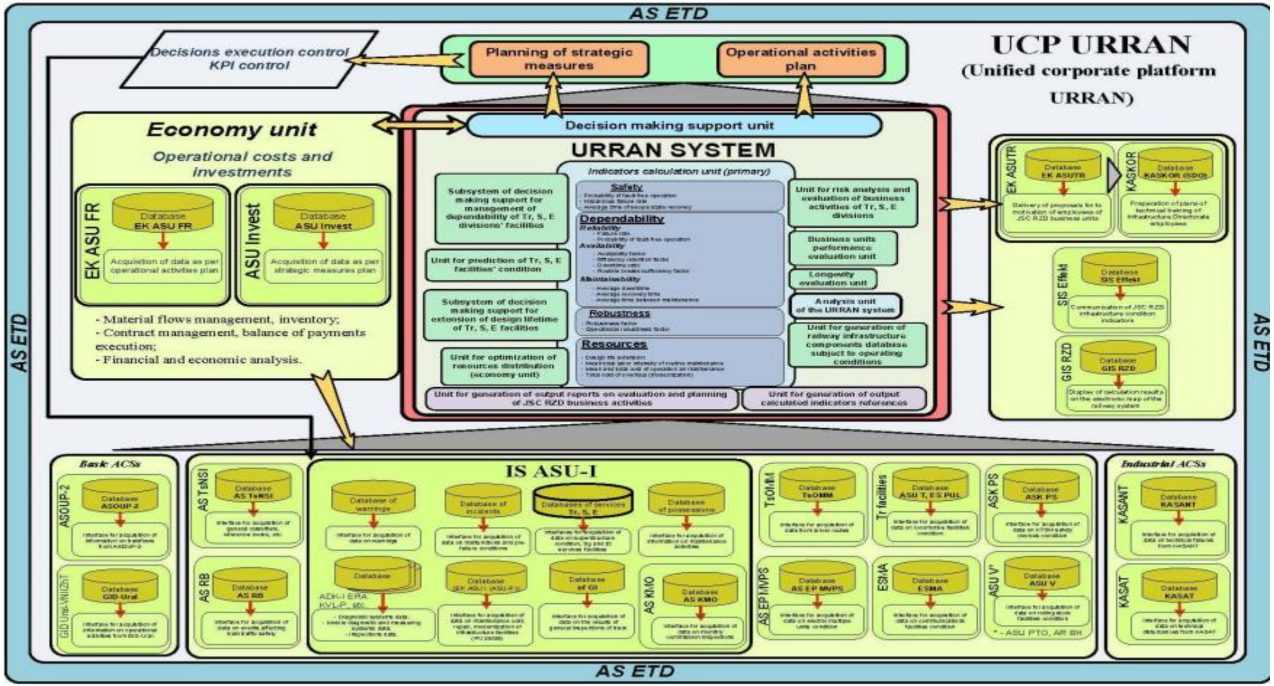
Structure of the Unified Corporate URRAN Platform



- The unified corporate URRAN platform – comprehensive automated system integrating the given automated information systems on the basis of which indicators are assessed as required for management of resources, risks and reliability at facility life cycle stages.

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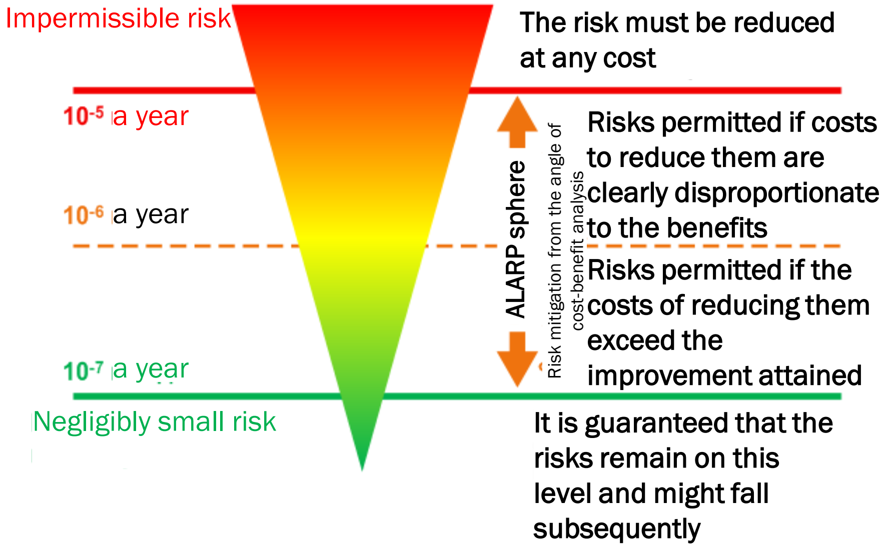
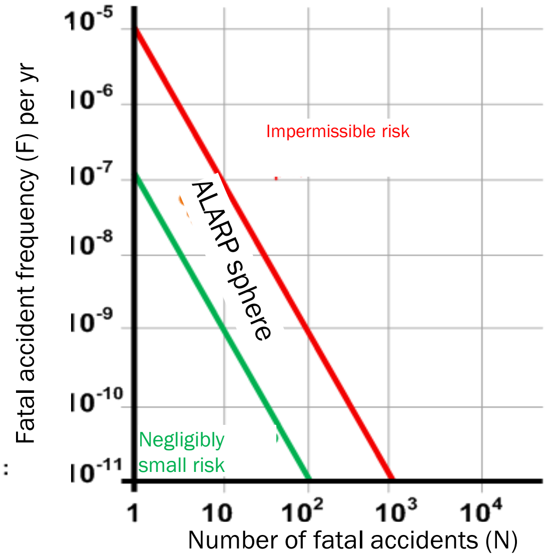
Risk Acceptance Criteria on The Basis of the ALARP Principle



(a) ALARP on the basis of individual risk permissibility criteria



(b) ALARP on the basis of the FN diagram for social risk permissibility criteria

- The ALARP (As Low As Reasonably Practicable) principle presupposes actions to mitigate risks for negligible to unacceptable risks. According to the ALARP principle, the acceptable risk level is that attainable for economically effective costs.

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Key Methods Used for Assessing Traffic Safety Risks

Method	Description	Pluses	Minuses
1. Process hazard analysis (*PHA*)	Determines the danger for the system and identifies components for performing an FMEA.	Is the first necessary step	
2. Failure mode and effects analysis (*FMEA*)	Considers all types of failure for each component. Orientated on technical systems.	Easy to understand, standardised, self-consistent. No mathematics required.	Considers non-hazardous failures, requires considerable time, often does not take account of combinations of failures and the human factor.
3. Failure mode, effects and criticality analysis (*FMECA*)	Determines and classifies components for system improvement	Well standardised, easy to understand and use. No mathematics required.	Often does not take account of ergonomics, failures with a common reason and interaction between systems.
4. Failure tree analysis (*FTA*)	Starts with initiated event, then seeks combinations of failures triggering it	Widely applicable, effective for describing the interconnection between failures, orientated on failures: allows system failure development paths to be sought.	Big “failure trees” are difficult to understand, do not coincide with usual patterns of how processes occur and are mathematically ambiguous. The method requires use of complex logics.
5. Event tree analysis (*ETA*)	Starts with initiated event, then considers alternative sequences of events	Allows the main sequences and alternative results of failures to be determined.	Not appropriate given parallel event sequence or for detailed study.
6. Cause and effect tree analysis	Begins with a critical event and develops using a “tree of effects” in direct sequence and a “tree of causes” in reverse sequence.	Flexible and robust, provided with documentation, well demonstrates the sequential chains of events	“Cause ad effect” diagrams are very big. They have many of the shortcomings inherent in the analysis methods using “trees”.

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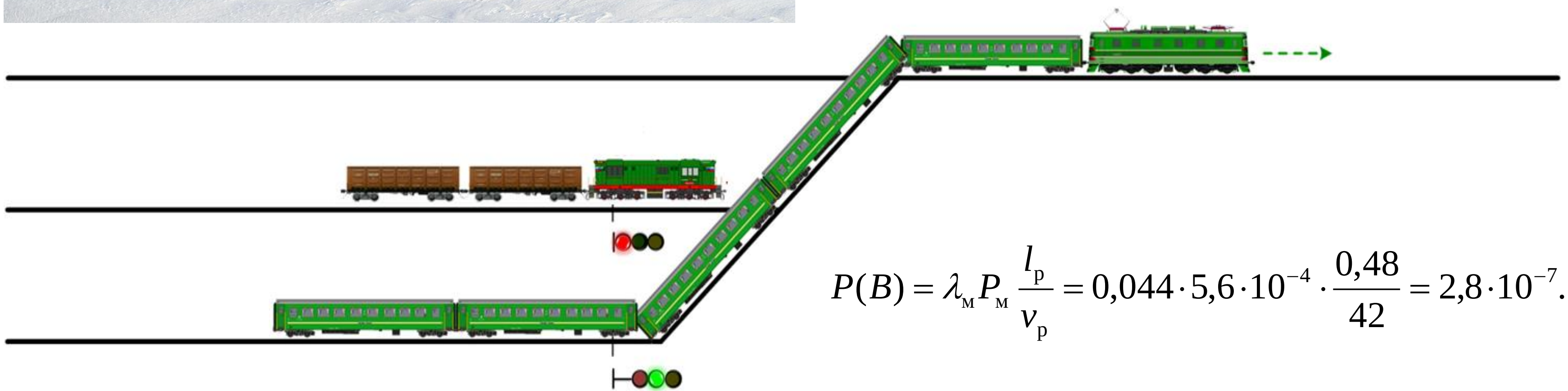
Probability of a shunting locomotive driver passing through a stop signal

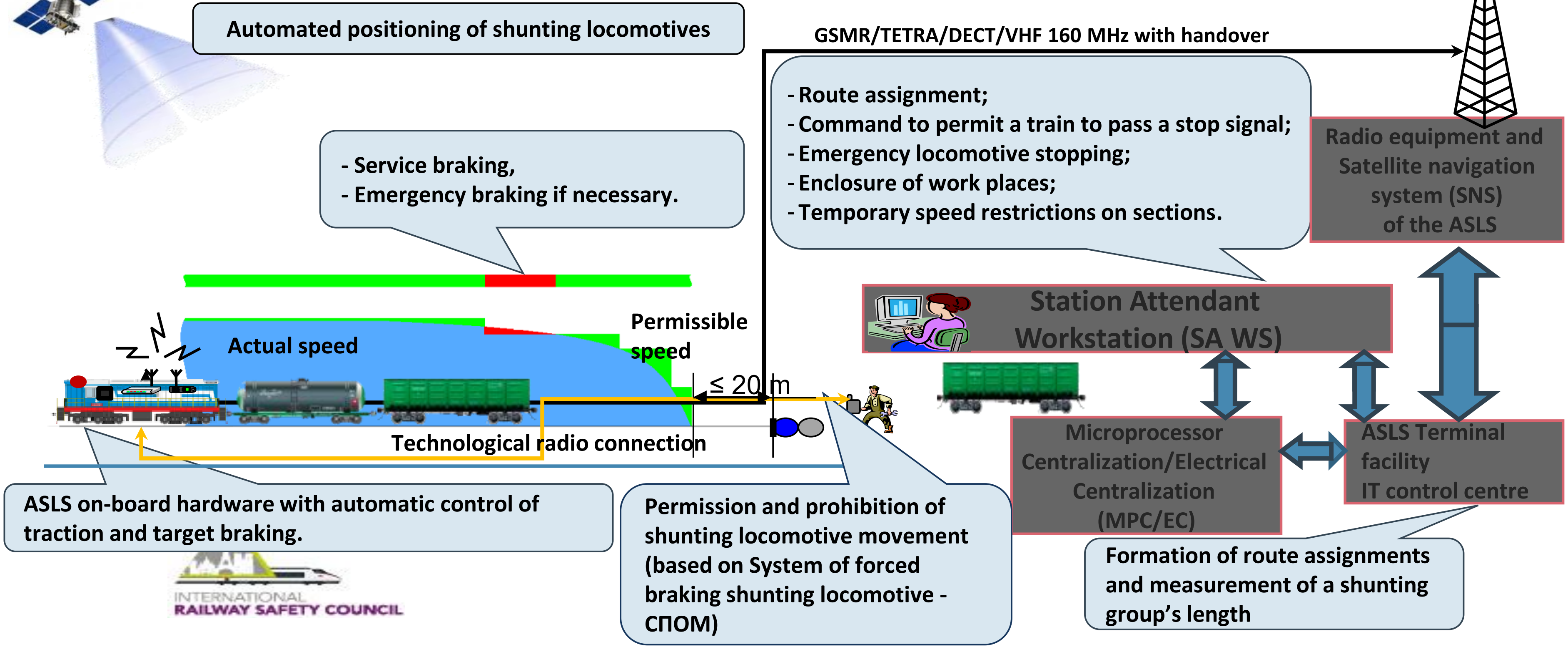
The probability of the event that a shunting locomotive which drives past a traffic light with a stop signal crashes into a passenger train that has not violated safety rules is equal to



$$P(B) = \lambda_{\text{м}} P_{\text{м}} \frac{l_{\text{р}}}{v_{\text{р}}} = 0{,}044 \cdot 5{,}6 \cdot 10^{-4} \cdot \frac{0{,}48}{42} = 2{,}8 \cdot 10^{-7}.$$

Objectives and functions of the Automatic Shunting Locomotive Signalling (ASLS) system

- ✓ To stop locomotives before stop signals;
- ✓ To control the operating speed of shunting locomotives according to a station's technical instructions, including during sorting;
- ✓ Occupational safety of station workers;
- ✓ To record and log the work of locomotive and station devices as well as radio communication equipment.



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Basic Initial Parameters for Calculating the Probability of a Collision Without ASLS

Probability of a shunting locomotive driver passing through a stop signal while working without an assistant driver (“one-man drive”)	$P_{m(one)}$	$6{,}5 \cdot 10^{-4}$
Probability of a shunting locomotive driver passing through a stop signal while working with an assistant driver	$P_{m(two)}$	$5{,}5 \cdot 10^{-4}$
Probability of a shunting locomotive crew being manned by a driver and an assistant	P_{two}	0,9
Probability of a passenger train passing through a stop signal	P_{p}	10^{-7}
Probability of a freight train passing through a stop signal	P_{g}	10^{-5}

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Additional Initial Parameters for Calculating the Probability of a Collision when using the ASLS System

Probability of coupling with the subsequent movement of a shunting locomotive together with railcars	P_{vm}	0,25
Probability of a station attendant failing to prevent a shunting locomotive driver from passing through a stop signal in 'release' mode	$P_d(s)$	10^{-2}
Probability of a shunting locomotive driver passing through a stop signal in 'release' mode when the shunting locomotive is at the front of the train	P_{tl}	$4 \cdot 10^{-4}$
Probability of a shunting locomotive driver passing through a stop signal in 'release' mode when the shunting locomotive is at the back of the train	P_{tx}	$4 \cdot 10^{-3}$
Probability of a traffic safety violation by a shunting master	P_{scx}	$4 \cdot 10^{-3}$

Probability of a train passing through a stop signal when there are one or two people in the cab also fluctuates and amounts to

$$P_{m(two)} = 0{,}9 \cdot 10^{-8} \qquad P_{m(one)} = 1{,}9 \cdot 10^{-8}$$

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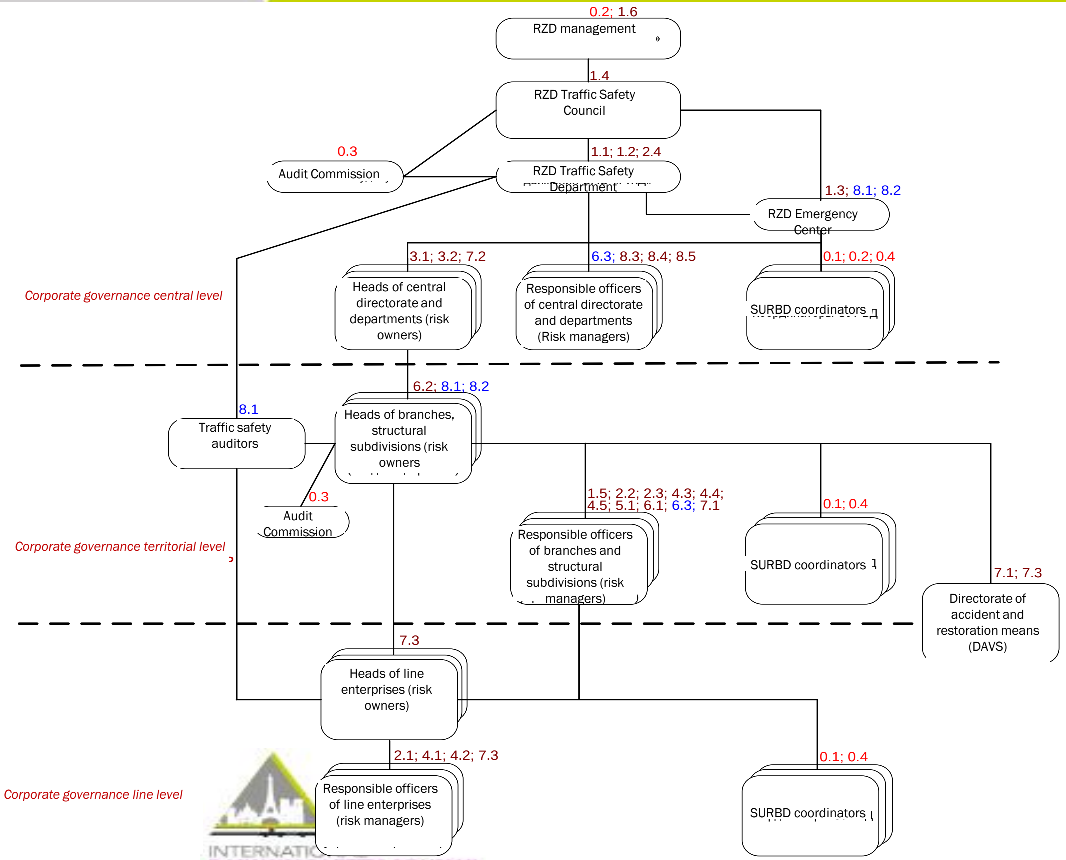
Diagram of the Traffic Safety Risk Management Structure



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- The organisational traffic safety risk management model establishes the functions of risk management as linked to the levels of corporate governance and organisational structure of the company.
- Responsibility for risks at the different governance levels is borne by the risk owners.
- Risk management is performed by those responsible for the risk management process in each structural subdivision.

CONCLUSIONS

- Implementation of the railway risk management system will promote functional safety of railway processes and facilities to meet the requirements of international, European and Russian standards.

- Functional safety management based on risk assessment shall take into account not only the number of adverse events but also corresponding damages, which, in correlation with the cost of safety enhancement measures will allow to make management decision that meet the economic criteria.

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Thank you for your attention!

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