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## HAZARDOUS MATERIALS TRANSPORTATION RISK MANAGEMENT

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**Abstract:** Hazardous Materials and components Transportation is significant source of dangerous. Transport system of these materials need concentration of state administration and transport operators. Volume of NLaP transportation is large. Total measure of Hazardous Materials transport and components in European Union is according about 110 billions ton-kilometre per year, from it 58 % is transport by road transport, 25 % train transport and 17 % inland waterways. Share of NLaP on general goods transport is about 8 % so around 8, 8 ton-kilometres. Improvement of general situation in transport of hazardous material and components, suggested good going risk management, improved methods of risk analysis by transport, better quality of transport monitoring, preparation of rescue system and first of all better quality of preventive activities.

**Key words:** risk management, hazardous materials, transport, risk analysis, risk Evaluation, and risk Reduction/Control.

### INTRODUCTION

Hazardous materials and components (NLaP) represent unthinkable part for many products and technology which are daily transport in whole world and represent seriously risk for people and environment by their transport, production, storage and used. Within the frame of its operating life are transporting many times and every part of this operating life is take its specification. Transports ways of these materials often go through populous areas, vulnerable places of environment and protected areas.

Volume of NLaP transportation is large. Total measure of Hazardous Materials transport and components in European Union is according [1] about 110 billions ton-kilometre per year, of it 58 % is transport by road transport 25 % train transport and 17 % inland waterways. Share of NLaP on general goods transport is about 8 % so around 8, 8 ton-kilometres. In European point of view trend of road transport and inland

waterways transport of hazardous materials grow up, however in case of train transport it has down trended.

This trend is not due by risks realized in transport process of hazardous materials, but individual state of train transport in competitive area for transport systems [2].

Transport of hazardous materials and components is regulated by international agreements namely ADR for road transport and RID for train transport. The accidents still happened with aftermath on human's lives and health, environment and property.

Realization of risks analyses by NLaP transport in nowadays is not on enough level. Basic reasons are two namely need of statistic data and basic open information or their unavailability and no implication total systems and basic methods for analysis, reviews and control of risks.

**PROCESS OF RISK MANAGEMENT**

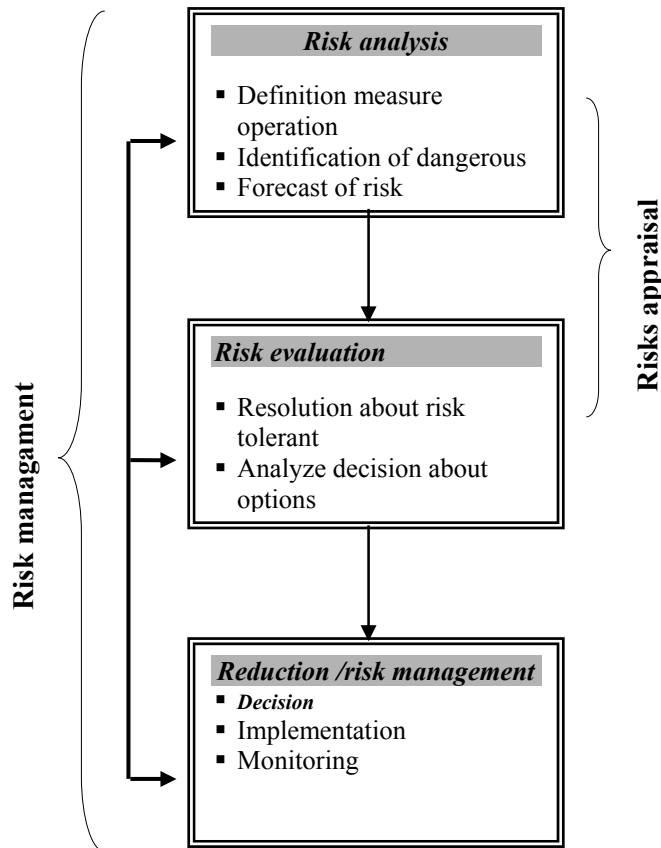
Risk management is understanding as systematic and systematic decision process, which by identification, analyze, appraisable, regulation, classification and monitoring potential risks allowance engineering, economic, social, politic and others factors.

Process of risk management is made by 3 steps:

- Risk Analysis,

- Risk Evaluation,
- Risk Reduction/Control,

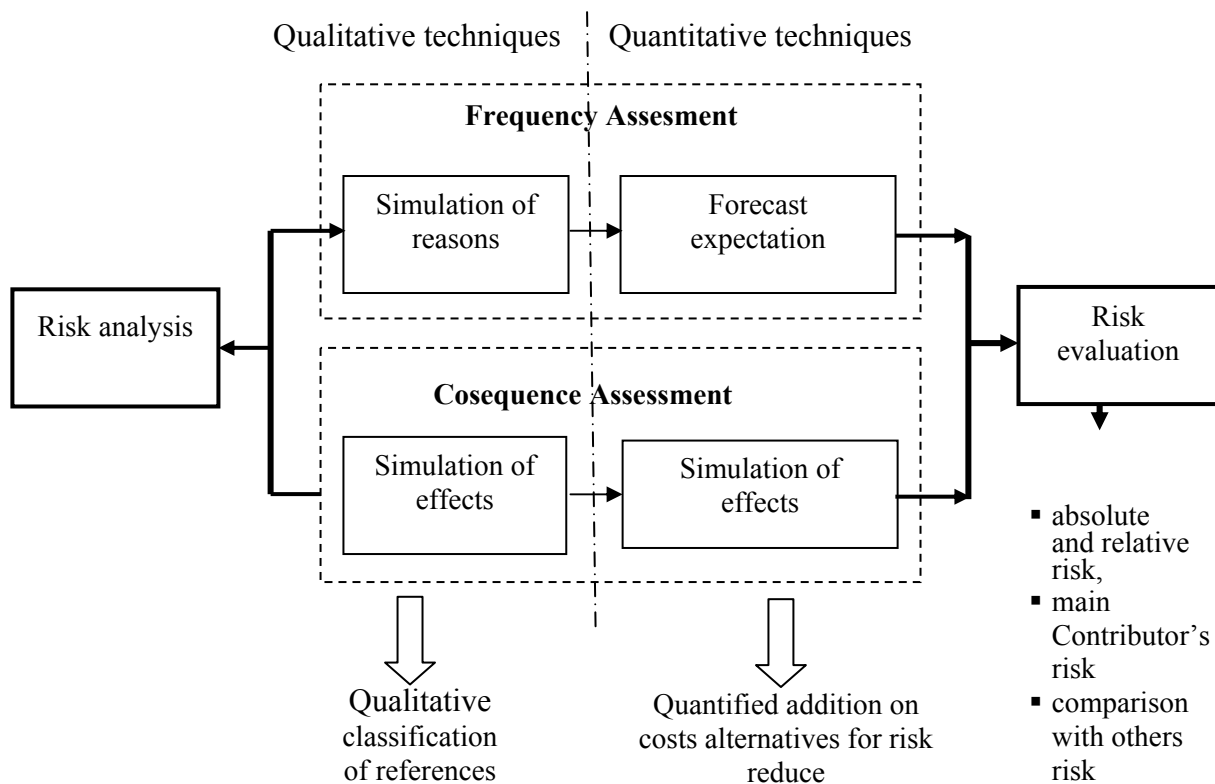
Process of risk management block schema is on fig.1 Risk analysis is made on quantitative and qualitative base or combination both methods. Quantitative analysis is given numeric outputs for excess expectation and their consistently statement in number of injures, deaths, material damages, traffic break and others.



**Fig. 1 Block schema of risk managements process [3]**

Risk evaluation expects, that are determinates individual scripts of excess and there are definite their safety criteria and appraisal if the risk level is still respectable. Reduction/risk management is related situation; when it is not possible accept

risk and it is necessary present arrangements. Suggested progress is come out from similar excess scripts and for them investigated different arrangements. Progress of appraisal of risk is on the fig 2.



**Fig. 2 Process appraisal risk [3]**

For Risk analysis execution is necessary in first off all defined system and conditions their using, specify area of analyses activity, introduce all established assumes and simplification system presentation. Implications analyses for fail system expects good knowledge of own system and their relations with surroundings.

Risk analysis is normally working with specifically indeterminateness level of information's. Indeterminateness results from material and equipments inconstancy and from faultiness of model

Important is always analysed system from view its possible defection and others unwanted implications. System analysis expects execution next 3 steps [3]:

- Decomposition system on subsystem and components
- Identification of dangerous contain with system (identification possible failure stages of system and subsystem),
- Identification of scripts failure situation of system.

For dangerous is defined failure situation of consider system – fire or explosion transported hazardous substances, escape of this substances, accident by which the system is collapse and others. Identification of dangerous means identify

all cases, which can make defects of system, its components, environment in which it is.

#### **METHODS OF RISK ANALYSIS**

For analysis and risk evaluation in nowadays are to disposition full line of methods and software equipments. This methods base on different models, by complicated the models is that more exact analysis results we can obtain.

At analysis and risk evaluation of serious industry accidents are usually used this methods [4]:

- Expert Judgment (EJ),
- Check List (CL),
- Safety Audit (SA)
- What-if-Analysis (WI),
- Preliminary Hazard Analysis (PHA),
- Statistical Data Analysis (SDA),
- Quantitative Risk Analysis (QRA),
- Relative Ranking/Hazard Indices (RR/HI),
- Hazard and Operability Study (HAZOP),
- Failure Modes and Effects Analysis (FMEA),
- Failure Modes, Effects and Critical Analysis (FMCA),
- Scenario Analysis (ScA),
- Fault Tree Analysis (FTA),
- Event Tree Analysis (ETA),

- Cause-Consequence Analysis (CCA),
- Human Reliability Analysis HRA)

Practice show, that it is not simple chooses right methods for solving problems. Every method has their specific properties, which affected their applicability. Single methods are different by access, requirements on input data and efficiency of results.

Selection of applicable method expects allowance this factors:

- Aim of methods,
- Type of analysis,
- Information necessary for analysis,
- Characteristic of analysis process,,
- Knowledge's with execution of risk analysis ,
- Analysis costs.

It is necessary point out those presentations methods are first of all use for evaluation stationary equipments. Hazardous materials transport has their specific and these are necessary allowance in risk managements.

Hazardous materials and components transportation is feature following basic specifics:

1. Ways of hazardous materials transportation intervening into geographic big territory, ways are historical led near or going also trough populous areas, around shopping centres, schools, hospitals, along water course, recourse of drinking water, near strategic firms and others. On transported ways is relatively big density of traffic.
2. Accident can happened in arbitrary place of ways, in danger can by different part of environment, which are changing during the way. List of endangered areas and place is regarding this very spacious and various.
3. Configuration of ground, climatic conditions, and communicative networks in surrounding of hazardous materials transport ways is changing and in place of accident can have negative affection on rescue. Domino effects from arose situation can block surrounding rescue intervention.
4. Set-up of rescue groups preparing on liquidation accidents with escape of hazardous substances, geographically doesn't correspondent with appearance of possible accidents.

Expectation of accident formation by transport of hazardous materials is inspire by many factors for example: trim and condition services of vehicles, by road transport also the density and quality of traffic ways, technical state of transport vehicle and others.

For estimation of accident expectation of by transport N is optimal use statistic data.

For risk analysis as basic target system of potential attack by accidents with escape of hazardous substance generally consider:

- components of critical infrastructure,
- people,
- environment,
- property,
- animals.

This target system can by attack by different types of application according kinds preparing hazardous materials. In generally is possible by physical matters this effects divided on:

- toxics effects,
- thermal effects,
- infection effects,
- effects shock wave.

These effects can work immediately or later.

Accident importance can by conveyed numbers of injured and death people, number of perish animals, economics lost.

Into damages on environment besides economic lost is necessary included also costs on decontamination, densification and revitalization area. Into lost is also necessary include cost on rescue works and security work, cut down general value of real property, temporary cut-down of working places and others.

For risk analysis transport of hazardous materials are appropriate methods, which are not primary, assigned for determination estimate reaches of accident results but for estimate their scripts. In article on the base of comparison selected methods [5] recommend used these methods *US EPA RMP Guide*, which is development agency EPA (Environmental Protection Agency USA) for estimate implication industry accidents with escape hazardous chemical substances.

Methodology US EPA RMP Guide thinking with estimate implication for the worst script and for alternative script. For the worst scenery is estimate case, when on accident is present maximum quantity of hazardous materials by

least good conditions for spread the accident implications. Alternative scripts allowance cases, when escape only specific quantity of hazardous materials, but expectation of accident formation is bigger than the worst script.

### HAZARDOUS MATERIALS TRANSPORTATION RISK MANAGEMENT

After finishing process of appraisal risk (fig. 2) following process of reduction, process reduced or risk management, which include decision about safety arrangements for cut-down risk, its implementation and monitoring.

In general are 4 groups of criteria's predetermined entrance to reduction/risk management [3]:

- criteria's base on using technology,
- criteria's base on enactments

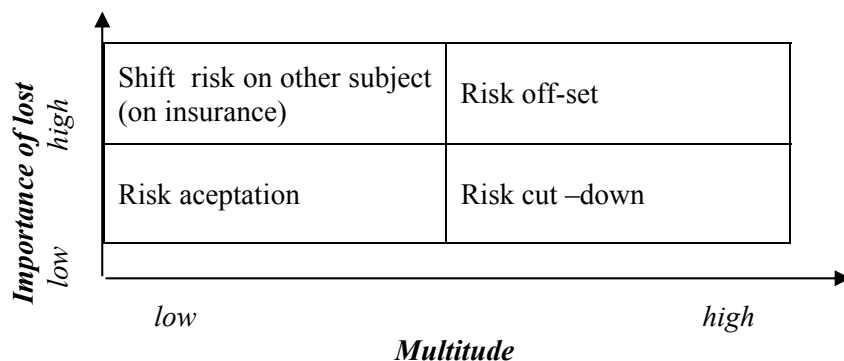


Fig.3 Possible reaction on risk [3]

By reduction /risk management of transportation hazardous materials are usually used first 3 methods. It expect, that transport operator used modern available technique, but it nit allowed to big waste of finance resources in tendency keep the trend.

Entrance of zero risk means determined target for total elimination of risk in future, generally implicated in area of traffic with vision of zero lost on lives. Target of Cost-Effective Analysis is selection such alternative, which provides in connexion to costs the biggest profit or additions.

In practice it means:

- Identify interested persons; define them their roles in process of prevention by formation of accident and accident readiness.
- Determined strategic targets,
- Risk evaluation,
- Make revision of preventive arrangements and accident plans.
- Determined tasks in prevention and accidents plans.

- Zero Risk Approach,
- Cut-down risk till over level  $10^{-x}$
- criteria's base on profit
- Cost Benefit Analysis (CBA),
- Cost-Effective Analysis (CEA),
- Combination of criteria's base on enactments and criteria's base on profit.

In general is possible on exist risk respond by different methods depends on important reasons and number of appearances - fig. 3.

- Allocate responsive source to individual tasks.
- Connect preventive activities with activities resulted from accidents plans.
- Take up with interested with accepted tasks, testing, revision and actualization accident plans, organization accident, and organization accident situations.

Important part of reduction risk is also education and information of population.

Interested parts of risk management are transport operators, owners and controller locations in surroundings of transports ways, self-government, state administration, nongovernmental organisation and integrated rescue system, interest area of transporters and commissary of press and others.

Coordination working-out system risk management it had supply by lends authorities state administration.

## CONCLUSION

Hazardous Materials and components Transportation is significant source of dangerous. Transport System of these materials need concentration of state administration and transport operators.

Improvement of general situation in transport of hazardous material and components, suggested good going risk management, improved methods of risk analysis by transport, better quality of monitoring by transport, preparation of rescue organs and first of all better quality of preventive activities.

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## МЕНИДЖМЪНТ НА РИСКА ПРИ ПРЕВОЗИ НА ОПАСНИ МАТЕРИАЛИ

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**Резюме:** Превозите на опасни материали и компоненти са важен източник на опасност. Транспортната система на тези материали се нуждае от внимание от страна на държавната администрация и транспортните оператори. Обемът на превозите NLaP е голям. Общото измерение на транспорта на опасни материали и компоненти в Европейския съюз е около 110 милиарда тон/километри на година, от които 58% с автомобилен транспорт, 25% с железопътен транспорт и 17% с вътрешноконтинентален воден транспорт. Делът на NLaP в общо превозените товари е 8 % или около 8, 8 тон/километри.. подобряването на общото положение в транспорта на опасни материали и компоненти предполага добре организиран рисков мениджмънт, подобрени методи за анализ на риска при транспортиране, по-добро качество на транспортния мониторинг, подготовка на спасителна система и преди всичко по-добро качество на превантивните дейности.

**Ключови думи:** рисков мениджмънт, опасни материали, транспорт, рисков анализ, оценка на риска и намаляване на риска/контрол.