

**Wrap up workshop
International Conference
Risk Assessment Tools
Krakow, 08 - 10 October 2003**

Risk assessment / goals and limitations

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Abstract

Risk assessment methods (RA) are used for ascertaining the risks at dangerous industry activities. The results of the RA are in particular good for communication about reasonable risks. In this case, risk communication takes place in different social tiers with different partners. Industrial risks however can not be matched with general everyday life risks. The Central point of the discussion on the methods of RA is the Translucency (comprehensibility) and reliability of the results. Translucency is guaranteed by the systematic investigation approach, the reliability is dependent from the available data and the quality of the employed computation models. In this case, the organisation of the investigation approach is fundamentally open, it leads to broadly accepted major accident scenarios. Data collection and the development of sound computation models follow the general evolution from science and technique. Translucency finds its limit in the continuing complexity of the underlying accident scenario, the evaluation of reliability is limited by the necessary regard of "tender factors", e.g. influence of safety management quality and through statistical boundaries, e.g. small population, singularity. On this basis qualitative and quantitative RA methods should be reevaluated.

Quantitative procedures (QRA) supply concrete values within the framework of the assumptions and are good in particular for the comparative risk assessment within precise boundaries, e.g. for the arrangement of plant design alternatives, maintenance strategies. The use of QRA values seems not to be suitable for balancing with absolute values, e.g. risk threshold limits because of principal methodical boundaries and high data uncertainty.

Qualitative procedures supply an overall expert judgement derived by a systematically procedure. The results can be used in the discussion with the risk communication partners, in particular if you talk about reasonable risks in a societal context. What RA method you use best depends strongly on the purpose of the results. Quantitative approaches are preferably suitable for technical analyses, qualitative procedures have preference within social discourses.

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Risk assessment - goals and limitations

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Content

1. Why risk analyses?
2. Personal and social risk acceptance
3. Risk acceptance
4. Procedure for the Risk Assessment
5. What must Risk Assessment perform ?
6. Use of Risk Assessment in the social discourse
7. Summary and Conclusions



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Why risk analyses?

Human activities and performances are combined with risks. This general knowledge of life can be experienced every single day by everyone.

People are accustomed to it, they have their individual strategies to handle everyday life risks. Essential is that the risk - for instance to fall from the ladder - is known from experience, the hazard combined with it, *is predictable* and - the main point - to have the decision, whether one takes the risk or not.

This can be summarized for the core variables of a risk evaluation:

degree of volunteer,

control,

prediction

A further, decisive feature is the risk benefit evaluation. Taking a risk voluntarily must be balanced by an individual benefit.

Personal and social risk acceptance

The personal risk acceptance can not be transmitted to the situation of industrial risks.

Industrial risks fill not even one of the mentioned criteria:

neither they are simply estimatable by personal experiences,

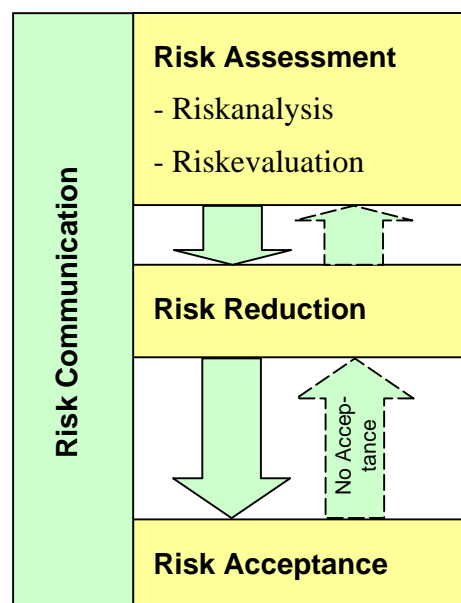
individually not steerable and

they are not voluntary, the neighborhood is forced to.

The evaluation of a possible benefit is also followable only at a very abstract social tier.

For this reason, industrial risks are hardly estimatable and little accepted.

The prediction of these risks and the accompanying discussion about acceptance is very complex and difficult. It must be carried out as transparently as possible for everybody involved. This process is summarized under the term of risk management¹. Picture 1 shows the individual elements of the risk management and their relationship each other.



Picture 1: Steps of Risk Management

¹ after ISO Guide 73

Risk acceptance

Industrials risks can in general be balanced by the benefit of a high standard of living provided by the industrial societies. However the problem of the risk distribution remains i.e. the entire society has benefit, a local community bears the risks. Since this problem is not solvable, industrial countries go another way:

Reasonable risks are defined for all members of the society equally. This standard settlement is valid for all, the risks may not be exceeded in any place or by any risk source.

The most important question, which risks (major accidents) are no more acceptable for the community, is a problem of the social standard settlement. This would be surely reserved to committees legitimized constitutionally in democratic societies.

In Europe there were chosen different approaches due to different historical experiences. The societies commit themselves either to concrete risk threshold values (e.g. Netherlands², Switzerland³) or on general high level legal standards, e.g. "integrity of life and health of man and environment" (Germany, France).

From this it is clear, that the order of the legal norm predicts the structure of the result of the RA Procedure. Societies which agreed on risk numbers, will such ones expect as a result from RA, societies with qualitative determination require one of their norm a the corresponding statement.

It is also clear, that RA must give a sound and reliable result in the case it is used in high level decision

Procedure for the Risk Assessment

Several Methods for RA were proposed. Common to them all, is a systematical investigation approach. Due to the great variety of possible situations, it is understandable that there must be always a case by case approach. Picture 2 shows a survey of the actuating variables which must be taken in account constructing major accident scenarios (MAS). For this purpose, assumptions must be made for every individual case.

The conditions for MAS can be derived on the basis from:

- carried out systematical analyses of the failure probabilities of the components available in the system (e.g. FBA⁴, FMEA⁵) or
- determined by a systematical interrogation of expert experiences (e.g. HAZOP⁶) .

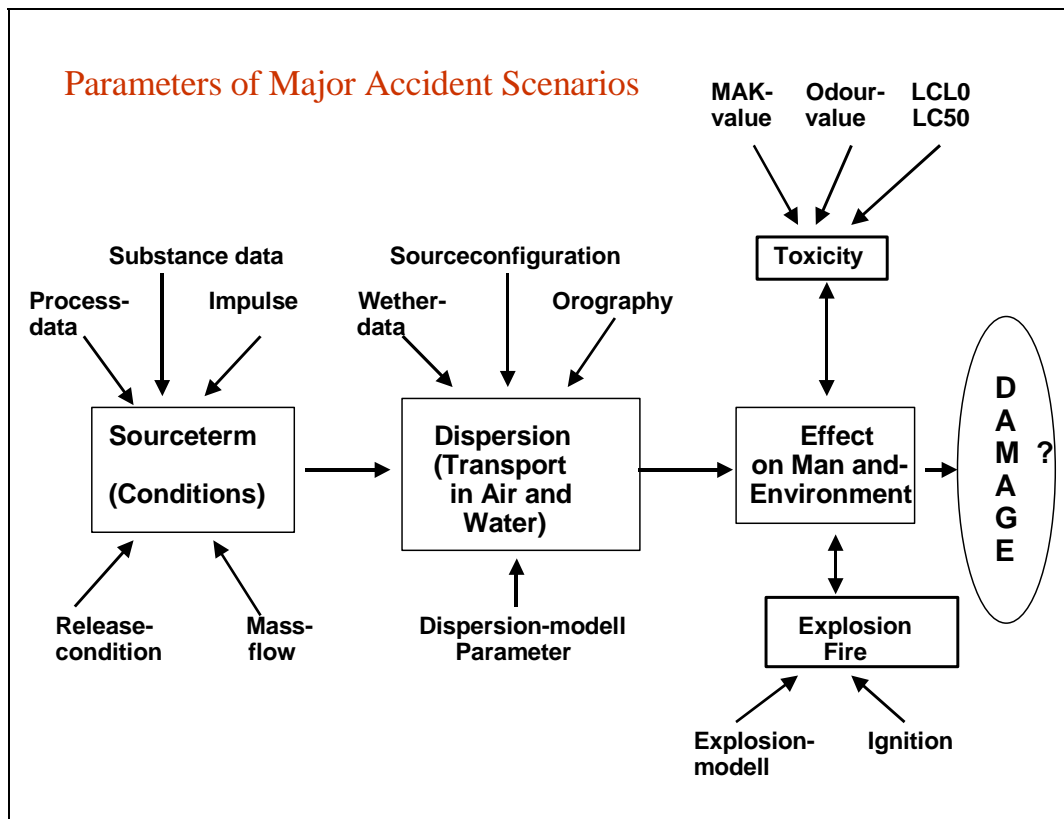
² *Premises of Risk Management*, Dutch National Environmental Policy Plan, The Hague: Directorate General for Environmental Protection at the Ministry of Housing, Physical Planning and Environment, 1988-1989

³ ESCIS, *Einführung in die Risikoanalyse: Systematik und Methoden*, Heft 4, 1996, 3. überarbeitete Auflage, Basel: Expertenkommission für Sicherheit in der chemischen Industrie der Schweiz (ECSIS)

⁴ Fehlerbaumanalyse DIN 25424 Teil 1, Methode und Bildzeichen; September 1981 Teil 2, Handrechenverfahren zur Auswertung eines Fehlerbaums, April 1990

⁵ Ausfalleffektanalyse (Fehlermöglichkeiten- und Einflussanalyse DIN 25448 (1990)

⁶ Hazard and Operability Studies Process Safety Report 2. ICI Ltd., London 1974



Picture 2 components of major accident scenarios

With it assist with first means the experiences with individual elements of the system in a way digitalized and set up into a mathematically logic course, in the case of the second means is summarized by means of systematical check lists and guiding words the expert estimates in a collected manner and too one SAZ. Depending on the chosen means, the preserved result is:

- quantitative statements about the process of the breakdown and of its probability. In this case, all breakdown processes depending on probability are determined and represented (e.g. f-N curve).
- qualitative statements to one or several breakdowns and their effects. In the procedure, the probabilities on account of experiences are evaluated qualitatively.

For the decision processes, the risk considerations, independent of their markedness supply (qualitative quantitative, derterministisch or probabilistisch), among other things, the following information:

- the structure of disturbing and course of the accident
- descriptions of damages as well as estimates of the corresponding expected entry frequencies
- event histories those add significantly for the risk
- insights into appropriateness of plant design and mode of operation by ascertaining of those system sections and of those modes of operation those supply the greatest contribution for the system failure.

In this way, basics are provided for the judgement - the achieved safety level of the technical plant of possible promising approaches - the safeguarding importance of new scientific and

technical finding or special company internal occurrences - for the further improvement in safety.

What must Risk Assessment perform ?

The decisive question is that according to reliability of the RA means. In this case, one can distinguish with regard to the means two main groups:

- means, those on mathematically logic structure and
- means, those at a collective estimate

may be.

Mathematically logic means reflect the respective know-how of the (isolated) customer. They require no discourse fundamentally. The results are numerical values whose quality depends on the statistical leakage of measurement variables. In this case, they are in particular afflicted with the coefficients of measure for its derivation the statistical population is not sufficient great insecurity (singularity problem). The numbers appear as abstract sizes in which the qualitatively different actuating variables no more recognizable are. Numerical values suggest an objectivity to be justified objectively not beyond ("apparent objectivity"). At numerical values, the question about the correctness and reliability of the number always sets itself up. This problem can only be solved in a closed manner by the description of the gained assumptions, in other words: For a numerical value as a result of a RA always need it the precise description of the general conditions under which this number determined was. This amounts to a qualitative description of the RA.

Qualitative expert estimates occur in the team discourse by means of structured check lists (e.g. HAZOP), they are on principle result open. Through it for instance appear better she for more complex for system concepts in a suitable manner, in particular in the case of systems with qualitatively very different actuating variables, technical component failure, human operating error, security management quality etc.

Also is for the decisive result and its further discussion in the social discourse which Abschneidekriterien chosen were. Full risk analyses for example hit statements about possible damages in the neighborhood of dangerous industrial plants. In this case, particular site parameters come in into calculation such as density of population, violability, state of the environment etc. In arrangement of the results with absolute risk boundary values, sites have "site advantages" with smaller density of population or environment burdened e.g. already, there, around the same risk to achieve, higher ejections computationally permissible would be. Such results set the wrong signals with regard to a lasting evolution. Risk considerations should always supply environment independent danger parameters, the desired arrangement would be possible too over it.

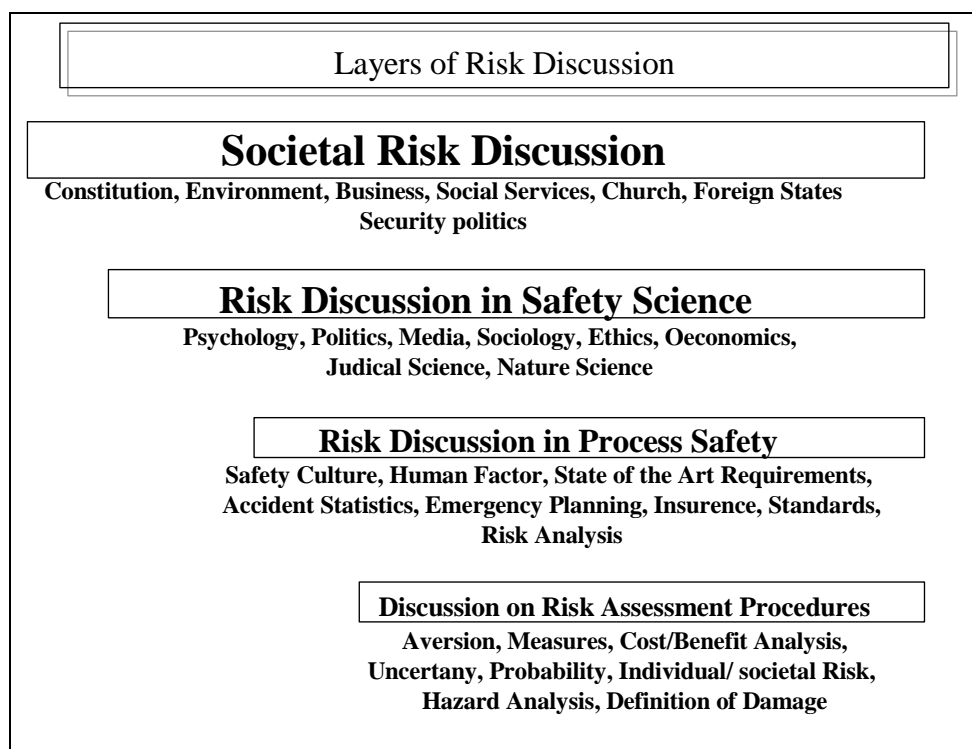
Use of Risk Assessment in the social discourse

The discussion of risks in the society occurs according to the rules of the Risikokommunikation(RK). In this case, contents and form are strongly dependent on the discussion partners, successful RK always must the social environment, the particular

conditions of the partners analyze and after this the thing contents in their representation may adapt. A survey of the tiers of the risk discussion shows picture 3.

Concrete numerical values e.g are communication ring as value statements for the judgement of only a risk for a specialized one (oriented technically scientifically). helpful during the safety analytical discussion.

Decisive in predominant measure, however, qualitative statements are in particular during the social and sicherheitswissenschaftlichen risk discussion, in a combined manner with translucent origin of the data and of the valid general conditions. There often worth it in the result of the discourse around social ones (ethical, moral ones) goes is a RA judgement in the same language and introduction world the best suitable form. This may be presumably most of all qualitative race achieve can, they are system inherent with respect to the relevant communication levels.



Picture 3 Layers of risk discussion

Summary and Conclusions

Combination and to the risk estimate (RADIUM) conclusions means are used for ascertaining in the case of dangerous industry activities the risks.

The results of the RA are employed for communication via the reasonable risks. Risk communication occurs in different social tiers with different partners.

Industrial risks can not be matched with general everyday life risks.

Industrial risks can in cleared up industrial societies one general benefit the standard of living provided by the industrial society be opposed.

Around a raked risk equilibrium, i.e. the entire society has benefit, it bears the risks to have a community limited locally, is a general boundary of the reasonable risks for all members of the society equally defined.

Those are decision, which risks (breakdowns) are acceptable for the community, are of effort within the framework of social standard settlement.

Depending on order of the norm (qualitative or risk coefficient of measure) the results must be adapted by RA procedures.

The most important feature of RADIUM - their translucency (comprehensibility) and reliability of the statements is means of the RA.

Translucency is guaranteed by the systematical investigation work, the reliability of the statement is dependent from the data and the quality of the employed computation models.

Translucency find its limit in that continuing complexity the scenarios the evaluation of reliability e.g. becomes safety management quality through regard and through e.g. small population, singularity limited.

Quantitative procedures (QRA) supply concrete keys within the framework of the assumptions and acquire itself in particular for the comparative risk consideration within precise celebration placed general conditions, e.g. for the arrangement of plant design alternatives, maintenance and maintenance strategies. The use of QRA keys is lesser suitable for arrangements with absolute keys, e.g. risk boundary values.

Qualitative procedures supply an expert appraisal determined systematically which can be employed in the diskursive process with the partners of the risk communication, of risks in particular reasonable for the discussion.

The use of the results of the RA decides fundamentally on the means to be applied.

Quantitative approaches, procedures qualitative in the social discourse earlier are suitable for technical analyses.