ANALYSES OF PROFESSIONAL DILEMMA SURFACED WHEN DRAFTING THE RESPECTIVE HUNGARIAN REGULATIONS

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Abstract

The Act on Disaster and the respective executive government order have been designed to transpose the European Union Directive SEVESO II into the Hungarian legal system. There vivid technical debates concerning the issue of risk assessment procedures related to the execution. In this essay of the above regulations we have made an effort to collect some practices in abroad and to present the Hungarian conditions of their implementation. On the basis of favourable and adverse features of the different assessment methods we have drawn conclusions concerning their applicability in Hungary.

Keywords

Risk assessment procedures, requirements of the assessment procedures, qualitative assessment approach, approach based on consequences, approach based on consequences.

Introduction

In a broader interpretation, risk assessment procedures related to major industrial accidents (hereinafter: assessment) means a structured procedure, which in respect of the dangerous facility concerned examines qualitatively and quantitatively the level of risk emanating from a source of hazards. [1] According to the generally accepted approach it assesses the safety of the facility concerned and defines the rate of exposure of the population living around it and the environment to the danger. In doing so, it takes into account the aspects of enhancing safety and reducing hazards. [2] It is worthwhile to mention that although the methods based on different qualitative and quantitative approaches can vary as far as the outcome is concerned, however all are directed to enhance safety and reduce hazards. [3] Its field of application extends mainly to the assessment of the content of the safety report [1] and resettlement planning.

Our main objective in writing this article was to present the assessment procedures and to compare them by their advantages and disadvantages. For this reason below we are outlining in detail the assessment methods used in the

Member States of the European Union and in several industrially developed states. We will shed light at the features due to which they have been applied also indicating the restrictions of their application. The review in this manner of the risk assessment procedures will help us in selecting the most useable method.

1. Requirements of the assessment procedures [4]

Unambiguousness. This means in brief, the method in question must permit the identification of danger zones with unambiguousness that the laying-out of their limits should not give rise to legal proceedings, that is to say neither the authorities, nor then operator should contest their authenticity.

Accuracy. The method should be as accurate as possible and the danger zone produced by such a method should express the actual hazard of the facility.

Sensibility. This means the capacity that all influencing factors should be taken into account for surveying the hazards. We must strive to do that even if we are aware that the design models we use reproduce a very simplified image of the reality.

Simplicity. This means that the method in question should be suitable for application with the use of the simplest tools and with the lowest qualification possible.

2. Hungarian conditions of the application of procedures [4]

The above theoretical requirements alone are insufficient for selecting the ideal method of assessment. In our country the following important circumstance influences the selection of the ideal method today:

- The qualitative assessment of exposure to major accidents has no antecedents in Hungary, that is neither similar, nor complicated tabular systems are available.
- The assessment of the consequences of major accidents has a relatively long past.
- The definition of the frequency of identified major accidents has no traditions in Hungary.

3. Qualitative assessment approach [2], [3], [4], [5]

Different methods can be applied for the assessment of hazard effects subject to the industrial activity concerned. Directive SEVESO II aimed at the enhancement of chemical systems requires from the operators falling within the scope of hazard identification and risk analysis as part of the safety report. Pursuant to the Directive the Member States are free to choose their methods of

analysis. The Acquis Communautaire maintains a single general criterion, according to which the methods applied and the measures should be commensurate to the risk rate. The practice followed by the Member States is divided in respect of the use of quantitative assessment methods; the priority of consequence and risk based methods is in the core of major professional debates. In this field mainly the German, Dutch and English views are in confrontation.

The Research Centre of the European Communities has been examining the possibility of standardizing and harmonizing the sector recently [4]. The EU does not take a position in the above debate either as there is no plan to introduce a single risk assessment and a management standard. However, it is considered necessary to elaborate a unique procedure of approach applicable with every analytical method and a related reference system (with criteria as to the form and content). The single procedure would define the basic risk concepts, the criteria for characterizing risks, the steps of risk assessment and the principal objectives of risk management.

The elaboration and application of tables is based on the fundamental principle that an adequate distance should separate the "non-compatible" sectors from each other. The extension of the individual zones is often made dependent on the quantity and type of the hazardous material present. In order to assist the application of this approach, the tables have been drawn up in such a manner that the different industrial activities are classified in categories and a fixed hazard zone is assigned to each category.

The distances are built on experience, the studies of the licensing authorities and the findings of environmental research. For this reason the guidelines prepared in respect of the safety distances contain the aggregated assessment on dangers to both the integrity and safety of the environment.

This approach does not discriminate between the amount of material present and the circumstances of the occurrence thereof. However, the majority of the tables is used for the reason to permit more accurate definition of the activity and to take into consideration the amount of the material present and also certain other characteristics of the definition of appropriate distances: for example in the case of gas tanks containing from 200 to 500 m^3 of liquefied household fuel a fixed distance has been prescribed. Naturally, it does not take into consideration the particularities of the design, the measures of safety and the individual characteristics of the facility concerned, either. The establishment of the safety distance can be based on: estimates of specialists, the evaluation of data of the system in place, experiences derived from the operation of similar facilities, a rough-in estimation of consequences or the facility's environmental impact. It is obvious, that the operation of certain industrial activities (mainly in the chemical industry) can usually be related (besides the dangers effecting the population) with several additional risk factors. These features extend to noise level, odours and the usual pollution. This is why the distances aimed to maintain separation are often fixed in respect of these industrial areas and area engaged in different activities (mainly built-up area) in order to assure that these risk factors do not endanger the population. In practice, the distances fixed in respect of "environmental effects" are conceived based on the conjecture that if appropriate protection can be

achieved against these hazardous points then the hazard control can be extended to the major accident risk factors of the industry. It is a recognized fact, that not all dangerous activities have characteristics accompanied by further nuisances (such as noise and odour).

Favourable features of qualitative approach

Both the operator and the authorities can easily and clearly decide in which circle a dangerous facility can be of danger to the environment and the population. The tables applied are unequivocal, no significant disputes can arise about their meaning. Due to its simplicity the method does not require special qualification or a solid computing (hardware and software) background. Because the endangering features of equipment and tanks have a degree of uniformity, the limits of the zones exposed to dangers can be predicted with much certitude.

Adverse features of the qualitative approach

The circumstances of the occurrence of hazardous materials (quantity, pressure, temperature, etc.), the conditions of major accidents (hole size, material flow, pool diameter, etc.) and other factors influencing propagation (wind, temperature, vertical stability, coarseness, relief, etc.) show such a big variety, that the actual exposure to danger can deviate by magnitudes from the radiuses of the danger zones indicated in the tables. For this reason, a modern facility equipped with all possible safety apparatus shall be considered just as dangerous as a pitted one long to be disposed of. By the same token, the modern or absolutely non-existent safety management of the facility cannot be evaluated.

We cannot measure the probability of occurrence of accidents, for this reason the accidents involving the most severe consequences, but with a negligible, small risk (an airplane crashing into a tank) and events that potentially may occur every day (burst in a pipe transporting hazardous material) are to be taken into consideration alike.

Conclusions in respect of the application of the qualitative approach

The methods designed to assess the consequences of major accidents and based on qualitative approach are simple and are capable of making quick deductions, however the actual conditions cannot be taken into account and this may give rise to the commission of considerable mistakes. Due to the numerous disadvantages of the approach the Member States of the European Union using qualitative methods are migrating to the quantitative methods of risk assessment. In numerous countries (e.g. Austria, Germany, France, etc.) the qualitative approach is used in conjunction with the methods based on the assessment of consequences.

4. Approach based on consequences [4], [5]

The consequence-based approach characteristically demonstrates in respect of the hazardous facility concerned the possibility of death or injuries occurring as a result of the chain of accidents examined. The consequence-based approach (often called deterministic approach) is built to survey the consequences of predictable accidents.

The consequence-based approach is often used for the definition of the "worst-ever situation". This can include implied, implicit deliberation of the probability of certain imaginative situations. This philosophy is built on the concept that should the measures introduced provide appropriate protection for the population against the most severe accident, then they would obviously be suitable also for the control of less severe accidents. Consequently, this method is restricted to estimating the reach of the consequences of such accidents and has nothing to do with their probability. Critics of the method say, that in fact, in certain cases accidents considered most serious have less severe consequences, than those previously considered less severe. Moreover, safety strategies shall extend to less frequent accidents with grave consequences, the same as for more frequent accidents eventually producing moderate impact.

During the application of this method, the operator gauges up the consequences coming from a severe industrial accident, and then it proves to have taken appropriate measures for the prevention of such an accident and the control of the consequences thereof. The selection of the chain of accidents is based on experience, and fundamentally presupposes a certain technology and mode of operation. We can also think of the option, that the chain of accidents has not been selected adequately. The authorities in their own discretion can request the assessment of another chain of accidents. The chains of accidents taken into consideration are accurately defined and the consequences are assessed with the appropriate method. Subsequently, the most severe chains of accidents are identified and then taken into account for the purpose of further planning. Finally, it will be examined to what extent the safety measures introduced in the plant to prevent accidents comply with the consequences explored. Should the authorities come to the conclusion that these measures are adequate (that is severe accidents are not likely to occur), there is no need to calculate with such risks of accidents any further. Independently of the probability of their supervention, the repercussions determine the measures to be taken for the prevention of the possible accidents and the control of their consequences. This is the most significant feature of the "consequence-based" approach.

The deterministic regulation strives to achieve the so-called "zero risk" (without quantity determination) that is it takes no notice of the differing probabilities of the chains of accidents and instead, it requests safety measures against the possible threats. In this case the required examinations besides the exploration of the dangers check the existence of certain safety measures, protective systems and conditions and also analyse the reference chains of accidents and their consequences, without the calculation of their probability. The

drawbacks of the deterministic approach also include, that it is difficult to select from the multitude of the chain of events the one leading to the most severe accident and also there could be much subjectivity in such a selection.

When addressing chains of events which are most likely to occur in practice we can accentuate each of their most frequently encountered versions. In this manner for the purpose of practical application we take into account six major chains of events in respect of the different types of facilities. All chains of events have been processed in detail: they contain the circumstances where the accident has occurred (the emission …, the weather conditions, etc.) as well as the permitted maximum values of …(heat radiation, air blast, poisoning, etc.).

In practice, the definition of the chain of accident events necessary to mark out the danger zones is generated as a result of co-operation, in the frame of which the authority and the operator come to terms with each other. The measures aimed at the prevention of a severe accident and the reduction of the consequences should also be thoroughly balanced. If it can be concluded that appropriate measures have been established, then the chain of accident events concerned will be taken into account only for emergency planning and not in resettlement planning. Despite the above statement the taking into account of severe accident risks is necessary during resettlement planning. In doing so we determine the zones of danger coming into existence as a result of the consequences of severe accidents. This area (with different restrictions on development) is usually divided into two zones.

Advantages and disadvantages of the deterministic approach and conclusions that can be drawn from the point of view of Hungarian implementation

Contrary to the qualitative method of assessment the sensibility of this method to taking into account the actual conditions of accidents and propagation is indubitable. Here there is a possibility to analyse the actual chain of events of accidents and the taking into account of propagation conditions in a manner permitted by the propagation model used by us. Compared to the risk-based assessment method the simplicity of this method gives an undisputable advantage, because in the other method the establishment of the probability of occurrence causes a lot of uncertainty.

Compared to the qualitative method of assessment it has the disadvantage of making calculations via application of complicated propagation models. The propagation of the different materials very much depends on the weather situation and the characteristics of the materials, but their calculation is very laborious even if the boundary conditions are precisely known. Because the amount of the material released cannot be previously known with certitude, the propagation models can only very roughly predict the extension of the areas endangered by the pollutants. The same is true for the dose-effect models describing the effect of the different materials on humans. Sensibility to particular materials very much depends on the individual and the very vaguely predictable concentration.

Compared to the risk-based method of assessment this method has the further disadvantage of mainly serving the preventive and protective regulations and giving no factual reference to the management of the settlement. The zones of exposure to danger identified according to the deterministic approach can affect an unrealistically huge area.

The critical comparison of the advantages and disadvantages related to the use of this method will show that it drops off behind the risk-based method of assessment. Due to the "zero risk" concept applied in it the use of this method has become general not only for professional reasons. Where the installation of dangerous facilities meets a considerable popular resistance (like in the Western Ländern of Germany) from a political aspect it is not correct to speak about a lesser or a higher rate of risks. Those who have a role in the installation should declare the safety of the installation. This can be best served by "Zero risk" instead of saying: only one person will die in a severe accident in each thousand years. For these reasons in Austria or Germany migration to the risk-based approach does not even come up [36].

5. Approach based on risks [2], [3], [4], [5]

Risk assessment can be defined as the systematic examination of a system structure and functions, the identification of dangers and the assessment of risk they produce in order to permit the estimation of the extent of the risk, taking the required measures to reduce risks, and finally the verification of their implementation. The probability approach is based on the inital point, that risk cannot be reduced to zero, therefore it should be decided by calculations whether the risk originating from the operation of the facility under examination surpasses the acceptable level defined in statutory law. Different methods are used to estimate the probability of the chain of accidents. There is one in use in which the chain of accidents made uniform in the database (and also based on experience) and the frequency of their occurrence are associated. In this manner the frequency of the severe accident can be selected as information in the database [10]. This method is simple, however can be the source of serious errors, because the chain of accidents examined by us can significantly differ from the one made uniform. The estimate of probability based on the analysis of the chain of accidents containing such methods as the error tree and event tree analyses means another approach. It can be established without any doubt, that the analysis-based surveys of the frequency with which the accidents occur permit a more complete risk analysis than the previously mentioned qualitative methods and deterministic methods. Nevertheless these are much more complicated, up-scale and result in more expenses for the operator. The critics of this method raise the problem, that factors of uncertainty surface in respect of the frequency of certain causal events. The validity of methods used in numeric risk assessments is limited, however the practical benefit of these methods is not in the establishment of absolute probability values (the accuracy of which can be vividly disputed) but rather more

in the accomplishment of a system analysis, which is directed in its perception at the exploration of dangers and the enhancement of safety [1]. The method that takes into account both the consequences of severe industrial accidents, the frequency of their occurrence and the assessment of the consequences means the accomplishment of the tasks composed of the following steps:

Step One: identification of the probability of a severe accident. The accomplishment of this step means that in the dangerous facility we analyse all steps, all operating modes and all equipment of the technologies used. In doing so based on our own experience and that of others, data in the literature and theoretical considerations we determine the chain of events of disturbed operation that would lead to grave industrial accidents.

Step Two: estimation of probability for the occurrence of the severe accidents identified. In doing so we establish the frequency with which the accident concerned will occur using the database or analysing the chain of events explored above (error tree and event tree analyses).

Step Three: assessment of the accident's consequences. We assess the consequences of the severe industrial accident: according to the different indicators we establish the distance the detrimental consequences can propagate to.

Step Four: integration of the severe accidents' consequences and frequency into a comprehensive risk assessment system (numeric risk assessment). According to this method the probability of occurrence received as a result of Step Two and propagation distances derived from Step Three shall be taken into account.

Step Five: qualification of the calculated risk (its comparison with the licensing criteria). In the knowledge of the limits of the danger zone (described by risk contour lines) we establish to what risk the buildings and constructions placed or planned in the danger zone (and by this token the population) are exposed.

Risk appraisal [2], [3], [6]

In the professional practice two concepts of acceptable risk are used in general:

Individual risk, the level of risk expressing the probability that the person at places located at various distances from the accident site in case of a severe accident related to hazardous materials would decease. Generally, the individual risk is taken into account form the point of view of acceptability if there the are persons at the accident site who (at least in theory) stay there continuously (for example in residential buildings).

Social risk, the level of risk expressing the probability that a group of persons at places located at various distances from the accident site in case of a severe accident related to hazardous materials would decease. The acceptable rate of social risk also depends on the number of the persons affected by the accident. Generally, social risk is taken into account form the point of view of acceptability

if there are persons at the accident site who do not stay there continuously (for example at workplaces, in shopping malls, etc.).

Conditions of the acceptability of risks

If the dwelling area is located in a zone where the individual risk of decease in a severe accident does not exceed the value of 10^{-6} event/year the level of exposure to danger shall be acceptable. When in a dwelling area the individual risk of decease is between 10^{-6} event/year and 10^{-5} event/year, the level of exposure to danger shall be unacceptable. In this case the authority obliges the operator to take measures to reduce the risk of the activity or to provide for such safety measures (alert, individual protection, close up, etc.), which reduce the level of risk. It is unacceptable if the individual death risk exceeds the rate of 10^{-5} event/year in the given part of the danger zone. If the risk cannot be reduced within the framework of resettlement procedure, the authority will oblige the operator to limit or terminate the activity.

If in the part of the zone under examination there are not only residential buildings, but a great number of people stay there regularly (for example at workplaces, in shopping malls, schools, entertainment facilities, etc.), the criteria elaborated for social risks shall be used as a starting point in assessing the exposure to danger. The more people are affected by the lethal effect the less acceptable the social risk shall be. So contrary to the constant values of individual risk levels the level of social risks can be defined only as a function of the likely number of fatalities. The rate of exposure can be deemed acceptable when the area examined is located in a zone where the social risk of decease due to severe accident is:

$$y < 10^{-5} * x^{-2} \ ,$$

where: y = risk level (death from severe accident/year),
x = number of victims.

The level of exposure to danger is unacceptable, if the social risk of death in the area is:

$$10^{-3} * x^{-2} \ y > 10^{-5} * x^{-2}$$

In this case the authority obliges the operator to take measures in order to reduce the activity's risk or to provide for the conditions of safety measures (alert, individual protection, close up, etc.), which reduce the level of risk. The level of exposure to danger is unacceptable, if the social risk of death in the area is:

$$y > 10^{-3} * x^{-2}$$

If the risk cannot be reduced within the frame of resettlement procedure the authority will oblige the operator to limit or terminate the activity.

Advantages and disadvantages of the approach based on risks and conclusions of applying the approach based on risks

Compared to the method of qualitative assessment this method has the undisputable advantage of being sensitive to taking into account the factual conditions of accidents and their propagation. It provides possibilities for the analysis of specific chains of accidents and for taking into account of the conditions of propagation in a manner permitted by the propagation model we use. A further advantage is the method's sensibility to take into account the frequency of the chains of accidents. In this way we can handle the events according to their weight, the consequences of which are devastating indeed, but the probability of their occurrence is neglectable. In the knowledge of the chains of accidents that most markedly contribute to the occurrence of grave consequences we can establish the order of importance of the individual elements, that is we can select the most critical ones from the point of view of safety.

When elaborating the safety building measures it should be considered how much the proposed measures will enhance safety and at what cost. It should also be analysed in which area the amounts, which can or may be affected to the reduction of costs can be used most effectively. The maximum risk reduction coming to a unity of expenditure should be given priority and this aspect can rank the measures. Due to the relatively rare occurrence of emergencies the staff has little practice in handling them. In complicated systems the number of potential breakdowns is so big that the operators cannot be trained to handle all of them. By selecting the probable chains of events we will be assisted in compiling the training program. Based on the exploration of chains of accidents we can introduce the tightening of operation and we can also introduce restrictions to avoid such situations, but we can also define the optimal testing, maintenance and repair strategies. The risk-based approach has the very significant advantage compared to the other methods, that besides the assessment of endangering effects it can be used for the analysis of almost all aspects of safety.

Compared to the qualitative method of assessment it has the disadvantage of applying complicated propagation models in calculations, and added to that the definition of the frequency of occurrence which is far from being a simple task. The application of this method requires profound expertise of several fields (estimation of the risks and assessment of the consequences). The main problem in applying the probability approach comes from the inaccuracy of the models applied and of the data used. Calculations concerning the same facility but carried out by different analysts may sometimes produce significantly dissimilar results. The most intricate part of the numeric risk assessments is the allowance for the staff's activity, as in the safe operation of hazardous plants the human factor plays an outstanding role. Practical experience has revealed cases, which the risk-based methods will never be able to take account of, even with allowance for the significant development of such methods. The prospective recognition of risks does not exclude the exploitation of the events that have already happened in the course of the risk assessment, which can be seen in the model of prospective

hazard point assessment. The critical comparison of the advantages and disadvantages related to the utilization of this model results in realizing that it has numerous advantages compared to the consequence-based approach. Its integrated concept extending to all aspects abundantly compensates first of all its weaknesses of accuracy.

Conclusions for the reasonable selection of a Hungarian assessment method

Considerations	Assessment method		
	Qualitative	**Based on consequences**	**Risk based**
Unambiguousness	the most unambiguous	Transitional	The less unambiguous
Accuracy	The most inaccurate	Transitional	Exposure to danger can be calculated with the highest accuracy
Sensibility	Insensible to change of conditions	Transitional	The most sensible to change of conditions
Simplicity (need of skill)	Very simple in case of limited accuracy requirements, but very complicated if accuracy is important	Transitional	Its utilization cannot be considered simple, as it needs profound and diverse expertise
Need in tools	Needs very little means in case of limited accuracy, however requires a lot of means if accuracy is at stake	Transitional	Requires serious background in hardware and software, and also databese
National antecedents of the implementation	None	Widely applied	None
International trends	Loosing out in the EU and industrialized countries		In spread in the EU and industrialized countries

Based on the above it can be established, that:

- Currently, there is no approach available in the assessment of exposure to threats, which would not have significant disadvantageous features.
- Its introduction would not be a source of serious difficulties.
- None of the many expectations towards the method has an absolute priority.

So when we qualify one of the procedures as "the most applicable" we should weigh up the advantageous and disadvantageous features in their complexity. This leaves some room for subjectivity. Supposedly (should we even give priority to the risk based method on the long run) these different methods would be simultaneously present in the Hungarian professional practice. The risk-based approach however is gaining ground. It has more advantages then weaknesses, and what is more, it is incorporated in the Hungarian legal regulation.

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