Requirements on emergency and disaster management at industrial major accident hazard sites – a status survey on Austria

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Awareness raising for industrial hazards and risks involving major accident hazard sites is becoming increasingly important for disaster management and public authorities. Current trends show an increase of hazards with high probability of damage to environment, infrastructure and surrounding communities along industrial sites. During the permission process for industrial plants, multiple authorities may be involved in terms of commissioning technical and organisational aspects of plant operation. This spread of responsibilities may lead to insufficient knowledge management and loss of information, resulting in improper execution of current legislation. Especially in emergency and disaster management, a close look has to be given towards local and regional administrative authorities involved in the commissioning and inspection of major accident hazard sites. Within the scope of this paper, the example of Austria is used for a status survey on risks, scenarios and external emergency planning procedures for major accident hazard sites. Current resources and structures of off-site emergency services as well as emergency procedures for external emergency plans in Austria have been analysed for different production sites liable to EUs Seveso legislation.

The present paper points out weaknesses of different legal responsibilities in multiple agency authorities during the approving process as well as deficiencies in contingency planning by external emergency response forces. Current scenarios have been analysed in order to derive and present the requirements for today's emergency and disaster management around major accident hazard sites.

1. Introduction

Current developments show a raising trend of ever-increasing potential threats, which develop into high-risk dangers with a high probability of damage for humans and animals, as well as environment and infrastructure and will no longer be limited to natural events. Climate change has long since ceased to be a present phenomenon, but has now become a reality, as has digitization and the unstoppable globalization and urbanization trend. By 2050, around 70 percent of the world's population will live in cities, which poses enormous challenges to the security of critical infrastructures. [1]

Ensuring this security claim in private and public life requires continuous development and improvement. In this context, particularly accident-prone businesses play an important role - at both ends. On the one hand as causer, since they are meanwhile an integral part of our today's supply chain infrastructure, and on the other hand by highly complex processes an increasing vulnerability exhibit. Risk analyses and the assessment of the potential hazards of accident-prone infrastructure provide realistic threat scenarios that can reach levels that can no longer be controlled with the resources of individual organizations alone. As a result of the development of relevant situational pictures and scenarios, even the lower administrative structures of the federal states will be given a higher status. This is already the case in many parts of Austria. Nevertheless, it is likely that too much will be done without adapting the framework and providing the resources that administrative authorities need to address these challenges. The systematic analysis and assessment of the risks of technical systems has been standard in high-risk areas such as the chemical industry, oil and gas industry, aircraft industry, medical technology and the like for many years. Due to the already existing and continuously increasing legislative, normative and liability requirements, the optimal design of quality and quantity as well as sustainability of comprehensive requirements planning is of the highest importance in crisis and disaster management. As a fixed component of a well-organized and structured, as well as well-networked and efficient crisis and disaster management, a synergetic co-operation of carriers and de-plausibility is indispensable for the management of events of extraordinary magnitude. Especially in the chemical industry, comprehensive security planning and development of strategies to strengthen resilience at all levels is necessary. Mutual knowledge and experience transfer, as well as an exchange of planning and operational knowhow are the basis of a promising and sustainable crisis and disaster management. [2]

The present paper on the "r*equirements on emergency and disaster management at industrial major accident hazard sites*" deals specifically with the challenges faced by operators of accident-prone infrastructure, relief organizations and local authorities of the individual administrative structures. Within the framework of a status survey, a concrete example of Austria is strikingly illustrated which friction losses occur in administrative enforcement and in how far municipal task forces are up to the challenge. Based on the LOPA method (Layers of Protection), the focus of this paper lies in the two outer layers, as well as their interfaces. In line with the Swiss-Cheese model, in particular internal and external emergency planning are the last safety nets to prevent or minimize major loss events. Such a scenario usually starts with triggering conditions and, if necessary, boundary conditions and can be stopped or influenced in the development of a serious accident by various levels of protection or by other influences on the extent of damage. Either it will maintain a safe state or at least limit its impact. In this case, the challenges facing security actors play a key role. The latter also serve semi-quantitatively to cover a large part of the residual risk. [2]

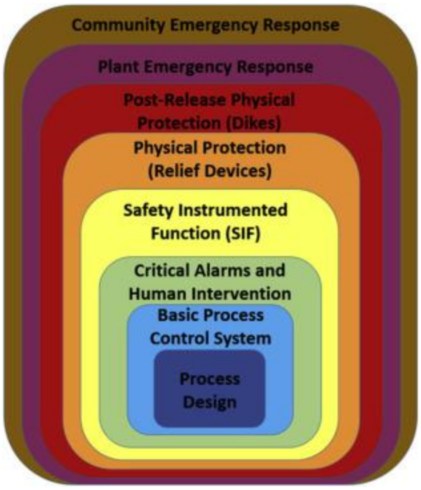

Figure 1: Layers of Protection [2]

Security in the protection levels of technical systems often arises as a result of many years of experience, which are expressed in norms and legal regulations or as experiences of the persons and institutions involved. This level of knowledge is inevitably never completely sufficient and always contains an element of uncertainty. Security-relevant information is more frequently available and evaluable wherever this information can be classified in comparable technical categories. Thus, on closer inspection of the official responsibilities, one can find a safety approach on the part of the permission authority, which is not identical with the emergency response planning at the municipal level. The operational licensing procedure in Austria knows no legal probabilities of occurrence. Although the substance-related potential for appropriate distances is taken into account in spatial planning, in turn by the official crisis and disaster management, only in few cases, a specific and systematic attention is drawn to substance-related risk potential in the context of external emergency planning. What, in synopsis, may result in inadequate security retention in civil protection. [2]

2. Consideration of risk analysis models

Complex facilities of accident-prone infrastructure require an adapted form of risk analysis to assess the hazard potential. This integrative approach includes, among other things, preventive measures to avoid dangerous operating conditions, as well as plant-related mitigation measures and contingency planning measures. In order to subsequently determine the assessment of the potential dangers of accident-prone operations, it is necessary to know the existing methods. In practice, there is a variety of methods that are modified in most cases and adapted for a specific application to systematically analyse all possible sources of danger for the individual case. In addition, it is necessary to know the process complexity of technical systems. This results naturally from their intended use and the sources of danger of their technology. The following factors are decisive: [3]

- substance properties and available quantities (e.g. flash point, ignition temperature, explosion limits, toxicity, reactivity)
- process conditions (e.g. pressure, temperature)
- plant condition (e.g. lifetime, damage mechanisms)
- location and surroundings (e.g. degree of urbanization in the neighbourhood, neighbouring facility, vulnerability)
- external factors (e.g. external mechanical damage, natural hazards, unauthorized access, terrorist activities)

The main limitations of the risk analysis presented can be summarized as follows. The more general the method, the less it takes into account the peculiarities of the event to be investigated. On the contrary, a too specific method is much more difficult to implement. It is also crucial who carries out the risk analysis. Because the competencies of the individuals involved are significantly influencing factors on the results of the analyses. For probabilistic analyses, the validity and timeliness of the data is a crucial parameter, which in turn requires a great deal of time, which, due to incomplete descriptions, makes the operative application often more difficult to realize. [4]

It therefore makes sense to demand a clearly defined strategy in the risk analysis methodology. The complexity of individual methods additionally requires a specific training for the implementation of results. Human factors thus play a central role in the application and implementation, and on the other hand, in the development of systemic specifications. [3]

In Austria, the systemic and historical approach in risk culture is predominantly deterministic. Which means that a certain event sequence is excluded as a result of careful consideration and thus countermeasures are either not required or another event sequence cannot be ruled out, whereby countermeasures are to be provided. Each event sequence is thus assigned the probability of occurrence 0 or 1 based on experience. In probabilistic analyses, on the other hand, it is taken into account that events occur with an arbitrary probability between 0 and 1 and that the countermeasures for controlling these events also have a probability between 0 and 1 – including their availability. The horizon of experience that is once available for the qualitative decision "neglecting or considering an event sequence" or for the quantitative determination of probabilities is of course the same. In contrast to deterministic methods, not only actually observed event sequences are taken into account, but also the hypothetical approach, which gives the event sequences a higher priority. Overall, it follows that the methods used must include the full range of triggering events and factors of the most up-to-date science and technology. [5]

An ideal methodology for risk analysis would therefore have to include the source term, as well as the event flow (propagation of the accident) and the objectives (human, environment, infrastructure, equipment). In addition, control mechanisms and management measures should be taken into account. The interaction of this ideal composition must subsequently allow both deterministic and probabilistic approaches to ultimately yield qualitative results on recommendations and a quantitative assessment of the main consequences. [3]

Probabilistic methods are now being used increasingly successfully to test the balance of security concepts. In addition, such methods provide decision support: [6]

- for optimizations in plant design, as well as maintenance strategies
- in the evaluation and evaluation of operating experience
- for the evaluation of event sequences
- for more detailed descriptions of the achieved security level
- for setting priorities in hazard planning and security research

However, as the safety philosophy in Austria is designed to be purely deterministic in terms of approval and hazard prevention planning, the corresponding conditions for the implementation of probabilistic methods should be created as quickly as possible in this country as well. This includes, among other things, the continuous registration of serious accidents and near misses, as well as the creation of a database for the corresponding failure data of components and systems in process plants.

3. Emergency and disaster management

3.1 Organizational framework

In Austria, the National Crisis and Disaster Management (SKKM – Staatliches Krisen- und Katastrophenmanagement) is based on the principles of primary response of local structures. It pursues the principle of subsidiary intervention by higher administrative levels. The Federal States are responsible for all forms of official and technical disaster management (Articles 9, 15 and 79 of the constitution). Only special and overarching threats are within the responsibility for the national government - major disaster events in the chemical industry are just as much an example as are pandemics or blackout scenarios. Due to federal legislation, the Austrian Disaster Management system is predominantly of coordinating nature, as it does not have an all-competent civil protection authority. In the overall system of the SKKM, the interaction of state actors and non-governmental organizations is of particular importance. At all federal levels (national, federal, district, municipality), easy access to emergency response and assistance services of the response agencies is therefore an essential element of in-phase, inter-state cooperation between the various actors. The comprehensive provision of security and disaster relief services is largely ensured by the involvement of voluntary organizations in public assistance systems based on laws and statutes, combined with few full-time institutions. These resources are supplemented by municipal emergency response, in particular in the case of major disaster events, through operational deployment structures for industrial hazard management as part of internal emergency planning. The Austrian emergency and disaster management is based on five pillars (citizens, authorities, response organizations, science, economy). A synergetic interaction of these five pillars is of particular importance especially for major accident hazard sites.

For this purpose, the “Federal Working Group Seveso” was set up as a steering instrument of the SKKM. It is the only national body that comprehensively deals with issues related to the control of the dangers of major accidents involving dangerous substances and is made up of representatives from ministries, federal states and provincial capitals. The Austrian State Working Group Seveso is a permanent committee of experts and was constituted in 1992 on the occasion of the entry into force of the former "Major Accidents Ordinance". The group’s tasks include the exchange of experience at expert level in technical and practical enforcement of industrial accident law and plant safety. For this purpose, international developments are observed, discussed and conclusions drawn. Another important area of responsibility is the preparation of uniform guidelines for enforcement, in particular for the technical official experts and, where appropriate, the expert advice of relevant committees or the responsible ministries. [7]

3.2 Legal framework

In Austria, there is no "all-encompassing" legislation governing large-scale incidents in case of accident-prone companies, but a plethora of different provisions in numerous federal and state laws, including the issued ordinances. Many of these legal norms are not aimed at protecting the population and the environment alone, but also at other public interests. The basis for our national law is based on the Seveso Directives - currently the Seveso III Directive (2012/18 / EU) of 12 July 2012. Like the previous directives, it aims at creating safety management systems as a precautionary measure for and regular inspection of installations storing certain quantities of dangerous substances. Heavy accidents are therefore to be largely prevented and the consequences of accidents on human health and the environment should be limited.

The recast of the directive was the result of significant changes to the EU system for the classification of dangerous substances. The implementation of the Seveso III Directive took place in Austria on June 1, 2015, whereby the Industrial Code 1994 (Gewerbeordnung 1994), Section 8a was replaced by the so-called "Seveso III Amendment". The regulations for informing the public, which were previously are now uniformly summarized in the Environmental Information Act for all federally regulated plants. In addition, important content in the Gas Act, the Waste Management Act, as well as the Railway and Aviation Act were adjusted. Industrial accident law applies to all companies in which hazardous substances are present or can arise in the event of an accident. The creation of these documents, among other things, focuses on the need to consider domino effects. In addition, the provision of the basis for various regulatory obligations (e.g. spatial planning, external contingency planning), as well as reporting obligations on occupational classification and major accidents, was regulated. As an alerting agency, the Federal Warning Centre is foreseen in the Austrian Federal Ministry of Interior. However, national implementation of the

Seveso III Spatial Planning and Civil Protection Directive falls within the competence of national legislation. Although the Industrial Code generally provides that the disclosure of the list of hazardous substances to the public may exclude those parts which contain business and trade secrets, this does not apply to the public authority. The authority must have all the information necessary to at least assess the possibility of a major accident occurring. The determination of a corresponding performance in the protection against civil protection is the sole responsibility of the responsible administrative authorities in accordance with the applicable civil protection legislation.

The legal framework for the competence of Austrian administrative authorities for major accident hazard sites arises primarily from the Industrial Code. Emergency planning is defined primarily by civil protection laws. This gives a priori the responsibility of different administrative authorities. For example, the permitting process mainly takes into account the impact of the neighbourhood, the impact on the environment and the impacts on waters. But in the context of disaster management and response planning the term neighbours, definitely is too small-scale executed. In the Federal State Civil Protection Laws, a distinction is made between disaster preparedness plans (external) and emergency planning at companies (internal). The latter is delegated entirely to the respective district administrative authorities, which do not have authority for response disposal and dislocation. Too that, municipal emergency planning is generally not based on incident-related scenarios. This leads to the conclusion that too much is expected of the district authorities to control large-scale events. It also complicates cross-organization, demand-oriented resource planning and provision by the higher-level authority and the relevant department.

4. Determination of the risk of major accident hazard sites

The scenario consideration starts with the collection of the consequences that are associated with a plausible event. Some of the considered sites have only few relevant accident scenarios (e.g. warehouses and fuel depots). However, as more processes and hazardous substances are present on the site, the associated material flows also increase the risk posed by possible risk scenarios. Therefore, it is particularly important to select scenarios that are most representative of the actual risk at the site. The following principles are used to select scenarios related to incidents in the chemical industry: [8]

- reference scenarios that are to be used for impact assessment in the context of spatial planning risk analysis - and therefore also in the approval procedure - are selected according to the frequency of their occurrence and the severity of their consequences
- "Worst Case Scenarios" are not a compelling basis for spatial planning, but very well in crisis and disaster management, as well as a need for setting standards
- timing of impacts should be considered when selecting scenarios
- the effectiveness or failure of safety barriers must be probabilistically calculated when selecting the reference scenario
- due to the hazardous properties of the substances, the most likely scenarios can be classified according to their effects, according to the following criteria.
    - release of liquids and solids
    - release of toxic gases
    - explosion
    - fire

In the determination of the risk potential of major disaster events, the consideration of safety barriers based on the LOPA method is an essential criterion. The focus of attention is the occurrence of a worst-case scenario. In this case, in order to represent its probability of occurrence as "1", a failure of the primary inclusions (e.g. containment, packing, drum, tank, reactor, pipeline) is generally assumed. This hypothetical incident also includes the failure of active safety mechanisms such as measurement and control technology, as well as fire-safety-related devices and alarm systems. These can in principle fail and therefore are not considered as retention barriers. The same applies to operational concepts in the context of internal emergency planning. Moreover, in most cases, actors in external emergency planning are already taking effect at the same time. Passive safety measures such as structural fire protection (fire zones), shielding walls, concrete catch basins, extinguishing water retention basins or earth cover are generally considered as limiting measures. In explosions, however, structural safety barriers are usually ineffective. The risk potential is thus determined by the nature and quantity of the substances involved, the time course of the accident and the (possible) existence of passive restraint barriers. [8]

The procedure for the subsequent determination of the risk potential for planning purposes in the context of crisis and disaster management is based on the following methodology. The scenarios were selected after identifying the specific dangerous substances. These substances have been taken into account in the context of the Seveso III Directive and its quantity thresholds. The risk assessment was carried out in the following steps: [8]

Step 1: Selection and consideration of the relevant hazardous substance
Step 2: Assessment and study of conditions (pressure, temperature)
Step 3: Reference Scenarios from Impact Assessment
Step 4: Identify the possible scenarios that may occur in connection with the hazardous substance
Step 5: Evaluate each scenario according to the relevant criteria and impacts
Step 6: If the risks associated with the particular scenario are inconsistent with Spatial Planning / Dangerous Planning, evaluate the order of events subordinate to the scenario
Step 6: Evaluate the sub-event, in terms of frequency or conditions
Step 7: Development and consideration of protective barriers to minimize risk
Step 8: Select the protective barrier and continue with step 4

Based on the substance-related data, triggering events (scenarios: release, fire, explosion) were described. Taking into account the respective hazard characteristics (physical, chemical, and hazard classification) and the corresponding propagation paths (air, soil, water), an initial assessment of the risk was made and explained in the impact description. Subsequently, the effective distance was considered with the state of aggregation, mode of release and amount of substance, as well as the effects on the environment (topography, settlement density, vulnerable environment). This made it possible to assess the consequences on people, environment and related infrastructure, and to assess the risk when the scenario occurred. In order to better visualize the risk assessment, the result has been georeferenced. The resulting risk map serves as a decision support tool for authorities and response organizations and their response and dislocation planning (quantitative and qualitive).

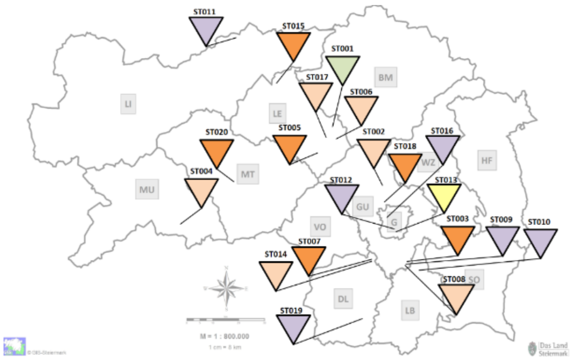

Figure 2: georeferenced risk map of major accident hazard sites [based on federal state data]

In order to be aware of the requirements in the response planning, it is necessary in the risk analysis, among other things, to place a specific focus on the impact assessment of major loss events. The approach to the use of deterministic methods also seems to make sense, as worst-case scenarios have their significance in crisis and disaster management. Only in the provision and dislocation of resources for safety, it is also useful in the context of the planning process on probabilistic results supported. Since the control of major accidents and disasters is only one part of the planning process in emergency and disaster management, the visualization of the risk in conjunction with other hazard potentials can complete the process and subsequently optimize the provision of resources. Combined with further datasets such as the potential hazard and risk of flooding, landslides, forest fires, etc. this interactive map provides an "all-hazards approach" in the planning and provision of emergency and disaster response. This would additionally provide local government with a better overview and access to resources, as well as a keener awareness of the need for such funds on the basis of adequate risk assessments. The resource-providing authority would have a quicker and better overview of existing resources, and is able to identify needs and gaps in response planning, reduce duplication, and support purposeful and efficient deployment and dislocation.

5. Derivation of requirements

To be able to conclude the requirements for emergency and disaster management for major accident hazard sites, it is necessary to assess and compare the existing response capacities at national and international level once scenarios and risks have been assessed. For consequence management, the coping capacity component at the international level is becoming increasingly important as a result of raising complex scenarios and the associated increased need for performance. In order to be able to make valid deductions for requirements, the evaluation also takes into account two specific case studies. [9]

5.1 Case Study

The chemical industry in Austria is responsible for more than 10 percent of the value of production in industry, with about 260 companies and 43,100 employees. This puts every eighth industrial workplace in the chemical sector, where 170 of these sites are major accident hazard sites. Nevertheless, statistics on major loss events in Austria amount to <1 per year. In Germany, around 10 to 20 serious accidents occur each year among the approximately 8,000 existing facilities. This brings different approaches to crisis and disaster management in both countries. [10]

To work this out, the recent events are briefly presented. These are a major fire of a recycling company in Wildon (Austria) in August 2015, as well as the accident at BASF in Ludwigshafen in October 2016. Although the company in Wildon is not a classic Seveso plant according to classification, the event is consistently comparable to an industrial fire in the context of the Seveso directive. Furthermore, it is precisely this comparison that underlines the fact that the term “major accident hazard site” does not always have to be directly linked to the classification under the Seveso III Directive.

On August 29, 2015, the company Ecoplast Recycling in Wildon, southern Styria, experienced a major fire. Although the company does not fall into the category of Seveso businesses, it claims that it processes about 28,000 tons of plastic per year, quite a lot of household and commercial waste. A plant fire service, as well as locally existing stationary safety systems are not installed. Fire investigators were most likely to cite self-ignition of the pressed plastic fraction. This thermal conversion resulted in a firefighting area of around 10,000 m². Nine firefighters were injured during this 24-hour operation. 72 local fire brigades with around 800 firefighters, 32,000,000 liters of extinguishing water, 8,000 liters of foam and 40 portable pumps were used. At the beginning water resources came only from fire trucks. Only at a later stage, resources from the river beneath were used. The success, however, only came with the targeted use of foam. Only five hours later, the necessary extinguishing foam could be provided. A claim that was made during the fire in 1993. A similar industrial fire occurred at the same site. Triggered by welding, the fire area at that time was only 500 m², but the challenges faced by the first responders and the authorities were almost identical. [11]

On 17 October 2016, a serious accident occurred at the BASF plant in Ludwigshafen. Two explosions and a resulting major fire over 10 hours resulted in four immediate casualties. Not quite a year later, another fatality was added, as a firefighter died as a result of the accident. 29 people were injured, seven of them seriously. The Ludwigshafen site is the main location of the company with a number of chemical plants. In the north port, all the flammable liquids and liquefied gases used at the plant are handled - a total amount of 2.6 million tons per year. The previously developed handling points are equipped with permanently installed foam fire extinguishing systems. However, these foam throwers do not reach the rear piping between the piers and the railway lines. The facilities in the port are operated by different companies. The pipelines where the accident occurred are not operated by BASF. The cause of the event was the incision of a line with an angle grinder. As part of this event, the incident was proclaimed in Ludwigshafen. The operation required an evacuation of 133 people from the hazardous area, as well as about 100 professional fire fighters from the departments Ludwigshafen and Mannheim and the volunteer fire service of Ludwigshafen, as well as another 100 from the plant fire department and 20 forces of the Federal Agency for Technical Relief. Two turbochargers with a capacity of 7,000 litres per minute each were used, a foam fire truck with a capacity of 16,000 litres per minute and five mobile water cannons with 3,000 litres per minute each. In total, 37,000 litres of foam were successfully used. According to BASF, this was the sixth reported incident in 2016. [12]

5.2 Consequence management capacities

National response capacities are limited on the one hand to the availability of operational plant safety, as well as to the entire range of external emergency planning. In the context of planning procedures in civil protection, the operational component is fundamentally seen as being detached from external resources because it is assumed that the task forces provided for internal emergency response are already in place anyway. In addition, industrial safety is always occupied in an operational sense and can only be used for external purposes in exceptional cases. [9]

In Austria mostly, volunteer fire brigades are in use. Even in the smallest villages you will find people who do this activity on a voluntary basis. In addition, there are company fire brigades, which are also composed mainly of volunteers from the ranks of the employees of the facilities and protect their jobs as a secondary use. Only in the larger provincial capitals such as Vienna, Graz, Linz, Innsbruck, Salzburg and Klagenfurt there are traditional and well-equipped professional fire brigades. The main task of the Austrian fire brigades are defense and preventive fire protection as well as assistance after accidents, disasters or other emergencies, and finally participation in civil defense. According to the Federal Constitution, the fire service in Austria falls under the jurisdiction of the federal states, which is why the legal foundations are reflected in the federal laws. These provincial associations are independent organizations themselves - and have their own country-specific character. Carrier of the local fire police is thus the community. The Austrian Federal Armed Forces Association is the umbrella organization of the federal fire brigade associations and the cities with professional fire brigades. Its task is the coordination of the fire brigade in the areas of organization, training, technology, etc. In addition, most of the revenues from the fire protection tax flow to the federal states and the state fire brigade associations. These cover mainly the expenses of the association, the costs for fire brigade schools and the demand for the procurement of vehicles and equipment. Nevertheless, these public funds hardly cover the financial needs of volunteer fire departments. On average, half of the funding for the fire brigades comes about through self-employment. Only for the procurement of disaster relief equipment of the fire brigade, the federal government also provides funding from the disaster fund. These different financial flows naturally lead to a difficult coordination in the provision of resources. [13]

The Austrian Red Cross is the national Red Cross Society in Austria recognized by the Republic of Austria and the International Committee of the Red Cross and Red Crescent. Like the federal structure of Austria, the organization is divided into federal associations, district offices and local offices. As a private, democratically organized organization of support and help, the Red Cross is non-profit and makes its own private and public tasks in the humanitarian field. It relies on dedicated, professionally qualified, volunteer and full-time staff. Activities include ambulance and ambulance services, health and social services, blood transfusion service, dissemination of international humanitarian law and conventions, education and training of the population and staff, search services (search for missing persons, family reunification), development cooperation and disaster relief in war and peace. In order to make helpfulness available to disaster victims and major events, National Radio Channel Ö3 and the Austrian Red Cross launched the "Team Austria" project. The aim is to get as many volunteer citizens as possible to help in the event of disasters. The overall management of Team Austria's mission lies with the Red Cross. At present, Team Austria comprises 50,000 people who have registered as members via the homepage. [14]

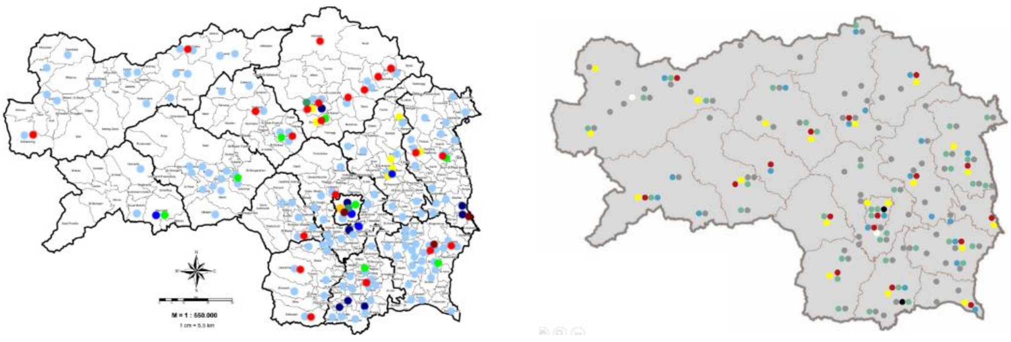

Figure 3: comparison of federal response capacities (example data: firefighting and red cross organisation) [13] [14]

Major disaster events in the chemical industry can reach proportions that can no longer be managed with the resources of individual national state resources. Particularly in countries that do not have the structures and reserve capacities, international mechanisms are essential. But even close-border incidents can reach dimensions that can only be mastered in international context. Therefore, the mechanisms of international disaster relief provide activities that, on the one hand, prepare a society for possible disasters and, on the other, anticipate and improve the response of various actors. While risk reduction often deals with the reduction of hazards itself, disaster relief mechanisms are already predicting the status of a disaster. The aim is to ensure that the various actors in a society are not caught unprepared and that the assistance measures take place in a coordinated manner. Disasters, especially those related to infrastructure prone to disruption, have no limits, and since the 1980s, international organizations, in particular the United Nations and the European Union have sought to develop concepts to improve international cooperation in disasters to develop. These concepts are geared towards the needs of the authorities to be assisted and designed according to the principles of humanity, equal treatment and neutrality.

In 1991, the UN General Assembly adopted Resolution 46/182, which standardized the basic rules of international disaster relief and gave the UN the leading role in managing and coordinating disaster relief. The former Department of Humanitarian Affairs was also created for this purpose. After reorganization in 1998, it became part of the United Nations Office for Humanitarian Affairs (UNOCHA) in Geneva. Located in the United Nations Secretariat, UNOCHA is present in more than 50 countries and is responsible for coordinating and managing information, advocacy, funding and policy development. Austria has actively supported these international efforts from the outset and played a leading role in developing the United Nations disaster relief system. The instrument of the United Nations is such a comprehensive and diverse to ensure a correspondingly efficient response around the globe. For example, UNOCHA has a 24-hour duty system connected to worldwide early warning and monitoring tools and an online communication platform. Through a global database, access and information is guaranteed to registered international experts and support teams trained to UN guidelines. This leads to a global network, which is of central importance especially in time-critical and complex disaster events such as earthquakes or industrial accidents. In terms of logistics, the United Nations has two centralized deposits for the coordinated distribution of its own resources (UN Logistic Base in Brindisi, Italy, UN Support Base in Valencia, Spain). [15]

Like the United Nations, the European Union, has a vital interest in preventing and restraining disasters. In 2001, the EU Civil Protection Mechanism (EUCPM) was established, which promotes cooperation between the national civil protection authorities of 34 participating States across Europe. It currently includes all 28 EU Member States plus Iceland, Montenegro, Norway, Serbia, the former Yugoslav Republic of Macedonia and Turkey. The mechanism has been set up to provide participating states with coordinated disaster relief assistance, and involves the mobilization of aid units and experts, support for coordination and cooperation, as well as information flow, to avoid duplication and to optimize assistance contribute. The Department for European Civil Protection and Humanitarian Aid Operations (DG ECHO) is the department of the European Commission for International Humanitarian Aid and Civil Protection. For interventions, ECHO does not itself implement aid programs, but provides funds through a wide range of around 200 partners (NGOs, UN agencies and international organizations). ECHO has 44 offices in 39 countries. These field offices provide an up-to-date analysis of existing and projected needs in a given country or region and contribute to the development of intervention strategies, provide technical assistance for ECHO-funded operations and ensure adequate monitoring and coordination on the ground. For major catastrophic events in the chemical industry, the Department for Environment (DG ENV) is also relevant. With the Joint Research Center, it has specific research instruments and spin-offs, including the management and prevention of industrial disasters. [16]

5.3 Quantitative and qualitative requirements

In order to derive quantitative and qualitative requirements in civil protection, it is important to take a closer look at existing coping capacity regulation. An essential and fundamental part of this is formed by the internal and external emergency plans of accident-prone companies. As already outlined in, they are required by the Seveso III Directive (2012/18 / EU), subsequently transposed by national legislation. Internal contingency planning shall regulate the protection of personnel in incident management areas and shall be developed by the operation, while external contingency planning shall be prepared by the security planning authority and designed to protect neighborhood areas. In the following, the main requirements, of the internal and external emergency planning, are listed: [17]

- organizational chart of the management organization (contact person)
- details of the object and its environment (plant, operation, factory, operating times, geographical location, protective objects and sources of danger in the area)
- general description (access routes, staging areas)
- hazard points (dangerous substances, authorized quantities, dangerous technical equipment, danger zones, hazard zones)
- security forces and facilities (operational, external, external)
- facilities and equipment of the establishment (coordination point, communication structure, mobile resources, equipment and devices, warning devices for indications of particular hazards)
- alarms, warnings and message paths (alerting process, warning of employees and the public, notifications to authorities)
- security (as an interface to external emergency planning)

In addition, the following contents are mandatory for external emergency planning:

- name or position of persons authorized to take immediate action or carry out and coordinate operations outside the premises
- provide for the reception of early warnings, as well as the triggering of alarms and the notification of emergency and rescue services
- arrangements to coordinate the resources needed to implement the external emergency plan

- provision for remedial action outside the premises
- information to the public about the accident and about the correct behavior
- provision for the training of emergency services of other States in case of a major accident with transboundary consequences

However, derivations for quantitative requirements need a more comprehensive consideration of contingency planning, which is why the contents of the hazard prevention planning of individual emergency organizations are also being considered. Through that approach, it becomes clear that the degree of resolution is already much more detailed and quantitative derivations for civil protection are given. In addition to the above-mentioned contents of the internal and external emergency planning, individual and organizational details of the directly responsible operational units are indicated (responsible fire department or service of the Red Cross). In addition, specific scenarios are already presented, analyzed by means of technical measures and backed up with measures and preparations to be made (release order, request for special forces, special protective measures, evacuation radii, etc.). This risk-analytical part is supplemented by a rough estimate of the number of people affected inside and outside the company premises. With regard to the operational planning of the respective task force, the availability of individual services and bases is already quantitatively examined and includes the number and quality of vehicles, as well as alarm and arrival times. This input data serves the federal authority for tactical spatial planning and allocation of forces (quantitative and qualitative) as well as all matters of logistics and communication. The consideration of the emergency and alerting plans gives a good overview of the operational readjustment of civil protection. If there is sufficient quantitative coping capacity among the responders, the question arises as to whether they are properly equipped and can be made available in time. However, the provisions of these regulators are limited to implementation measures based on existing capabilities and capacities in civil protection. That results in the derivation, that for example the introduction of large amounts of water, coupled with the appropriate distance throw, is a central ability to create extinguishing effect. High-capacity pumping, such as those used during flood events, can already make a substantial contribution here. But still the gap in effectiveness remains open, due to missing extinguishing distances. Furthermore, the capacity for treatment of a mass casualty event is another major component of industrial accidents. Encountering a large number of victims and casualties often puts response organisations at their limits. Mobile treatment units with surgical capacity are a valuable addition to triage, as well as the treatment of burn injuries and poisoning on the ground, since stationary emergency infrastructure is already busy in most cases. Another significant capability is the ability to search and rescue casualties, especially under CBRN conditions (chemical, biological, radiological, nuclear), as well as capacities in sensor technology and decontamination.

The comparison of capacity planning approaches has shown clear differences in the quality and quantity of the discussion on requirements and performance parameters for coping capacity. Existing national guidelines mainly take into account the requirements of fire and civil protection. Therefore, it is quite understandable why, municipal capacities within Austria, in the event of incidents in major accident hazard sites are often insufficient to master the scenario. In addition, it can also be clearly deduced that far too much is required of the responsible administrative level in emergency and disaster management.

6. Conclusion

The emergency and disaster management of major accident hazard sites is gaining in importance due to increasingly complex processes and systems and the associated raising tendency of high-risk dangers. Along with this, however, there are also growing demands that need to be met, but at least taken into consideration in order to counteract the trend towards greater potential for damage. The systematic analysis and evaluation of the risks in the technical system provide a significant contribution in order to subsequently derive and assess the resulting potential risks and realistic threat scenarios. These results lead to requirements that serve the authorities as the basis for their response planning in civil protection.

The respective emergency plans of the responder organizations are to be seen as complementary to the emergency planning, as they already contain specific scenarios and risk analysis, as well as with concrete measures and actions. The risk-analytical part is supplemented by an estimated number of people affected inside and outside the site's premises, which already serves as a basis for the requirements in response and performance.

The attempt undertaken in the context of this elaboration of an "all-hazards – all-organizations approach" in the official emergency and disaster management for the control of large-scale incidents in major accident hazard sites, offers a complementary solution that can only be implemented at the national level.

Thus, as has been developed in the scenario analysis, the visualization of the risk analysis in combination with other potential hazards can lead to a completion of the requirements planning and, subsequently, optimization of the provision of resources. If one integrates datasets of further risk assessments such as flood risks, landslides, etc. into geographic information systems, this interactive map conveys an on-demand, resource-oriented planning and deployment. In addition, the resilience of critical and vulnerable infrastructures (e.g. effects on transport or energy infrastructure, impact on schools, kindergartens, retirement homes, etc.) could be considered in combination with spatial planning measures, for example under the cadastral system. In addition, this form of application would provide a quicker and better overview of existing capabilities, indicate needs and gaps in hazard planning, reduce duplication, and support the creation of response concepts (e.g. dislocation, quantitative and qualitative requirements, etc.).

This would also provide the local authorities with a better overview and access to resources, as well as a better awareness of the need for such resources based on adequate risk assessments.

This conclusion thus confirms that the municipal authorities responsible for the control of large-scale incidents in industrial environment must be accorded far greater importance.

The demand for more importance for emergency and disaster management of major accident hazard sites is underlined by several open issues. As an outlook, the analysis of lessons learned, and lessons identified from past disaster events as well as near misses in connection with changing safety and security architecture in emergency planning is an issue. Also, to be addressed, is a more targeted analysis of probabilistic and deterministic risk management in major accident hazard sites, especially in connection with the ability to quantify or qualify measures and performance parameters in emergency response planning.

In addition, the consideration and analysis of international coping capacities – especially those of EU civil protection authorities and public health institutions - provides a further consideration.

As EU coordination and support to the Member States, both, in the context of Seveso and in the EU disaster management policy, are further developed, more opportunities and ideas for optimization could also be researched and developed in future.

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