Principles and Strategies of Major Accident Prevention and Response in the Federal Republic of Germany under special consideration of on- and off-site Emergency Planning in Seveso Type Installations

by Hans-Joachim Uth, Federal Environmental Agency Berlin, FRG

Part I Principles and Strategies of Major Accident Prevention and Response in the Federal Republic of Germany

1. Introduction

Meeting high technical hazard potentials in plants requires a concept of prevention ensuring that hazards will, under no circumstances, develop in a socially incompatible way. Proceeding from this global principle involves the adoption of any potential measure and approach to prevent hazard potentials, spreading of hazards and to limit their effects to a socially compatible extent. This basic approach will affect industrial and trade settlements in the same way as the requirements for planning, building and operating plants involving a hazard potential and the requirement for averting hazards and disaster control. (All sectors involved refer to fig. 3)

In implementing the EC-SEVESO[1] guideline in the framework of the German Major Accident Regulation[2] a three-stage safety concept (barrier concept) has been developed. In this connection, 3 principles of accident prevention policy have been formulated:

A. Prevention principle

- The plant shall be constructed and operated in a way as to avoid accidents.
- The plant shall be constructed and operated in a way as to limit the effects of accidents.
- The plant shall be supervised by authorities and qualified technical experts.
- The plant is subject to a licensing procedure.

In the area of process technology the prevention principle shall be implemented particularly through

- safety regulations,
- standards,
- training and instruction,
- supervision,
- licensing.

B. Consideration of Systems

Complex systems may be sufficiently examined only by means of systematic, logical methods. This is taken into account by applying:

- system analytical investigation methods,
- detailed safety analysis considering the conditions of the individual case.

[1] 82/501/EC and 96/82/EC

[2] 12. Bundesimmissionsschutz-Verordnung (Störfall-Verordnung) v. 1991

C. Relativity Principle

Safety requirements are graded according to the "type and scope of hazards to be expected". To this end, rules are set up for:

- accident relevant substances (substance criteria, list of substances),
- accident relevant methods (list of plants).

The objective dependence of the disaster potential upon the quantity of hazardous substances is considered by a quantity threshold concept defining staged safety requirements, as a function of quantity.

2. Location-related Requirements

2.1 General development plan (safe distances)

Basically plants subject to a licence may be only erected and operated in specified industrial areas, in conformity with the 4th Federal Immission Control Regulations[3]. In this connection, the use of land will be fixed in a so-called zoning plan according to the regulations of the Building Code[4]. It is envisaged that the citizens concerned shall participate in drafting the zoning plan.

As regards hazard control in the case of accidents safe distances shall be kept for specific plants or plant units. These distances have been fixed from the viewpoint of accident prevention. A protection against effects of accidents has, as a rule, not yet been connected with it.

2.2 Environmental Impact Assessment

The method of environmental impact assessment is applied for new plants suited to avoid harmful environmental impacts. Thereby, the environmental impacts have to be determined, described and assessed for the concrete project. This shall be based on a complex approach. The population living in the vicinity who will be potentially affected will participate in the assessment. Apart from the impacts which the plant in normal operation has on environment accident risks will perhaps play a decisive part in the decision to be made as to the location. An EIA is performed in the framework of licensing in conformity with the Federal Immission Control Act[5].

2.3 Emergency Planning

Depending on the type and scope of the hazards to be expected emergency preparedness is required. This covers on site and off site planning of emergencies. The planning is directed to the specific type of hazard. The requirements for averting hazards are included in the Federal Disaster Control Act, the Land disaster control acts, the fire service acts etc (details see below).

2.4 Information to the Public

The population has to be comprehensively informed on hazard averting plans. Only being informed the population may properly react in the case of accidents. In addition, informing the population provides the possibility of developing a risk acceptance. When informing population the principles of risk communication shall be taken into consideration. Minimum requirements as regards the type and extent of informing population are fixed in the Major Accident Regulation.

[3] 4. Bundesimmissionschutzverordnung über genehmigungsbedürftige Anlagen
[4] Bundesbaugesetz (BauGB)
[5] Bundesimmissionschutzgesetz

3 Substance-related Regulations

The type and extent of the hazard potential of plants is connected with the existence or formation of hazardous substances. Thereby, the scope of the potential is, as a rule, dependent on the quantity of substances which may participate in the accident. Proceeding from this basic knowledge a system involving the qualitative and quantitative assessment of hazardous substances has been developed.

3.1 Qualitative Regulations

In the legal framework of the Chemicals Act (and the respective EC recommendations[6]) chemical substances are characterised and assessed. Related to plants subject to the Accident Regulations a big part of the usual industrial chemicals has been included in enumerative lists (Annex II, III of the Major Accident Regulation) or in substance categories (Annex III, IV).

3.2 Quantitative Conditions

It should be always proceeded from a minimum substance quantity giving rise to the emergence of hazardous effects of substances, with the exception of cancerogenic, mutagenic and teratogenic effects. Based on this, a quantity threshold concept has been developed in the legal framework of the Accident Regulations. Three indicated quantity thresholds resulting in specific safety or administrative obligations, if exceeded, are now in existence for plants subject to these regulations.

4. Plant-Related Technical Requirements to be Considered in Planning, Construction, Operation and Modification

4.1 Technical Regulations, Instructions, Standards

Plenty of technical and legal regulations serving

- to avoid emissions into air,
- to avoid emissions into sewage,
- to avoid emissions into groundwater and soil,
- to avoid waste heat,
- to avoid toxic wastes, recycling,
- to avoid immissions due to accidents

are applicable to planning, building and operating plants involving a hazard potential.

All these regulations shall be considered. They form the framework for the economic activity of an enterprise.

4.2 Safety Concepts, Experience

Experience made with comparable activities in the individual enterprises or in the branch are essential for planning, building and operating plants. During the many years' activities "safety philosophies" have been developed which are followed. They have been partly reflected also in semi-governmental and governmental regulations. (Examples: Explosive Guidelines, distance regulations of the fire service regulations, distance regulation in the framework of the Explosive Agent Act, distance regulation in storing water threatening substances).

4.3 Alternative Production, Economic Considerations

[6] e.g. 67/548/EEC and followers

Planning, building and operation of plants is, in the first line, aimed at implementing economic objectives. Thereby, attention should be paid to the fact that, in principle, subsequent costs may not arise from a non-hazardous substance , owing to its hazard potential. The requirement that hazardous substances should be substituted by non-hazardous ones has been e.g. laid down in § 17 of the Chemicals Act[7].

5. Requirements on a Safety Organisation (safety management)
A safety organisation shall be in a position to agree on comprehensive requirements. The branches where these requirements emerge from can be roughly characterised as follows:

- fulfilment of the requirements arising from changing technical regulations,
- fulfilment of the requirements arising from licensing and the current supervision by authorities, experts etc.
- fulfilment of requirements to keep the level of safety engineering,
- organisation of responsibilities (questions of liability),
- organisation of maintenance/repair,
- quality assurance for products and plants (safety facilities),
- organisation of the in-plant co-operation between the shop agents charged with immission control, sewage, wastes, accidents, industrial safety etc.,
- communication, open information flow,
- maintenance of expert knowledge (advanced training, accident evaluation),
- training, motivation of staff, co-determination
- organisation of the employment of third persons,
- organisation concerning changes or the plant/mode of operation.

5.1 Fulfilment of External Requirements
Plants subject to a licence according to the Federal Immission Control Act shall be designed and operated in conformity with the technological or safety engineering level (e.g. state of the art in safetytechnology). This requirement exceeding the fulfilment of the technical regulations presupposes a constant information on the advancement of technical and organisational measures taken to improve safety. Thus, a safety organisation has to ensure the continuous transfer of relevant know-how to the relevant branches. In this connection, great importance is attached to the transfer of knowledge from accidents.

Apart from the fulfilment of the afore-mentioned general requirements, as a rule, special requirements relating to the respective plant mentioned in the notice of approval shall be fulfilled. The responsible persons ensuring the implementation of general and specific requirements shall be reported to the authority (§ 52a Federal Immission Control Act).

5.2 Quality Assurance
A plant subject to a licence may be only operated to the extent and in the condition for which it has been approved. There shall be furnished proof of the fact that the plant has not essentially changed throughout its whole service life (duration of licence).

5.3 Exchange of Experience, Co-operation, Advanced Training
The exchange of information within the enterprise and between enterprise and concerned parties outside it is attached special importance in setting up a safety organisation. The exchange of

[7] Chemikaliengesetz

experience is the prerequisite for passing on any external requirement to the place where it will be required and implemented. The exchange of experience shall be carried out in an atmosphere of openness and trust. That is why important information shall be made available to all employees (no hierarchy of information). Special attention to the human factor issue is required.

The shop agents charged with Immission control, water pollution control, waste and major accidents and the specialist of industrial safety are excellent junctions of the information flow. Uniting them to form a shop committee for environmental protection has proved a success. The shop agents/specialists of industrial safety are also suited best for implementing the necessary co-operation with the competent authorities or external experts. Their position as to the respective legal regulations and their remarkable responsible position held in the enterprise qualify these persons/authorities for fulfilling this task. And it has proved a success to entrust the agents/specialists of industrial safety with the systematic evaluation of the experience made in the enterprise, particularly with the evaluation of accidents.

Part II Principles of on- and off-site Emergency Planning and Interdependencies between the two

In the Federal Republic of Germany, each Federal State (Bundesland**)** has its own legislation with regard to emergency response organisation, although there are some general guidelines at the Federal Government level, setting minimal requirements and defining the philosophy of emergency response organisation. The latter is based on article 2 of the German Constitution (Grund Gesetz) requiring that dangerous installations should not create any risk to the public, according to the available knowledge. The only conceivable and acceptable risk is then the residual risk, due to lack of knowledge, and this is to be borne by the community in its whole.

1 Principles of on-site emergency planning

Major chemical companies have had emergency-plans even before the implementation of the Seveso directive in the Major Accident Regulation[8]. Following the new regulations these have been re-drawn and new ones have been established, to cover all potential on-site and off-site hazards and designing procedures to be followed by the plant staff in the event of an accident. Proper design, instrumentation and control systems, training of the personnel are identified as fundamental obligations by the regulation. The emergency-plan is to be used in plant staff training and drills, as to enable them to react promptly in the event of an emergency. A typical plan contains an organisational section (what is to be done, by whom, when) and an information section (overview of the plant, activities and hazards, safety equipment and systems). Table 1 shows the typical content of an on-site emergency-plan. The plans are to be endorsed by plant committees (Betriebsräte).

In a recent special regulation[9] for the further implementation of the Major Accidents Regulation the obligations for emergency-planning are tightened. The operator has to adopt his emergency-plan on the results of accident scenarios.
The operator is obliged to agree his plans with the competent authorities. There is a detailed checklist for this procedure (see Table 2). The main point is to have clear alarm routes. In practice we have made good experience with a four-step-alarm-system, which will be described later. Fig. 1 shows the proposed flow of alarms in the event of an accident.

[8] 12. Bundesimmissionsschutz-Verordnung (Störfall-Verordnung) v. 1991
[9] 3.Störfall-Verwaltungsvorschrift v. 23.10.1995 GMBl. S 782, 1995

2 Principles of off-site emergency planning and its linkage to the emergency response in the installation

Depending on the type and scope of the hazards to be expected emergency planning is carried out in the surrounding of hazardous industrial plants. The planning is directed to the specific type of hazard. All necessary data are to be delivered to the competent authorities by the operator. The requirements for overall emergency planning are included in the Federal Disaster Control Act[10], the particular Land Disaster Control Acts[11], the Fire Service and Rescue Acts[12] etc.

Emergency plans should be applicable in the event of an accident at fixed installations and during transportation, and should cover all phases of the accident. They should also draw on previous experience gained from past emergencies.
Emergency plans for each administrative district are designed by local Fire Brigades, Rescue Services and Civil Defence. The Emergency Plan, updated every year by the district disaster protection plan of the authorities and the alarm plan of the operator.
The manufacturer is obliged to alert the authorities according to the Law of Fire Protection[13], the Law on Contingency Planning[14] and the Regulation on Major Accidents[15]. Other regulations exist at state (Land) level. Seveso type installations require a uniform accident alarm system. A standard form is to be filled in, in which the event is ranked on a 4 tier alarm scale, each echelon requiring the alert to pre-defined groups.

The criteria for that classification are as follows:

Step 1 signifies an internal irregularity, e.g. a minor release of toxic gas, a small fire.

Step 2 signifies an internal danger with the possibility of a threat to the internal staff but not for the public or the environment. Examples are a runaway reaction, overheating of a pressure vessel or a small release of toxic substances.

Step 3 is announced if the danger spreads off-site. An impact of the public or the environment is likely. Examples are the release of a toxic cloud which leaves the limits of the installation or a major fire which spreads toxic fume in the neighbourhood.

Step 4 is the catastrophic level. The accident is no longer controlled by on-site forces, here is a severe danger for the public or the environment.

The notification of each step triggers a distinct response action. There are different groups involved (see Fig 2). The following reactions, depending on their levels, are triggered in particular:

Step 1 The fire fighting forces, the police, and the local authorities (Group I) are alarmed. No

[10] Katastrophenschutzrahmengesetz des Bundes
[11] Landeskatastrophenschutzgesetze der Bundesländer
[12] Feuerschutz- und Rettungswesengesetze der Bundesländer
[13] Feuerschutzgesetz
[14] Katastrophenschutzrahmengesetz
[15] 12. Bundesimmissionsschutz-Verordnung (Störfall-Verordnung) v. 1991

alert is given to the public and no measures are to be taken off-site.

Step 2 Besides the fire brigades and the police on duty the heads of their regional offices are informed as well as services of Group II. They go into a stand-by position (silent alarm). In case of disturbing signals from the site, e.g. a fume columne, smell or noise of explosions without any severe danger the public is informed.

Step 3 Additional alarm groups (group III-V) are informed and go into a stand-by position. The Emergency Operation Centre (EOC) and the Technical Field Headquarters (TFH), which are uniformly organised within the German Law on Contingency Planning[16]**,** are activated to a stand-by position. Some public emergency forces take action as a response to the accidents. The common public is informed.

Step 4 The accident is classified as a disaster. The EOC and TFH is fully operable and takes over the guidance of all response forces. All groups, including group VI and VII if necessary, are alarmed. The public is informed by standardised radio messages in a broad manner. Directly affected people are additionally instructed through patrol cars with loudspeakers or fixed loudspeakers.

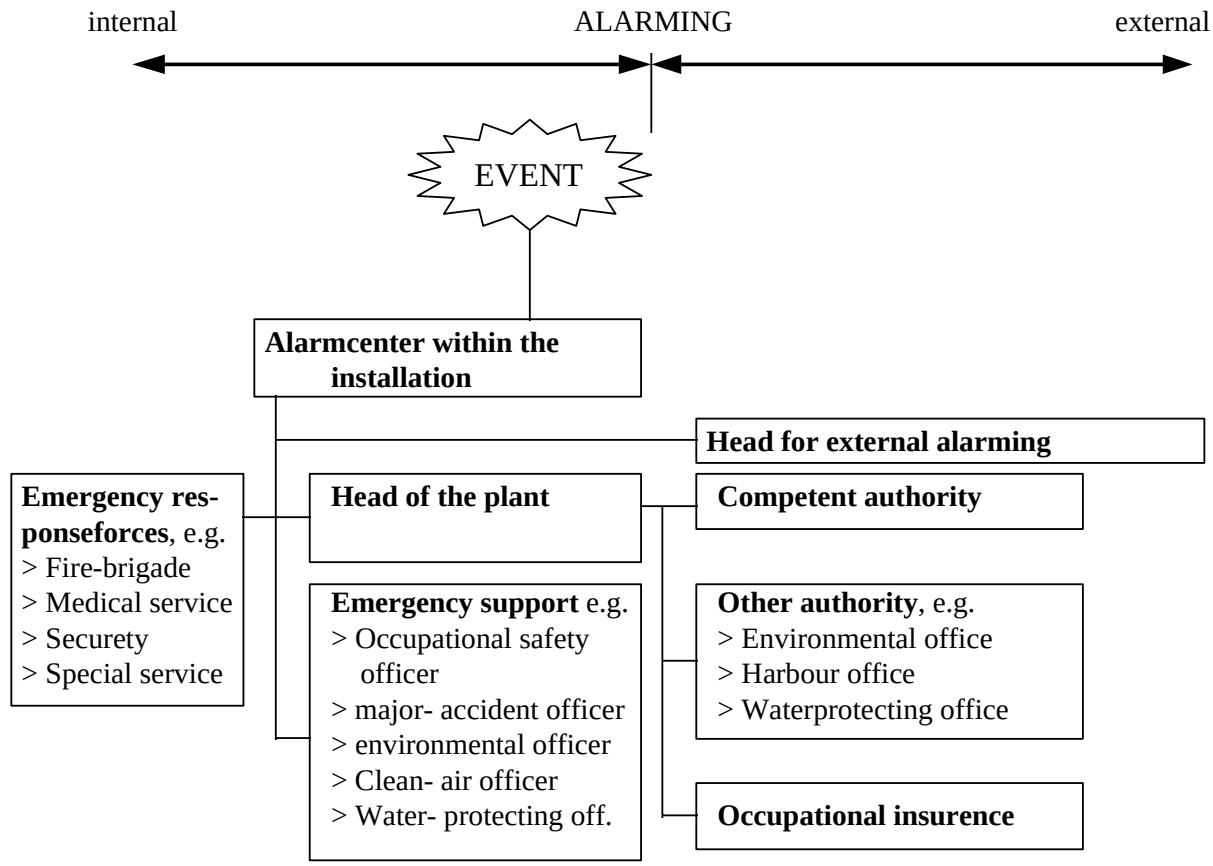
Both the EOC and die TFH are uniformly organised under the Law on Contingency Planning.

The population has to be comprehensively informed on hazard emergency plans. Only by being informed the population may react properly in the event of a major accidents. In addition to that, informing the public provides the possibility of developing a risk acceptance. When informing the population the principles of risk communication shall be taken into consideration. Minimum requirements which regard the type and extent of informing the population are fixed in the Major Accident Regulations.
Furthermore the 3rd Regulation on implementing the Major Accident Regulation (3. Störfall-Verwaltungsvorschrift) which was published 1995 settles detailed requirements to inform the public. People likely to be affected have to be informed by the operator prior an accident.

3 Concluding Remarks
The *ultima ratio* in the comprehensive system of industrial safety is to be prepared for an major accident. A key element is thereof a uniform guidance for the notification of chemical accidents. The notification must contain a balanced information on all circumstances of the accident to trigger the correct levels of response. The FRG has experience with a four-step notification since 15 years. Depending on the severity of the accident, there is a mobilisation of on-site and off-site response forces. To let those different forces act in a proper way it is particular important to fix the command structure. Within the framework of the Federal Law on Contingency Planning there is the compulsory establishment of a central emergency operating centre which co-ordinates all response measures in a severe accident. All response actions must be carefully preplanned and the planning in the different levels must be agreed. Seveso-type installations are subject for detailed emergency planning under the framework of the German Regulation on major Accidents. In the event of both an accident and a disturbance without severe danger the local authorities are responsible to inform the public. The operator of hazardous installations is obliged to inform the neighbourhood about possible hazards in advance.

[16] Katastrophenschutzrahmengesetz

Figure 1 Alarm flow sheet



UBA,1996

Figure 2: Different groups to be alarmed in a major accident

PROFESSIONAL GROUPS

Group I

- authorities
- public services
- private fire brigades

Group II

- rescue forces
- medical services
- water/electricity supply

VOLUNTEER GROUPS

Group III

- transport enterprises
- civil engineering enterprises
  etc.

Group VI

- scientists
- engineers
- experts

Group VII

- information services

SPECIAL GROUPS

Group IV
- operator of hazardous installations

Group V
- persons or facilities which
  need special protection

Table 1 Typical content of an on-site emergency-plan

1 Identification section
- Name and address of plant, telephone, fax
- Distributor of the plan

2 Scope of emergency planning

3 Description of installation
- General
- Ways to the installation
- Times of operating, business hours
- Special plans, like
    - fire fighting plan after German standard DIN14095
    - energy supply plan
    - piping plan
    - wastewater catchment including water from firefighting
    - location of alarmsystem components
    - escape and rescue plans
    - emergency shut off plans
- Main hazards in the installation, like
    - hazardous substances
    - hazardous technical equipment
    - area of danger
    - area of possible danger derived from standard scenario
- Surroundings, neighbourhood
    - general
    - special vulnerable objects
    - sources of danger

4 Emergency forces and equipment
- On-site emergency forces
    - alarmcentre
    - fire fighting personal
    - medical service
    - security service
    - special expert service
- Responsible person of the installation
- Special emergency support by
    - occupational accident officer
    - environmental officer
    - clean air officer
    - major accident officer
    - water protecting officer
- Off-site emergency forces (this section is filled in by the competent authority)
- Equipment and infrastructure
    - emergency co-ordinator
    - structure of communication channels
    - mobile equipment
    - list of emergency equipment within the installation
    - measuring equipment
    - internal alarm equipment

5 Alarm-plan
- classification of different alarm steps
- alarm flow sheet

6 Warning of the public
- warning of workers
- warning of the neighbourhood

7 Organisation of emergency response
- emergency response by on-site forces
- emergency response together with external forces

8 Special events, e.g.:
- worst weather conditions
- information channel break down
- bomb alarm
- terrorist threat
- special plant procedures

9 Information of authorities and media
- information of authorities by special formula
- agreement with press, radio and TV for standardised messages

10 Equipment and experts available off-site

11 List of annexes and material of the emergency plan

Table 2 Checklist for the agreement on emergency plans between operator and competent authority (examples)

1 General section
- Distributor
- Procedure for up-dating
- Description of surroundings
    - special vulnerable objects
    - public buildings
    - sources of danger
- Area of danger as results from scenario
    - dispersion calculation
    - dispersion models
    - selection of scenario
    - selection of sectors/radii for response
- Special plans, like
    - local surroundings of the installation
    - water supply
    - waste water catchment
    - energy supply
- Instant response of on-site forces
    - alarming of external support
    - internal alarm procedure
    - information channels
    - information of neighbouring installations
- On-site organisation of emergency response
- Evacuation procedure
- Shut-off procedure

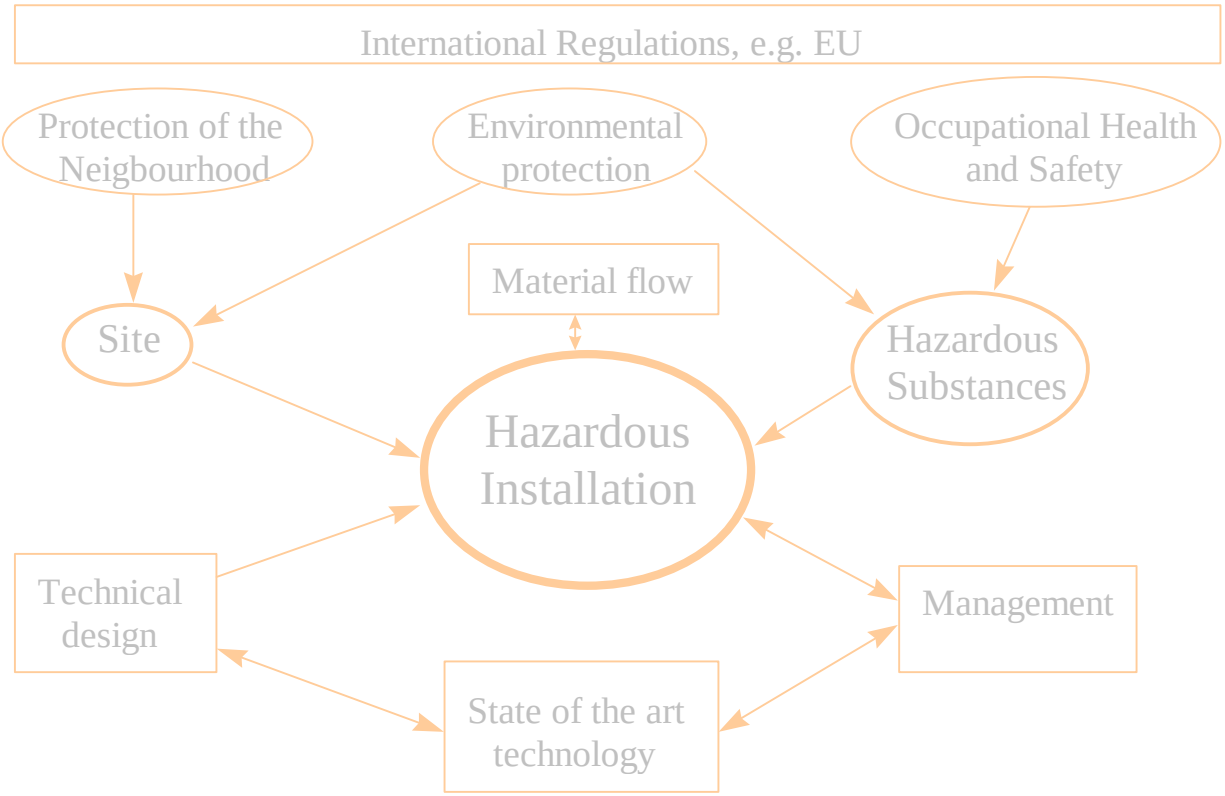
2 External emergency forces
- Mission and role of on-site forces
- Emergency response strategy
- Preparation of external response
- Reservation of places for external response forces
- Informationtransfer
- Technical field headquarters
- Local field headquarters
- Shut-off procedures
- Warning of the public
- Mission and role of external forces
- Medical support
- Information of the public, media

3 Fire protection by constructive measures
- Fire safe constructions
- Safety distance
- Isolation
- Fire distinguishing water catchment
- Automatic fire detection
- Stationary fire fighting equipment
- Explosion-protection
- Emergency power supply

4 Fire protection by organisational measures
- Responsible person
- Availability of on-site fire fighting personal
- Combined training of on- and off-site forces
- Adopting a common fire protecting order for workers

5 Fire safe storage of hazardous substances

Fig 3 Affected Areas of Major Accidents



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