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Principles of on- and off-site Emergency Planning and Interdependencies between the two[1]

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Modern society poses a considerable amount of industrial risks. Chemical risks are a part of them, which require special attention. In the FRG each year some 35 million metric tons of chemicals are processed and distributed. To control those risks a modern integrated major-accident-precaution-system[2] was developed. Response measures to limit the effects of a major accident are an integrated part thereof. Recently the general industrial accident response system in Germany was completed with special reference to major chemical accidents as described below.

1 Introduction

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.

In implementing the Seveso directive (85/501/ECE) in the framework of **Major Accident Regulation** (Störfall-Verordnung)[3] a three-stage-safety concept (barrier concept) has been developed. In this connection, 3 principles of accident prevention policy have been formulated:

1. 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.

[1] UN/ECE Workshop on Industrial Safety, 29-30 January 1996, Geneva, Switzerland
[2] Uth, H.-J. Risk Management in the FRG, Environmental Management Vol.13,No.3, pp.317-323, 1989
[3] 12. Bundesimmissionschutz-Verordnung (Störfall-Verordnung) v. 1991

2. 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.

3. 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:

- hazardous substances relevant to major accidents (substance criteria, list of substances),
- accident relevant processing (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 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** 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).

The **Major Accident Regulations** contain regulations relating to on-site emergency planning and their agreement to off-site emergency planning. In a recent special regulation[4] 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.

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

The leading preventive strategies for **Off-Site Emergency Planning** consist in the location of the industry and keeping separation zones between industrial and residential areas.
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

[4] 3.Störfall-Verwaltungsvorschrift v. 23.10.1995 GMBl. S 782, 1995

operator. The requirements for overall emergency planning are included in the **Federal Disaster Control Act**, the particular **Land Disaster Control Acts**, the F**ire Service and Rescue Acts** etc. **Guidelines for emergency planning** have been published as the result of different studies. The basic principles are those of: simplicity and clarity, lack of ambiguity, allinclusiveness, that is to say consideration of all possible contingencies while allowing flexibility for managing unforeseen developments. The emergency plans should:

1. assess risks and potential harm;
2. establish intervention means and actions;
3. address organisational aspects of emergency management (resources, capabilities);
4. foster collaborations between authorities and manufacturers (alerting, exchange of information, mutual assistance).

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**. They are kept by the competent district **Disaster Prevention Authority** and include information useful for public and environmental protection. The Emergency Plan, updated every year by the district disaster protection plan of the authorities and the alarm plan of the operator. It is compiled in the form of a checklist in five sections. Among the actions to be taken, is warning and information of the populations. Preventive and response measures, such as evacuation, have to be carefully pre-planned, because of high population density. They are drawn up starting from the DIN safety data sheets that must be filled in by the manufacturers and contain information on the characteristics of dangerous substances, their negative effects and adequate protective measures. In some Länder, the industry participates in financing the equipment and supports the implementation of emergency plans.
The manufacturer is ogliged to alert the authorities according to the **Law of Fire Protection**, the **Law on Contingency Planning** and the **Regulation on Major Accidents**. 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 1 to 4 alarm scale, each echelon requiring the alert to pre-defined groups.
Their action is triggered by the announcement of a major accident (Störfallmeldung). The criterias for that classification are as follows:

Step 1 signifies an internal irregularity, for example a minor release of toxic gas, a small fire or a failure in the control system which causes an abnormal situation.

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 firefighting forces, the police, and the local authorities (Group I) are alarmed. No alert is given to the public and no measures are to be taken off-site.

Step 2 Besides the firebrigades 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 fumecolumne, smell or noise of explosions without any severe danger the public is informed.

Step 3 Additional alarmgroups (group III-V) are informed and go into a stand-by positon. The Emergency Operation Centre (EOC) and the Technical Field Headquarters (TFH), which are uniformly organised within the German **Law on Contingency Planning,** are activated to a stand-by position. Some public emergency forces take action as a response to the accidents. The common public is informed by sirens or radio. The public which is directly endangered is instructed by radio and in some places by patrol cars with loudspeakers.

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 radiomessages 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 EOC operation staff group consists of officers of the professional fire brigade together with the directors of various city offices, such as the **Health Office** and the **Press Office**, together with members of state agencies such as the police, the military services and (if necessary) members of private companies. The TFH may be one or more according to the situation at the site of the emergency. Each one consists of an officer of the professional fire together with a small operation staff, with the task of directing intervention units under their command.

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. In FRG about 2000 operators in about 1000 sites are to inform the public.
Preventive action also include exercises. These exercises are performed by each town together with the industry in order to assess the effectiveness of emergency plans. Exercises simulating a complete emergency are performed about once every five years. Alarm and staff exercises are more frequent but they are addressed only to certain phases or certain tasks.

4 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.

Figure 1 Alarm flow sheet

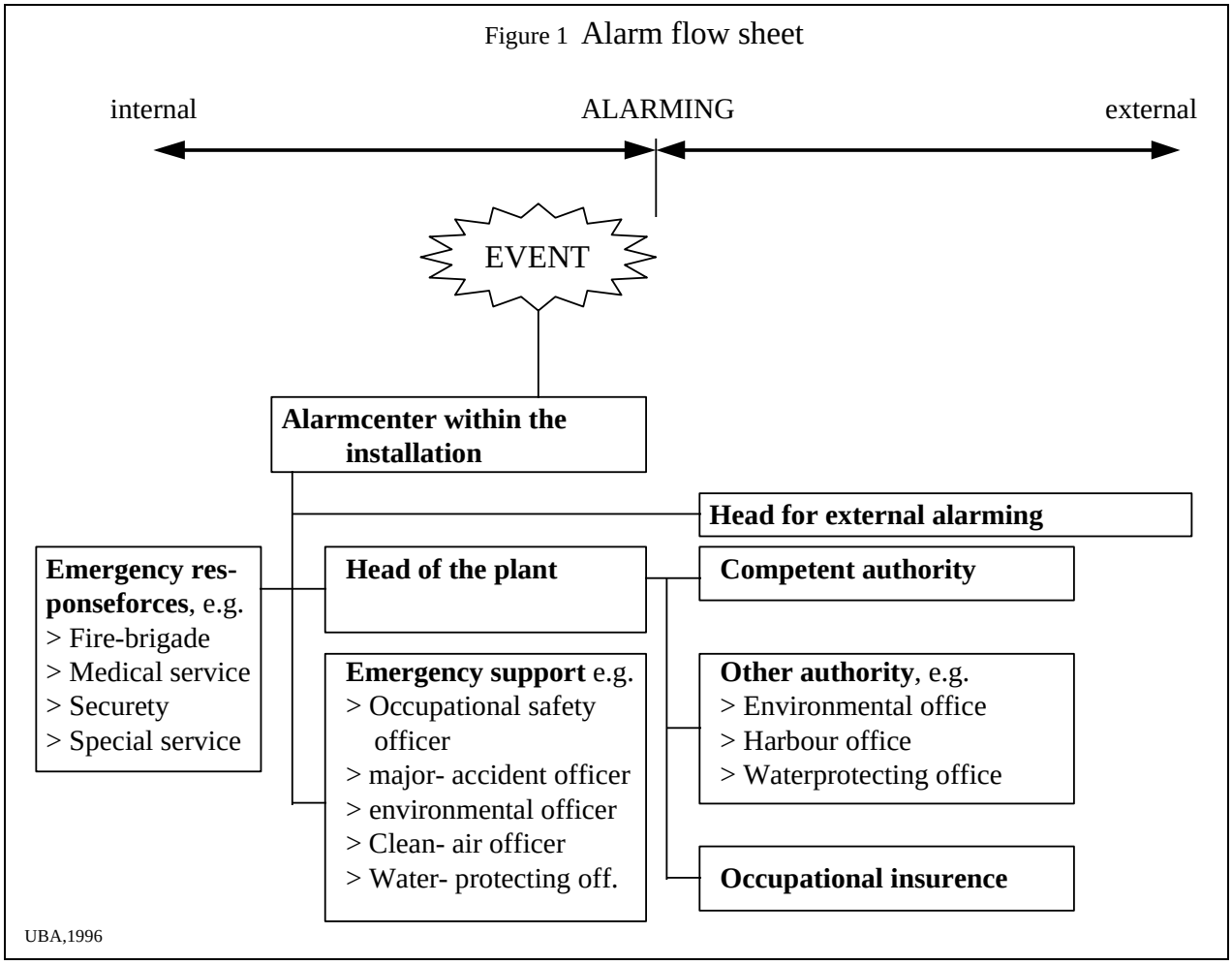

Figure 2: Different groups to be alarmed in a major accident

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