Accident Commission (SFK)

at the
German Federal Ministry of Environment, Nature Conservation and Nuclear Safety

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Guide

for

Plant Safety

Status as of January 1997

Adopted at the 16th Meeting of the SFK on 12 September, 1995

The Accident Commission (SFK) is a commission constituted at the German Federal Ministry of the Environment, Nature Conservation and Nuclear safety under Section 51a of the Federal Immission Control Act.

Its registered office has been established at the premises of the Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) mbH.

Guide

for

Plant Safety

for the safety-oriented design and construction as well as the safe operation of plants for material conversion processes

as at November 1995

Adopted at the 16th SFK meeting on 12th September 1995

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0 Task of the Accident Commission

At its 13th meeting on 25th November 1994, the Accident Commission decided to work out a guide for plant safety in the chemical industry and asked Prof. Dr. Pilz and Dr. Wiesner to prepare a first draft for further discussion within the SFK. In this context, the two aspects of design and operation of the plant up until decommissioning were to be considered among other things. The guide was to be considered as an umbrella to existing regulations, guidelines and ordinances and was to take into account the licensing prerequisites as specified in Section 6 of the Federal Immission Control Act (*Bundesimmissionsschutzgesetz, BImSchG*).

At the Accident Commission's 15th meeting on 9 May 1995, Prof. Dr. Pilz presented the draft guide "Plant Safety" in the version of 2 May 1995.

At the Accident Commission's 16th meeting on 12 September 1995, Prof. Dr. Pilz presented the draft guide "Plant Safety" in the version of 25 August 1995.
The Accident Commission discussed the draft and passed the "Plant Safety" guide in its present version with one abstention.

1 Preface

The safety of plants for chemical production processes is not just a given fact but has been the result of careful analyses of the development of processes, conscientious planning during the design stage, exact implementation of the plans in the erection of the plant, conscientious selection of suitable materials and expertly performed construction of the plant, qualified operation and constant supervision and maintenance during the plant's operation, and technically correct planning and implementation of the decommissioning and dismantling of the plant.

In this context, all specified measures and actions must correspond to the state of the art.

1.1 Cause

To have absolute safety is impossible. Residual risks that may develop from unforeseen events and procedural processes lie outside human cognitive capacity and must be accepted. On these grounds, the so-called "Technical Law" prescribes principal requirements for sufficient safety. However, the specifications of the legal requirements and relevant technical regulations only constitute that part of the requirement profile which can be regulated in a generalising way. The provisions that have to be taken for a concrete plant normally have to be defined on a case-by-case basis. Furthermore, the principle applies that the safety-related requirements that are laid down in the prescriptions and regulations as well as the developing safety-related state of the art have to be taken into account.

In the Federal Republic of Germany, the safety of plants requiring a licence is governed by a large amount of legal and subordinate regulations relating to industrial safety laws, accident insurance laws, hazardous materials laws, planning and building laws, immission control laws, and water pollution prevention laws. The large number of instructions and regulations that have accumulated during the industry's history and apply to the plant's technology under various kinds of aspects has led to a system that is not free from overlaps and double-regulations.

This legal complexity justifies the attempt of drawing up a summary of a general procedure to ensure an overall plant safety concept that is largely applicable and has been tried in practice.

Within the framework of the above-mentioned safety-related activities, the protection goals of

- safe retention,
- industrial safety,
- protection of the neighbourhood
- protection of the environment

to be reached in the different areas of regulation are of equal importance.

The implementation and constant surveillance of the technical and organisational measures specified in this context results in an integral safety concept which ensures the safe operation of a plant during its entire lifetime.

1.2 Objective

This paper describes specifications and procedures which represent "good practice" in the shared opinion of all those responsible in the area of plant safety, from the plant's operator and the various experts to the authorities involved. It is to serve as a common basis of understanding.

1.3 Scope of application

This guide applies to procedures relating to chemical plants that are subject to the extended obligations of the Hazardous Incident Ordinance (*Störfallverordnung, StörfallV*). However, in large parts it is also applicable to chemical plants in general and - with restrictions - to other plants that are subject to the *StörfallV*, with the

question of proportionality having to be considered for these plants on a case-by-case basis.

2 Principles of safety-oriented work

Hazards arising from plants where materials are stored or physically or chemically converted are caused by the processed materials' ability to react, their toxic and environmentally relevant characteristics, and their stored energy.

In general it is not possible to predict without experimental evidence whether materials or material mixtures will start an uncontrolled reaction with other materials, polymerise or decompose. This has often to be established by experiments. The same is true of the ecological and toxicological material data.

Development of processes

One of the first tasks for the safe handling of reactive materials is therefore the determination of safety-related data and the systematic, experimental analysis of possible reactions, also including the clarification of parameter ranges (e.g. temperature, pressure, composition) in which no undesired reactions can take place. With the help of these analyses it is possible to determine the admissible ranges for the individual parameters that have to be adhered to during plant operation and, furthermore, to investigate the effects of inadmissible parameter deviations and undesired reaction processes.

This way, the procedure's hazard potential can be estimated to form the basis for adequate safety measures to be specified at a later stage.

The results of this assessment may generate a further task, namely the reduction of the hazard potential by modifying the process and its parameters, e.g. by reducing material amounts or changing compositions.

Plant design

During the plant's planning stage, particular attention must be paid to the fact that the plant is designed in such a way that

- the occurrence of faults is reduced by the use of suitable, reliable technology and organisational measures (fault prevention), and that

- the plant behaves in a fault-tolerant way in case faults and disturbances still do occur, which means that one fault alone must not cause any inadmissible effects (fault tolerance).

The fulfilment of these tasks requires a systematic analysis of all potential hazards.

In this context, the principle of proportionality inevitably demands that the higher the hazard potential is, the greater have to be the efforts put into fault prevention and fault tolerance.

Operation

The basic prerequisite for a plant's safe operation is that it is operated by qualified and reliable operating personnel. Once a plant has been started up, its "in-built" safety has to be constantly maintained or even improved on the basis of the latest knowledge and experience. To ensure the availability of the technical systems, inspections before start-up are just as necessary as regular recurring function tests, examinations for special reasons, and maintenance and repair measures. In this context, the quality of the requisite organisational processes is ensured by instruction and training given to the operating and maintenance personnel, assisted by such aids as operating instructions, shift logs, permits, and specified procedures applying to changes.

Course

The most practical way of tackling the identified safety-related tasks is to deal with them in a defined course system, which together with the corresponding structural organisation constitutes a "Safety Management System".

The focal point of such a system is the binding definition of safety-related procedures carried through in a company. This includes especially the clear regulation of assigned tasks and responsibilities as well as instructions how to solve safety-related problems.

Within the framework of such a system, the documentation of processes and results is also of considerable importance. Last but not least it must also be ensured that gained operating experience is included in the safety management.

The safety-related activities are always carried out step by step in the order "analysis - assessment - measures - control - improvement"; depending on the result of the control step and also within the framework of the constant improvement of plant safety, this cycle may be run through several times.

The following illustrates how the individual safety-related activities can be performed in the different lifetime phases of a process or a plant.

3 Development, planning and construction of safe processes and plants

Safety-related considerations must be made during all phases of a plant's lifetime and already have to set in during process development. This is the only way to recognise deficiencies at an early stage and solve any safety-related problems in an economically and ecologically appropriate manner.

3.1 Systematic procedure

From process development up to the construction of the actual production plant, the definite documents are elaborated in a structured approach. This means that for the requisite safety-related work there needs to be an iterative procedure divided into different working steps which is oriented on the development stages of the process and the plant in which the objects, methods and the intensity of the investigation have to be adapted to the individual working steps. At the end of each working step, the results are summarised and phrased in such a way that they can be implemented organisationally and technically during the steps that follow.

The aim of the iterative procedure is to achieve an integral safety concept. This is to be understood as the entirety of all technical and organisational measures and characteristics of a plant which can serve to exclude hazards during normal operation as well as those caused by technical disturbances or maloperations.

A systematic procedure composed of the following working steps has proved to be efficient for safety-related work:

- determination of safety-related principles,
- elaboration of a safety-related plant concept (safety-related planning),
- safety-related checks during procurement and construction,
- safety-related checks before and during first start-up.

3.2 Contents of individual working steps

Determination of safety-related principles

- Determination and complete compilation of safety-related data for the materials and basic process-related operations,
- definition of suitable materials,
- investigation of the kind and extent of potential hazards,
- examination of possibilities to prevent or reduce potential hazards,
- compilation of the process's safety-related boundary conditions, including supplies and waste management,
- development of a basic flow chart with definition of the principal safety requirements.

The result of this working step is to show that a safety concept can be realised in principle and that the project can thus be continued.

Safety-related planning

- Identification of the relevant hazard sources of the planned process by way of comparing the safety-related data, material amounts, processes and procedural parameters with the characteristics of the planned machinery and its design data,
- specification of the kind of and requirements for the technical and organisational safety measures for the plant, using the results of a systematic safety analysis based on the current planning stage.

Some methods for the systematic identification of hazard sources and the definition of appropriate counter-measures have proved to be particularly suitable, namely

- check lists,
- failure effect analyses,
- maloperation operability analysis (PAAG method),

- lists in tabular form.

Apart from this there are a number of other methods available for individual cases.

- Investigation of the effects of the planned plant on other, connected plants, on the neighbourhood and on the general public,
- determination of a suitable plant site and the construction concept.

The result of this working step is to provide all safety-relevant information that is required for the licensing procedure and for starting with detailed planning.

Safety-related checks during procurement and construction

- Final decision on the kind of and requirements for the safety-related technical measures by way of a concluding, systematic safety-related examination, based on the definite detailed planning documents,
- formulation of operating instructions, especially for organisational protection measures,
- design of engineered safeguards,
- documentation of the results of the safety-related examination to represent the integral safety concept, e.g. within the framework of the safety analysis required by the *StörfallV* (Hazardous Incident Ordinance).

The result of this working step is to provide all safety-related information and documentation that is required for the procurement and construction phase.

The selection of suitable firms for manufacturing and construction, the performance of the legally prescribed inspections according to European guidelines and national regulations, additional quality assurance measures in the selection of materials, supervision of the manufacturing process and checking of the declarations of EC-conformity and type approval certificates constitute the relevant necessary quality assurance measures during this phase.

Safety-related checks before and during first start-up

The relevant body of regulations normally demands the following inspections with the corresponding documentation:

- preliminary inspections by independent experts,
- quality inspections at the manufacturer's factory and on the construction site
- assembly surveillance,
- function tests,
- operational acceptance examinations by independent experts,
- plant walk-downs
- acceptance examinations by the authorities,
- examination of the operating instructions with regard to completeness and conformity with the specifications of the safety-related documentation.

The result of this working step is the confirmation by those technically responsible that the planned safety measures exist and that their functioning is ensured. After this, the plant can be licensed for first start-up.

3.3 Organisational regulations

Documentation

The results of safety-related work are to be documented. The point of this documentation is to keep the entire safety concept of a plant available. This documentation should contain in particular

- the safety-related material and reaction data as well as their assessment,
- the results of the systematic safety-related inspections and calculations,
- the safety-relevant operating instructions and regulations.

Chemical plants and processes are subject to frequent changes during their operating lifetime. Thus the safety documentation, as an internal document, is an important working document for the efficient and safety-oriented performance of regular activities, e.g. the

- examination of safety-related effects of plant modifications,
- transfer of safety-related know-how among changing staff,
- examination of the effectiveness of safety-related measures following disturbances.

To meet the demands of these tasks, the documentation should include the contents of the safety examinations as well as the systematic approach on which they are based so that in particular the reasons for the implemented safety measures are documented.

The documentation is to be kept up to date by the operator during the plant's entire operating lifetime.

Responsibilities

It is advisable to have the safety-related examinations carried out, according to the basic systematic approach, by a team that brings together the expertise required for the project and which has specific experience in operation (procedural development, production, engineering, MSR technology, planning), specific safety-related know-how beyond plant operation (general plant safety, industrial safety, fire protection, environmental protection) as well as knowledge of the different technical regulations.

The respective operational and project management are responsible for the initiation and performance of the individual working steps; they also draft in other responsible bodies and experts.

4 Safe plant operation

Apart from safety-oriented planning and development as well as the resulting technical equipment of the plant, the ensurance of safe plant operation requires in particular

- satisfactory technical qualification of the personnel (including staff from external firms),
- a managerial organisation structure that considers safety issues with the same priority as other objectives (e.g. product quality, plant capacity),
- written operating instructions,
- effective measures for the protection of the operating personnel.

4.1 Personnel qualification and staffing

Initial and further qualification

A plant can only be operated safely if there are sufficient numbers of qualified personnel. The members of the personnel obtain qualification by a corresponding professional training and in-house measures for further education. The latter consist of a conscientious introduction of new staff to their work by explanation of the process, description of the handled materials - especially of their effects on man and the environment - and an introduction to the local conditions. In the case of complex processes, this general introduction is carried out with the help of procedural descriptions, flow charts, possibly by way of computer simulation programmes, and information about all existing operating instructions and measures for the prevention and limitation of operational disturbances.

These topics are updated during regular safety-related instruction courses and the personnel members are informed about any procedural changes, new operating instructions, and how to handle materials. The minutes of these safety-related instruction courses are kept for the purpose of documentation.

Training

Further education of the staff is supplemented by practical training measures. Newcomers, for example, are supervised by more experienced colleagues and are introduced step by step to their new tasks. The entire staff take part in emergency exercises at regular intervals. Also, possibly existing plant-specific safety systems are activated from time to time for training purposes.

Special events are analysed and technical and/or organisational measures are taken to prevent them from happening in future. Moreover, events that have occurred in comparable plants of the chemical industry are evaluated. In this context, particular attention is paid to the man/machine interface.

Finally, information channels are established so that members of the personnel can put in their experience and proposals to make their work easier and to prevent accidents at work.

To prepare the personnel for unusual operating conditions, recurring exercises are performed. Their kind and scope are laid down in the operational alarm and hazards prevention plans.

Use of external staff

If work is contracted out to other firms, the safety measures that are relevant for the intended activities are already included in the description of the working programme. When the external staff begin their work and during their entire presence at the plant, the management takes operations-specific measures for their safety (traffic safety obligation). The external staff members are prepared for their work under the aspects of the working programme, the operation of the plant and the materials to be handled. They are informed about the operational hazards and are given the operational safety instructions which contain in brief references to general, operations-related safety instructions including the alarm plan and operating instructions in accordance with Section 20 of the Hazardous Materials Ordinance (concerning possible contact with materials).

4.2 Managerial organisation to ensure the safety of production-mode operation

Responsibility for the operation and the observing of the operator's duties can be delegated by the company's general management to the responsible operating levels and the operating management. In this case it is necessary to lay down in writing the rights and duties connected with the management of the company's operations in internal regulations.

Apart from the planning and control of the production processes, the operation of a chemical plant also requires manifold specifications as regards organisation and surveillance; here, the objective is not only to ensure high availability of the equipment and to manufacture high-quality products but also to guarantee the safety of the plant, its employees and the surrounding environment. Existing plants and processes are constantly developed and adapted to the state of the art to the necessary degree.

Operation of the plant

Chemical products are made in continuous or batch processes. A plant may be suitable for the manufacture of either a single product or several different products that are produced one after the other (multi-material or multi-purpose plant).

The plant's management has to ensure that the production plants and their processes are operated in line with their specifications and design. Any product changes in multi-material plants and plant sections are carried out according to strictly defined procedures.

The operational work processes and the handling of the materials are laid down in detail in the operating instructions and prescriptions as a precaution against human error. The staff are placed under the obligation to adhere to these instructions with great care, observe the parameters that are necessary for a safe course of the process and to prepare a chronological protocol of them; they are supervised in all these activities. The prescriptions, for example, are supplemented with additional check lists and are given to the staff members together with accompanying instructions.

Within the framework of the existing safety concepts for technical plants, regular operational surveillance is also provided.

The orderly condition of the plant is subjected to routine checks during regular inspection rounds. Any special observations are noted down in the shift/repair manual. If there are any serious deviations, the plant management is to be informed immediately.

Maintenance

Maintenance, inspection and repair work is carried out under consideration of the relevant legal prescriptions.

The plant management ensures in particular by regular checks that the existing technical safety and control devices are able to function normally.

Repair work on safety-relevant plant components is carried out immediately. To avoid mix-ups, all plant components that contain chemical products are marked correspondingly. The same applies to the plant's safety and control devices.

Maintenance work is carried out under safety-related aspects according to predetermined maintenance and inspection plans, taking into account the legal requirements (e.g. Pressure Vessel Ordinance, *VbF, VAwS, ElexV*), supplemented by prescriptions of technical rules and under consideration of the manufacturer's information or the operator's own experience. In the case of unforeseen repair work made necessary by damage that has been detected and noted down in shift/repair manuals, the plant management initiates the requisite operational measures to prepare the repairs to be performed by a suitable workshop that ensures technically correct rectification of the damage. The shift/repair manuals serve at the same time as auxiliary supplements to the documentation of the temporary interventions in the industrial process of the plant that are required for maintenance purposes. In the case of increased hazards or plants for which the Hazardous Incident Ordinance requires a safety analysis, corresponding documents are drawn up for all maintenance and repair measures carried out on safety-relevant plant components.

For a certain range of activities, safety measures are to be prescribed by the plant management in an approval form.

In this form, the safety measures which are required to be carried out before, during and after the repair work are prescribed by the plant management. Adherence to these measures is confirmed by the signature of the person carrying them out.

The last step in the procedure is the acceptance of the repair work before restart.

The approval form is kept for documentation purposes.

Plant modifications

In case any modifications are applied to the plant and processes, initial investigations are carried out to find out which effects they might have with regard to safety, quality, environmental protection and possibly also licensing-related issues.

The investigation results are included in a written modification concept which also lays down the temporal progression of the intervention and possible special conditions.

Clearance for minor modifications is given by the plant management.

Should the modification turn out to be a major one during the development of the modification concept, the methodology of Chapter 3 is applied.

Decommissioning and dismantling of a plant

The safety of the operating personnel as well as the protection of the general public and the environment are also ensured during the decommissioning and dismantling of a plant by a systematic procedure that is carried out accordingly.

Particular attention is paid to possible hazards posed by residual materials remaining within the plant and to any influences on neighbouring plants that are still operating.

4.3 Protection of the operating personnel

Measures for safety on the shop floor

The personnel are provided with working clothes according to the kind and scope of hazards and with protective clothing for special cases. Emergency showers, eye showers etc. as well as hand fire extinguishers, fire blankets etc. are installed in specially marked locations at regular distances in the plant. Escape routes with emergency lighting allow rapid evacuation of the buildings in an emergency. Further personnel protection facilities are communication, fire alarm and other alarm systems, ventilation and suction devices, possibly missile and splash protection devices, gas warning systems, protection devices on power-operated equipment etc. Special protection measures are provided for staff working in one-person places of work. The control rooms may be equipped according to special safety criteria since it is from here that counter-measures have to be initiated in case of operational disturbances. in addition, the control room often serves as safe assembly point for the personnel in case of any dangers outside, while specially marked assembly points outside the operations building are earmarked for alarms calling for internal evacuation.

Safety with regard to the handling of hazardous materials

The plant management ensures that only those materials are used and products are manufactured for which the equipment is suitable and that only those prescriptions/processes are applied for which the processing equipment has been designed, build and provided with engineered safeguards.

Wherever possible, hazardous materials - especially carcinogenic ones - are exchanged for less hazardous materials. Open handling of hazardous materials is largely avoided by the use of technical aids. As far as open handling is unavoidable in individual cases, the exposure of the personnel is minimised by the installation of additional concentrated suction devices and, if necessary, the use of personal protection equipment.

The measures that are taken ensure in principle that the maximum concentration at the workplace (MAK values) or the technical standard concentration (TRK values) of

the handled materials are adhered to in the different working areas. If necessary, adherence to these limit values is checked by regular control measurements.

The recommendations of the professional trade association (e.g. leaflets of the M-series) are taken into account. The staff are informed about the materials that are handled in the plant. They have access at any time to the written operating instructions according to Section 20 of the Hazardous Materials Ordinance.

The legally required in-house medical care, which consists of an aptitude examination as well as regular medical check-ups, is provided by industrial medical services. They also act as consultants to the personnel and management concerning health-related issues in connection with the work in a chemical factory.

A sufficient number of staff are trained in first aid to be able to give emergency aid to injured persons until the arrival of an ambulance.

5 Plant surveillance

The technical implementation of the safety concept is ensured by quality assurance measures during the planning and construction phase, and its functionability is safeguarded by constant surveillance and regular maintenance during operation.

5.1 Quality assurance

A safe chemical plant which at the same time has a high availability rate requires all its equipment and components to be designed to meet the demands of the loads and stresses acting on them and to be able to be carried out in a normal manufacturing process.

For this purpose a quality assurance concept is necessary which comprises all phases of the plant's lifetime, from the first development of the plant to normal specified operation.

In chemical engineering, many influences resulting from the special characteristics, e.g. the materials used and the products of reactions, as well as special safety-related aspects of the industrial process are the determining factors for the plant's design and future operational behaviour. These cannot be regulated generally but have to be considered on a case-by-case basis.

Due to the variety of materials in a chemical plant and the resulting loads and stresses, great importance with regard to the safe retention of these materials is attributed to the choice of materials and preceding material examinations as well as to the manufacturing methods that must meet the requirements of the design.

During the course of construction of the plant, the responsible technical experts examine the agreement of the planned safety measures with the actual implementation after their installation as well as their functionability so that the existence of an effective safety concept can be assumed during the following operational phase.

These activities, which are all based on the results of the preceding material and process analyses, comprise the following steps:

- quality inspections during planning, i.e. examination of the design of equipment, instruments and machines with regard to their suitability for the intended use,

- surveillance of the manufacturing process, i.e. individual inspections of the manufactured vessels with regard to the state of the art of their design and manufacture,

- function tests during construction, i.e. in particular pressure tests to find out whether pressurised components are sufficiently tight under specified test pressure conditions and show no safety-relevant deformations,

- acceptance tests before first start-up.

The first three inspections are mainly related to the design data of the inspected vessel. The acceptance test investigates its operating modes and is intended to furnish proof of its safety even in cases of pressure or temperature changes resulting from disturbances of normal operation. By using the piping and instruments flow chart and configuration chart and by considering the requirements of the integral safety-related concept, the main point of inspection within the framework of the final examination before first start-up is whether the required engineered safeguards and precautionary protection devices in the plant are available and suitable and have been correctly installed, calculated and adjusted for the intended operating modes.

The result of the last phase is the approval for step-wise commissioning of the plant.

5.2 Integral plant surveillance

One important element of plant safety is integral plant surveillance. Here, the plant is surveyed with regard to the laws and ordinances from all relevant areas of applicable law and the conditions imposed in the licensing procedure; this surveillance lasts for its entire lifetime, i.e. planning, manufacture and construction, first start-up, operation, shut-down, decommissioning and dismantling.

Integral plant surveillance takes place in a system comprising three steps in which the operator, experts and authorities have different tasks:

- constant surveillance of the operation of chemical plants and their components by the operator and so-called 'operator-commissioned third parties',

- periodic surveillance and inspection of the plants and their components initially and then at regular intervals by experts,

- surveillance by state authorities both initially during the permission or licensing procedure and through occasional on-site plant inspections.

Surveillance by the operator

The plant operator is responsible for the safe operation of the plant. He is therefore under the obligation of constant surveillance in accordance with i.a. industrial safety laws, immission control laws, water laws, hazardous materials laws and the Imperial Insurance Ordinance.

During specified normal operation, a plant is constantly monitored and checked from various points of view by different persons/technical departments according to the defined distribution of tasks, which eventually leads to an integral surveillance of the entire plant and its surrounding environment. This surveillance ensures industrial safety, fire protection, immission control and water protection on an equal level.

The plant operator, for example, monitors the specified process of operation himself, e.g. with the help of the operational data signalled in the control room and by inspection rounds. The functions of e.g. safety-relevant process instrumentation and control systems, like protection systems, process analysis devices, etc., are monitored by senior plant personnel or technical departments with the help of maintenance plans.

Other technically responsible persons/technical departments monitor the buildings with regard to the adherence to fire regulations (e.g. regarding the existence and functionability of the systems for precautionary fire protection), legal regulations governing the use of hazardous materials, regulations of the Working Place Ordinance, and instructions for accident prevention.

The factory security service supervises the traffic within the factory grounds and in particular any objects that require special security measures. In this context, general access restrictions serve to reduce the risk of unauthorised third-party intervention.

Individual statutory regulations furthermore place the operator under the obligation to nominate so-called special officers for particular aspects of his responsibility. These special officers are employed for the supplementary control of certain safety and health protection areas.

They are in particular

- industrial safety experts,
- plant-internal immission control officers
- accident officers,
- experts as specified in the Pressure Vessel Ordinance,
- experts as specified in the Ordinance relating to Electric Systems in Rooms at Risk of Explosions,
- hazardous materials officers,
- water protection officers.

The tasks of these officers are i.a. the surveillance of the adherence to regulations and conditions in the area of plant safety as well as the regular inspection of the chemical plants, especially with regard to the functionability of the technical and personal protection devices.

The environmental protection officers check e.g. the plant's emissions into air and water as well as the pollution situation in the factory and its surrounding environment. The accident officer performs i.a. regular inspections of the workshops.

The special officers have the right and the duty to inform the operator immediately of any detected deficiencies and to propose remedial measures. In their respective special functions, these officers are not subject to directives.

Surveillance by independent experts and experts that are approved by the authorities (Section 11 GSG)

Various legal norms provide for safety-related inspections by independent experts.

These are among others the experts of the technical inspectorates (TÜV) and their counterparts of the supervisory departments of large companies who are granted equal authority. In addition, safety-related inspections of the plants and their components are also carried out e.g. by the technical supervisory officers of the professional trade associations.

The regularly recurring inspections of the plants and components concerned, for example, are carried out at predetermined intervals by independent experts, like safety experts as specified in the Industrial Safety Act, on the basis of the laws relating to plants that are subject to supervision in accordance with the Equipment Safety Act, water-related laws in accordance with the Federal Water Act, laws concerning the transport of hazardous materials, as well as various accident prevention regulations.

Surveillance by state authorities

Even before a chemical plant is started up for the first time it has to undergo various inspections with regard to plant safety issues that are performed by several technical authorities - which are differently structured according to each individual *Land* - including

- building inspection authorities / building regulations authorities,
- factory inspectorates or industrial safety and environmental protection authorities,
- subordinate water authorities.

The licensing authority is informed about the respective inspection result and consequently serves the licensing notification on the applicant, taking the comments of the technical authorities into consideration.

In addition to the application documents containing the description of the plant and the process, it is required in the majority of the chemical plants applied for that a safety analysis according to the Hazardous Incident Ordinance is produced which describes among other things the most relevant hazard sources and how they are controlled by the engineered safeguards. This safety analysis, too, is reviewed by the technical and licensing authorities and generally also by an additional independent external institution.

Once the plants have been started up they can be supervised and inspected at any time, either on site or by the evaluation of documents requested by the supervisory authorities, which in general are the above-mentioned technical authorities. Here, these authorities can once again draft in independent experts.

6 Defence against hazards (alarm and hazard prevention plans, information of the general public)

Hazard prevention plans serve as preventive measures that go even further than the safety measures defined by the above procedure. They are to provide for effective damage limitation measures when operational disturbances have occurred. During the planning of these measures, the activities to be performed by the personnel at the plant in case of such an event are co-ordinated in advance with the action of the responsible factory fire service, the public fire brigades, the emergency services or other security services wherever this is possible.

Alarm and hazard prevention plans

Alarm and hazard prevention plans are to show the main points of the most relevant information about operational activities, the hazards resulting from them, and the plant's safety concept.

The principle requirement for the preparation and updating of operational alarm and hazard prevention plans is derived from working place law and the 12th BImSchV (Hazardous Incident Ordinance); the contents of the requirements have first been specified in the 3rd Administrative Instruction (3rd VwV) relating to the 12th BImSchV.

Especially important is the fact that the operational alarm and hazard prevention plans mainly serve to support the security and emergency services. Therefore they have to be adapted to the requirements for the security and emergency services (especially the factory fire service and public fire brigades) with regard to their structure and contents. Here, simply structured, often graphic representations which are most likely to ensure the necessary quick information even under emergency conditions are normally preferred to detailed information that may be more precise but is often unclear and in some cases even superfluous.

In the case of large factory units with a large number of individual plants it may be useful to divide the alarm and hazard prevention plans into one general alarm and hazard prevention plan for the entire factory and separate alarm and hazard prevention plans for the respective individual plants. Here, the interfaces between the individual plans and the general plan have to be brought into tune.

Similarly, the operator's alarm and hazard prevention plans have to be brought into tune with the superordinate alarm and hazard prevention plans of the responsible local authorities, like e.g. the special protection plans or disaster control plans of the local authority districts.

Information of the general public

Rapid and exact information of the general public by the factory management, if necessary in combination with public alert measures, are to ensure the requisite protection of the population in the neighbourhood of the factory. It is useful to plan all information channels that are needed in case of an event in advance, co-ordinate them with the responsible public security forces and incorporate them in the operational alarm and hazard prevention plans. A system that has been tried and tested is the advance information system ("D1-D4") that is already widely used in North Rhine-Westphalia. It serves as the basis and trigger for information or warnings to the general public by the responsible authorities.

However, any quickly available information will only have its desired effect if the general public reacts and behaves in a way that is appropriate for the event. This means that precautionary information has to be given to the general public, advising them of the possible hazards and of correct behaviour or possible protection measures. For those plants that are subject to the extended obligations of the 12th BImSchV (Hazardous Incident Ordinance), such precautionary information of the general public is stipulated to be provided in the form specified in Section 11 of the Hazardous Incident Ordinance.

7 Summary

The procedure described in this guide provides for the performance of activities during the entire lifetime of a plant for material conversion processes, from the planning and production stages up to decommissioning, that are required for safe and reliable plant operation during all operating states.

By their integral approach, these practices that have been established in many companies lead to safety-related measures and organisational specifications which represent unambiguous solutions for the various protection goals stipulated by the regulations.

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