Checklist System for Safety Reports

INSTRUCTIONS for preparation and inspection of a safety report (SR)
in accordance with

UNECE CONVENTION ON THE TRANSBOUNDARY EFFECTS
OF INDUSTRIAL ACCIDENTS

and

the EU Directive 96/82/EC (SEVESO II)

by a consistent Checklist system

Foreword

These instructions on preparing and inspection of a safety report provide a checklists system for safety reports. The document can be seen as containing four main parts:

Part I, the introductory chapter, describes the purpose of safety reports and provides important definitions. This includes a useful definition of accident scenarios.

Part II contains the checklists. Under chapter 2.1 the systems of the master, sectoral and detailed checklists are explained. Chapter 2.2 suggests a simple score system for evaluation of safety reports based on the checklists. This scoring system allows the reader to interpret the score as ‘high performance’, ‘performance to be improved’ or ‘poor performance’. The chapters 2.3 and 2.4 include the checklists presented in a tabular form.

Part III provides background information on the content of the checklists. In the chapters 3 to 5 the user can find the explanation of the items contained in the checklists. When the checklist is used in the electronic format, the user can simply click on the reference and will be automatically linked to the explanation.

Part IV, chapter 6, contains the list of useful literature.

This checklist system has been prepared within a project on the evaluation of safety reports under the UNECE Convention on the Transboundary Effects of Industrial Accidents which was implemented with funds of the Advisory Assistance Programme for Environmental Protection in the Countries of Central and Eastern Europe, the Caucasus and Central Asia provided by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety and managed by the Federal Environment Agency.

Any statements and opinions made are neither official statements nor opinions of the Ministry, nor can they be attributed to the managing agency. They solely reflect the opinion of the authors.

Content

1. Introduction, General Principles and Definitions

Learning from major chemical accidents in the past, the international community took action to issue several regulations dealing with prevention of, preparedness for and response to major industrial accidents. In particular:

- UNECE Convention on the Transboundary Effects of Industrial Accidents[1]
- OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response[2]
- EU Directive 96/82/EC (SEVESO II)[3]

Those regulations aim at the prevention of major accidents which involve certain dangerous substances, and the limitation of their consequences for man and the environment, with a view to ensure high levels of protection throughout the whole international community in a consistent and effective manner.

The responsible handling of bigger amounts of hazardous chemicals requires a systematic approach on safety and accident control. This is efficiently laid down in a Major Accident Prevention Policy (MAPP), which basic principals are made operational by the measures of the Safety Management System (SMS). The SMS is a part of the overall management system; the whole system represents the safety culture. The core instrument to demonstrate that all measures are taken in a consistent way is the Safety Report (SR). The preparation, auditing and inspection of SRs are strongly facilitated using a consistent system of checklists, which is described below.

The following document is mainly based on the European *"Guidance on the Preparation of a Safety Report to meet the Requirements of Directive 96/82/EC as amended by Directive 2003/105/EC (Seveso II)"*[4] and the German Guidance SFK-GS-24, *"Outline of a major-accident prevention policy and a safety management system pursuant to Article 9 (1) a and Annex III of the "Seveso II" Directive"*[5]

1.1 PURPOSE OF A SAFETY REPORT

WHY? Safety reports are intended to demonstrate that:

- a major accident prevention policy (MAPP) and a safety management system (SMS) have been put into effect;
- all major-accident hazards are identified and necessary measures have been taken to prevent such accidents and to limit their consequences for man and the environment;
- adequate safety & reliability have been incorporated into the design, construction, operation and maintenance of any installation;
- internal emergency plans have been drawn up, supplying information to enable the external emergency plan to be drawn up; and
- information for land-use planning decisions has been given.

HOW? The safety report must include the following minimum data and information:

- Information on the MAPP and on the SMS;
- Presentation of the environment of the establishment;
- Description of the installation(s);
- Hazard identification, risk analysis and prevention methods; and
- Measures of protection and intervention to limit the consequences of an accident.

[1] http://www.unece.org/env/documents/2006/teia/Convention%20E.pdf
[2] http://www.oecd.org/document/61/0,3343,en_2649_34369_2789821_1_1_1_1,00.html
[3] http://mahbsrv.jrc.it/Framework-Seveso2-LEG-EN.html
[4] http://mahbsrv.jrc.it/downloads-pdf/guidance-amended-by-2003-105-EC.pdf
[5] http://www.kas-bmu.de/publikationen/pub_gb.htm

The safety report may be combined with other reports produced in response to other legislation to form a single safety report in order to avoid unnecessary duplication or repetition of work.

WHO? The safety report must be submitted to the competent authority by the operator.

It is up to the operator and within its responsibility to decide on the sufficiency of competence of the people and organisations involved in the preparation of the safety report. **Relevant organisations entrusted with such tasks must be named in the safety report.**

WHEN? The safety report must be submitted:
- in case of a new establishment a reasonable period of time prior to the start of construction or operation; and
- without delay after a periodic or necessary review.

The safety report must be reviewed and, if necessary, updated:
- in a regular period, which is laid down in the respective regulations or
- at the initiative of the Operator or at the request of the Competent Authority, where justified by new facts, new technical knowledge about safety or about hazard assessment, or
- in case of a modification of a site, this means modification of the establishment, the installation, the storage facility, the (chemical) process, the nature of dangerous substance(s) or the quantity of dangerous substance(s). The decision whether these modifications would have an impact on safety and, therefore, would require a review of the safety report should be taken by using a systematic analysis such as for instance a screening method or a rapid ranking tool.

1.2 DEFINITIONS

The safety report should demonstrate that necessary measures to prevent, control and limit the consequences of a possible major-accident have been put in place and are fit for purpose.

1.2.1 Demonstrate

For this specific purpose, “demonstrate” is intended in its meaning of: “justify” or “argue the case” but not “provide an absolute proof”. In reality, the hazard identification, its associated risk analysis and the subsequent decisions in regard to control measures are processes that are always characterised by a certain degree of uncertainty. As such, it is normally not possible to prove absolutely in the safety report that “all necessary measures” have been taken.

In addition, it should always be assumed that the Competent Authorities will take the information and conclusions in the report largely as presented, using professional judgement more generally to assess the credibility and logic of the conclusions reached in the report. An extensive in depth scrutiny or exhaustive examination is not envisaged in most cases.

Finally, the effective implementation of this principle is strictly dependent on the correct identification of all potential major accident hazards and proper selection and application of the necessary control measures for each of them.

From these considerations the following guidance may be derived:
- The operator shall expect professional judgment from the assessor of a safety report and should base its demonstration on this assumption.
- The demonstration must be “convincing”. This means that the rationale for deciding the completeness of hazard identification and the adequacy of the measures

employed should be supported and accompanied by all assumptions made and conclusions drawn.
- The demonstration should provide evidence that the process was systematic which means that it followed a fixed and pre-established scope.
- The extent to which the demonstration is performed should be proportional to the associated risk.

1.2.2 All necessary measures

"Necessary measures" shall be taken in order to prevent, control and limit the consequences of a possible major-accident. In the context of the assessment of a safety report it means that, in applying the identified measures, all risks of concern have been properly reduced according to current national practices.

A point to note is that, although the "necessary measures" are properly taken, some 'residual risk' will always be present.

The decision as to whether the residual risk is acceptable depends very much on national approaches and practices.

Nevertheless there are some widely accepted supporting principles for this decision:
- The efficiency and effectiveness of the measures should be proportionate to the risk reduction target (i.e. higher risks require higher risk reduction and, in turn, more stringent measures).
- The current requirements of technical knowledge should be followed. Validated innovative technology might also be used. Relevant national safety requirements must be respected.
- There should be a clear link between the adopted measures and the accident scenarios for which they are designed.
- Inherent safety[6] should be considered first, when feasible (i.e. hazards should always be removed or reduced at source).

1.2.3 Prevent, Control and Limit

Prevent, control and limit can be defined as:

Prevent: to reduce the likelihood of occurrence of the reference scenario (example: automated system to prevent overfilling);

Control: to reduce the extent of the dangerous phenomenon (example: gas detection that reduces intervention time and may prevent major release);

Limit: to reduce the extent of the consequences of a major accident (e.g. through emergency response arrangements, bunding or firewalls)

1.2.4 Major Accidents

The regulations aim at the prevention of major accidents, which involve dangerous substances, and the limitation of their consequences to the man and the environment. As defined in Article 3 of the Seveso II Directive, *major accident* means an

> *"adverse occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment covered by this Directive, and leading to serious danger to human health and/or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances."*

[6] See [6]

To qualify an accident as “major accident”, three criteria must be fulfilled:

1. the accident must be initiated by an *uncontrolled development;*
2. *one or more dangerous substances* must be involved; and
3. the accident must lead to *serious danger* to human health, the environment, or the property.

Whereas the criteria *“uncontrolled development”* and *“dangerous substance”* are viewed as relatively unambiguous, the interpretation of *“serious danger”* is more controversial and reflects often national policies. However a “serious danger” might be connected with:

- potential life-threatening consequences to one human (on-site and off-site);
- potential health-threatening consequences and social disturbance involving a number of humans;
- potential harmful consequences to the environment at a certain (larger) extent; and
- potential severe damage to property (on-site and off-site).

A major accident may be considered as a specific event (or a group of specific events) that is characterised by certain potential consequences.

In applying the criteria listed above a major accident may include those events involving dangerous substances that are often classified as "occupational accidents" (on-site) as well as those events that have effects outside the boundary of the establishment (off-site).

1.3 PRACTICAL CONSIDERATIONS FOR SAFETY REPORTS

- The overall approach followed should be properly described and explained.
- The level of demonstration should be proportionate to the extent of potential consequences and the complexity of the installation/process/systems involved.
- Preparation is the sole responsibility of the operator. The Competent Authority has no responsibility for content.
- One of the main elements of the safety report is the definition of reference accident scenarios. These scenarios normally are the basis for demonstrating that the necessary measures are adequate. For this purpose, the scenario description should be structured and evidence provided to highlight the consistency between the scenario selected and the measures taken.
- The safety report should be of a summarising character, in which the information provided is limited to its relevance in regard to major-accident hazards. However the information should be sufficient to demonstrate that the requirements with regard to major accident hazards have been met and allow the competent authority to come to justified conclusions.
- The description of measures should be limited to the explanation of their specific objectives and functions. Specific technical details should be provided within the safety report when this is necessary to demonstrate that the measures are sufficient, i.e. the measures have the required reliability and effectiveness, thus enabling the competent authority to come to appropriate conclusions.

1.4 DEFINITION OF "ACCIDENT SCENARIO"

In general, accident scenarios are based on the following main elements (see image 1):

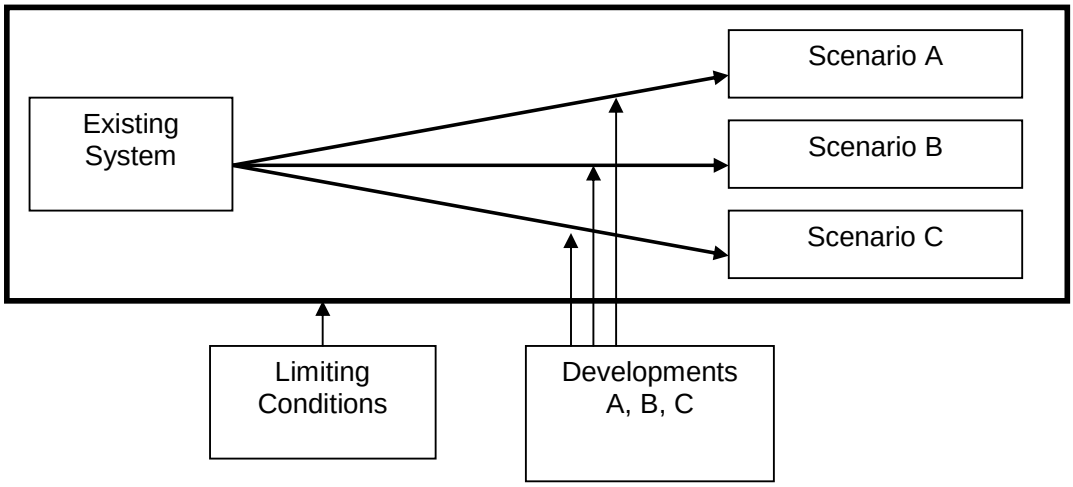

Image 1 Development of accident scenarios

For the specific purposes of safety reports, a scenario is always an undesirable event or a sequence of such events characterised by the loss of containment (LOC) or the loss of physical integrity and the immediate or delayed consequences of this occurrence.

1.5 ESSENTIAL ELEMENTS OF A SAFETY REPORT

The essential elements of a SR are (illustrated in image 2) logically grouped in three main parts:

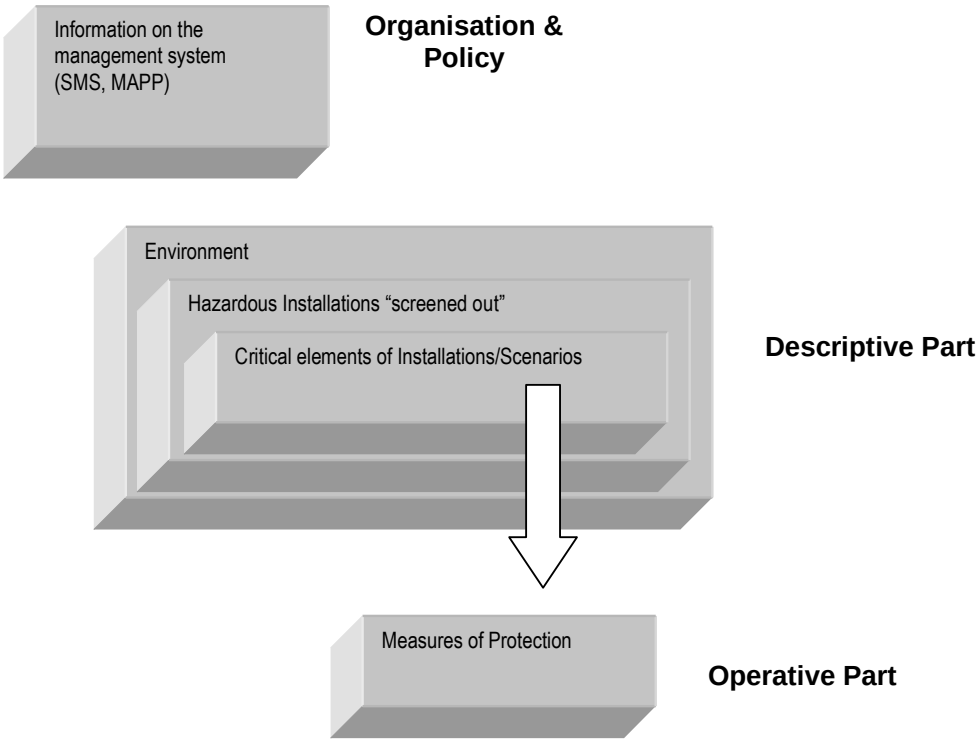

Image 2 Elements of safety reports

An essential and extensive part of a safety reports is the central box, which refers to the description of the establishment, its surrounding, the hazardous installations and the critical scenarios which could lead to a major accident.

In this case, the description of the different sections is expected to be characterised by a different level of detail depending on the relevance of the involved topic to the purpose of the safety report. A suggested general approach is illustrated in image 3.

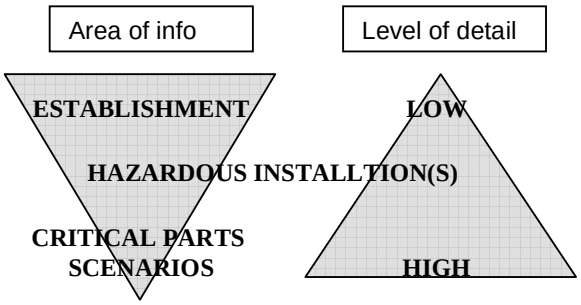

Image 3 Content of safety report vis-à-vis the level of detail

In the safety reports, establishments can be described in a low level of details, whereas the parts of report describing risks and possible emergency scenarios should provide high level of details.

2. CHECKLISTS

2.1 SYSTEM OF CHECKLISTS

To support the preparation, auditing and inspection of Safety Reports a hierarchical system of checklists was developed (image 4).

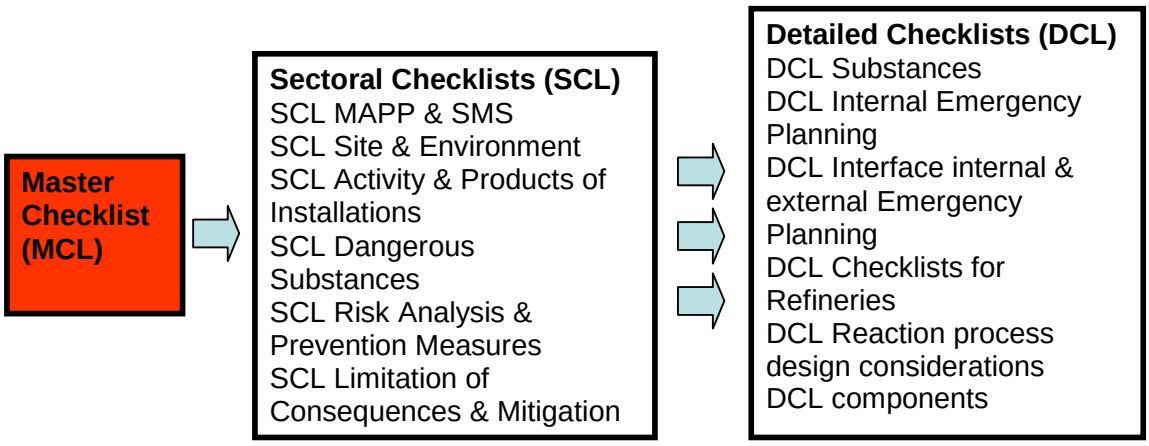

Image 4 System of Checklists for Assessment of a Safety Report

The number of DCL can be extended accordingly to the need of the investigator.

The master checklist **(MCL)** deals with all requirements on a supervision level. It summarizes the results of the different sectoral checklists **(SCL)** and gives an overview on all Safety performances, numerical expressed by the performance factor I.

The different areas of organisational and technical safety measures, including risk assessment and mitigation measures are addressed by 6 SCL with references to several detailed checklists **(DCL)** and other relevant material to be found in the literature list (chapter 6).

The system of checklists is preferably used in a single electronic document which allows an easy switch between the checklists, guidance text and literature.

To involve several experts at the same time, it is recommended to split up the document according to the different areas, e.g. description of substances, SMS, risk assessment. This procedure is possible because:

- SCL´s are short and comprehensive;
- SCL´s address a limited area;
- SCL´s can be performed by sectoral specialists (share workloads);
- SCL´s can be evaluated separately according to similar topics (not to compare apples & pears); and
- via MCL the involvement of TOP Management is possible.

In the open literature there are several references to other checklist methods, which follow other principals as given in the “SEVESO-world”. Those systems give within their limits also valuable information on the safety record of the objects investigated. As good examples are mentioned:

- the Belgium Metatechnical Evaluation System M.E.S[7]; or
- checklists of the German Federal Environmental Agency especially designed for Installations handling substances, which are dangerous for the environment.[8]

2.2 SIMPLE SCORE SYSTEM (SSS) FOR EVALUATION OF QUESTIONAIRES

For inspection and surveillance purpose it is useful to have a simple yardstick, to give the evaluation a numerical value for the overall safety performance of the whole establishment or every single installation investigated.

The SSS should be used for every questionnaire separately. It gives a number for the completeness and in certain extent of the plausibility of a given subject and is expressed by a Performance Index **I,** which value lies between 100> **I** > -100. The Index is calculated from the respective questionnaire with **n** questions, which are allowed to be answered as follows:

- Answer: yes score = n_y*F
- Answer: no score = n_n*F
- Answer: partly yes score = n_p*F*D
- Answer: not applicable score = n_0

Factor **F** is a weight factor for the particular question and can be set between 0,1<**F**<1. The default value is F=1. Factor **D** stands for the portion to what extend the question can be answered as yes, it has a value between 0,3 <**D**<0,7, the default value is D=0,5.

Both factors are set by the investigator individually (expert judgement) and reflect the plausibility & importance of the question/answer.

The average values Q of the answers are calculated as follows:

Q_y [%] = $(\sum n_y*F / n-n_0)*100$; $0<Q_y<100$

Q_n [%] = $(\sum n_n*F / n-n_0)*100$; $0<Q_n<100$

Q_p [%] = $(\sum n_p*F*D / n-n_0)*100$; $30<Q_p<70$

From this you can calculate the Performance Indicator **I** :

$$\mathbf{I = Q_y + Q_p - Q_n ;} \qquad \mathbf{100> I > -100}$$

Example: Different answer scenarios of a questionnaire with 100 questions (n=100), all question are applicable (n_0=0); Weight factor F=1; Portion factor D=0,5.

Answer: yes (Q_y)	Answer: partly (Q_p)	Answer: no (Q_n)	Index I
100	0	0	100
80	20	0	90
80	10	-10	75
50	50	0	75
30	70	0	65
80	0	-20	60
0	100	0	50
50	25	-25	37,5
30	35	-35	12,5

7 http://www.employment.belgium.be/WorkArea/showcontent.aspx?id=6642

8 http://home.arcor.de/platkowski/Raffinerie/Site/

50	0	-50	0
0	50	-50	-25
30	0	-70	-40
0	20	-80	-70
0	0	-100	-100

Image 5 Schematic areas of performance indicator I. (The values should be set individually according to experience.)

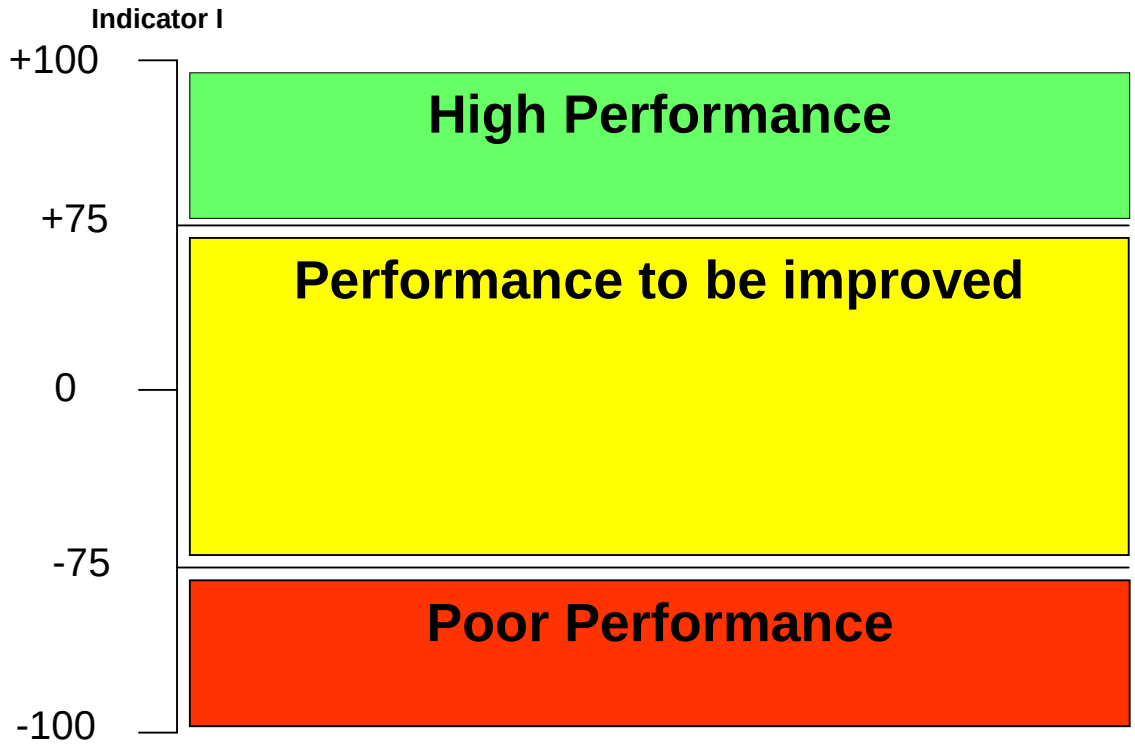

Image 6 Areas of concern

Image 6 shows an example on different areas for follow up actions. If only 25% of the questions are answered sufficiently one must consider a poor performance, this means that the particular area does not meet the necessary safety provision. If the score is between 25% - 75% still the performance is not perfect and should be improved, if the score is 75% or higher, the performance can be taken as good and fulfil all requirements. These limits, however, should be set according to the experience of the investigators.

2.3 SCL CHECKLISTS

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
I	**2.3.1 SCL Description of the Site and Environment**						
I.1	General Lay out of the establishment	e.g. installations and other activities of the establishment					
I.2	History of the site	e.g. Historical soil contamination					
I.3	Location						
I.4	Map of establishment and surroundings						
I.5	Site map of establishment						
I.6	Traffic route plan						
I.7	Piping plan	e.g. product pipeline, energy supply					
I.8	Approach area	e.g. Near by airport, rail traffic					
I.9	Waters and flooding areas	e.g. Near by surface waters, rivers					
I.10	Seismic zones	Classification by EU norms					
I.11	Meteorological data						
I.12	Site specific natural factors	e.g. Near by natural protected area					
I.13	Land subsidence	e.g. due to mining activity					
I.14	Energy supply	Power-, steam-, fuel supply, etc.					
I.15	Plant security	Security analysis	See German guidance on security analysis (SFK-GS-38)	[23]			
I.16	Accessibility	e.g. Roads, rails, path access, Means of protection and control, fences, walls, etc					

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
I.17	Use of neighbouring areas	e.g. agriculture, urban settlements	See guidance on internal emergency planning (TUVBB)	[25]			
I.18	Distances to kindergartens, schools, hospitals, nursing homes and places gathering outside of buildings like stadiums	Vulnerable objects	See guidance on internal emergency planning (TUVBB)				
I.19	Land use planning	e.g. Safety distances	See EU guidance on LUP	[26]			
I.20	Consideration of Domino-Effects	e.g. Location of neighbouring establishments with hazardous substances					
I.21	Information to the Public	Means of risk communication, participation committees, etc.	Public participation See EU Guideline	[3]			
	Identification of installations and other activities of the establishment which could present a major-accident hazard						
I.22	Criteria to identify safety critical installations		See German Guidance KAS-1	[24]			
I.23	List of safety critical installations	Result from screening process					
	Major accident prevention measures of the site (general)						
I.24	Organisational prevention measures	e.g. SMS, Quality assurance, using best available technique (BAT)	See DCL Checklists for Refineries Part 2: Requirements on the structure and equipment of production plants	[8]			
I.25	Constructional Measures	e.g. state of the art construction, seismic proof construction					
I.26	Technical protection measures	e.g. current state of the art lay out of technical equipment					
	Major accident mitigation measures of the site (general)						
I.27	Organisational mitigation measures	e.g. internal emergency plan, fire safety	See guidance on internal emergency planning (TUVBB)	[25]			
I.28	Constructional Measures	e.g. catchment facilities, safety distances					

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? **Yes = y** **No = n** **Partly yes = p** **Not applic. = 0**	**Impor-tance?** **Factor F** **(0,1<F<1)** **default=1**	**Portion of "partly yes"?** **Factor D** **(0,3<D<0,7)** **default=0,5**
I.29	Technical mitigation measures	e.g. water and steam curtain, safety walls					
	Occupational Health and Safety Measures of the Site (general)						
I.30	Safety at work	e.g. clear and comprehensive instruction, time management, occupational health & safety system, personal protective equipment	See ILO Guidelines (various)	[12]			
	Internal Emergency Plan of the Establishment (general)						
I.31	Internal emergency plan		See guidance on internal emergency planning (TUVBB)	[25]			
Evaluation I							
∑Questions=	Summary				**∑y*F=** **∑n*F=** **∑p*F*D=** **∑not applic. = n_0**		

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
II	**2.3.2 SCL Dangerous Substances**						
II.1	Updated inventory of the dangerous substances in the establishment.						
II.2	Identification of dangerous substances: - chemical name, - CAS-number, - name according to IUPAC nomenclature, - GHS classification						
II.3	Correct application of the classification and quantification of dangerous substances according to criteria of Annex 1 Seveso II						
II.4	Correct application of the classification of dangerous preparation/mixtures according Annex 1 Seveso II and the corresponding chemicals legislation (Dangerous Substances Directive, Dangerous Preparations Directive, CLP Regulation)						
II.5	Water hazard class of the substances correct Physical, chemical, toxicological characteristics and indication of the delayed hazards for man and the environment		1. See Substances hazardous to waters" 2. See DCL substances	1. [38] 2. [15]			
II.6	Estimation of maximum quantity of dangerous substances present	e.g. whole inventory of establishment					
II.7	Estimation of maximum quantity of dangerous substances likely to be present in case of derivation of industrial process	e.g. quantity of dangerous substance generated by run away reactions					
II.8	Quantity of the dangerous substances present/threshold quantities ratio	Gives an idea about the quantities of the hazardous substances onsite and the associated risks of a major accident					
II.9	Correct application of summation rule according Annex 1 Seveso II	Summation according to hazardous properties					

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? **Yes = y** **No = n** **Partly yes = p** **Not applic. = 0**	**Impor-tance?** **Factor F (0,1<F<1) default=1**	**Portion of "partly yes"?** **Factor D (0,3<D<0,7) default=0,5**
II.10	**P**hysical, chemical, toxicological characteristics and indication of the immediate hazards for man and the environment	LD, LC data; ERPG, AEGL, AETL, IDLH, etc.					
II.11	**P**hysical, chemical, toxicological characteristics and indication of the delayed hazards for man and the environment	e.g. Bioaccumulation and magnification data					
II.12	Physical and chemical behaviour under normal conditions of use						
II.13	Physical and chemical behaviour under foreseeable accidental conditions		See SCL risk assessment				
Evaluation II							
∑Questions=13	Summary				**∑y*F=** **∑n*F=** **∑p*F*D=** **∑not applic. = n_0**		

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
III	**2.3.3 SCL main activities and products for single installations**		**Examined Installation:**	**Each identified hazardous installation separately**			
III.1	Technical function of the installation		See DCL Reaction process design considerations	[6]			
III.2	Main procedure of activity						
III.3	Building structure of the installation						
III.4	Technical design of the installation		See DCL Reaction process design considerations	[6]			
III.4	Safety critical parts containing dangerous substances		See guidance on SRP identification (KAS-1)	[24]			
III.5	Safety critical devices		1.See SCL Risk Assessment 2.See DCL on components	2. [15]			
III.6	Basic Flow sheets with indication of process conditions (pressure, temperature, composition) and any relevant thermodynamic and transport properties						
III.7	P&I-Flow sheets with indication of instrumentation, control/alarm and other safety systems						
III.8	Location and environment of the installation						

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? **Yes = y** **No = n** **Partly yes = p** **Not applic. = 0**	**Impor-tance?** **Factor F (0,1<F<1) default=1**	**Portion of "partly yes"?** **Factor D (0,3<D<0,7) default=0,5**
Evaluation III							
∑Question s=	Summary				**∑y*F=** **∑n*F=** **∑p*F*D=** **∑not applic. = n_0**		

IV	2.3.4 SCL Major Accident Prevention Policy (MAPP) and Safety Management System (SMS)						[4], [5]
IV.1	**Elements of MAPP**						
IV.1.1	Does the written MAPP exist?	• The aims in preventing accidents shall be specific and controllable • The procedures to prevent accident hazards shall be specified and controllable • The formulations in the Safety policy shall be clear					
IV.1.2	Is the company MAPP clearly stated?						
IV.1.3	Have the prevention of accidents priority in company policy?						
IV.1.4	Is the hazard potential in the establishment clearly identified?						
IV.1.5	Does a complete list of all hazardous substances exist?		See also SCL substances				
IV.1.6	Are the main processes or activities clearly described?		See also SCL activities				
IV.1.7	Are all basic technical and organizational measures of accident prevention & limitation described?						
IV.1.8	Are employees acquainted with MAPP?						
IV.1.9	Is the document easily accessible?						
IV.1.10	Is the document signed by the top manager?		See German guidance on Safety Culture	[21]			
IV.2	**Organisation and personnel**						
IV.2.1	Are all tasks for involved staff (at all levels of organisation) clearly documented? In doing so is every phase of the life cycle of the plant considered?	Life cycle: design, normal operation, maintenance during normal operation, maintenance during “stops”, dismantling					
IV.2.2	Is the competence and authority of all involved staff (at all levels of organisation) clearly documented? In doing so is every phase of the life cycle of the plant considered?	Life cycle: design, normal operation, maintenance during normal operation, maintenance during “stops”, dismantling					
IV.2.3	Are the responsibilities of all involved staff (at all levels of organisation) clearly documented? In doing so is every phase of the life cycle of the plant considered	Life cycle: design, normal operation, maintenance during normal operation, maintenance during “stops”, dismantling					

IV.2.4	Are tasks of personnel of third parties (contractors) involved with major accident risk control documented?						
IV.2.5	Are responsibilities of personnel of third party (contractors) clearly defined and documented?						
IV.2.6	Is the competence and authority of the third party (contractors) clearly defined and documented?						
IV.2.7	Is the communication and supply of information on major accident risk control organized according to the established structures?	e. g. safety committees, safety representatives, top management					
IV.2.8	Are requirements formulated for own personnel regarding major accident risk control (knowledge and skills, training and education)?						
IV.2.9	Is personnel reasonably trained and educated in major accident risk control?						
IV.2.10	Is there a mechanism that responds to external information (requirements) which might influence the organization and demands on the personnel?						
IV.2.11	Are there checks whether own and third party personnel complies with the requirements formulated for major accident risk control?						
IV.2.12	Does daily work comply with the division of tasks, responsibilities and authority?						
IV.3	**Identification and evaluation of major hazards**						
IV.3.1	Does the SMS demonstrate that the major accident hazards have been identified?	Identification shall comprehend a role of human factor					
IV.3.2	Does the SMS demonstrate that the necessary measures have been taken to prevent and limit the consequences of major accidents?		See also SCL Risk Assessment				
IV.3.3	Does the SMS demonstrate that a systematic and sufficient comprehensive approach to the identification of risk reduction measures has taken place?						
IV.4	**Operational control**						
IV.4.1	Are there sufficient operational instructions for safe handling hazardous chemicals?						
IV.4.2	Does the SMS demonstrate that adequate safety and reliability have been incorporated into the design linked accident hazards in the establishment?		See also SCL Risk Assessment				
IV.4.3	Does the SMS demonstrate that adequate safety and reliability have been incorporated into the construction linked to major accident hazards in the establishment?		See also SCL activities				

IV.4.4	Does the SMS demonstrate that adequate safety and reliability have been incorporated into the operation and maintenance linked to major accident hazards in the establishment?						
IV.4.5	Is there evidence that the establishment and installations have been designed to an appropriate standard?						
IV.4.6	Is there evidence that the layout of the plant limits the risk?	e.g. in the course of routine operations, testing, inspections, maintenance, repair and replacement	See also SCL limitation				
IV.4.7	Is there evidence, in the SMS, that there are no serious deficiencies in the measures taken to prevent, mitigate a major accident?						
IV.5	**Management of change**						
IV.5.1	Is there a document setting the way and realization of changes in technology, equipment, organization and materials?						
IV.5.2	Does the document include impacts and evaluation of the influence of changes into safety?						
IV.5.2	Does the document include safety measures in the field of organization, human resources and technology?						
IV.5.3	Is there mechanism ensuring that implemented changes will be recorded and documented?						
IV.6	**Planning for emergencies**						
IV.6.1	Does the SMS demonstrate that an internal emergency plan has been drawn up?		See SCL mitigation				
IV.6.2	Are the foreseeable emergencies derivate by scenarios?						
IV.6.3	Is the internal emergency plan tested on a regular basis?						
IV.6.4	Are the internal alarm systems in compliance with external alarm structures?						
IV.6.5	Does the information supplied enable the local emergency planners to draw up an off-site emergency plan which will take the necessary measures in the event of a major accident?						

IV.7	**Monitoring performance**						
IV.7.1	Is there a mechanism for ensuring that all policy makers are informed of safety issues and concerns	Policy makers: top management, management, experts					
IV.7.2	Is there a mechanism for providing feedback from the policy making group to employees and their representatives?						
IV.7.3	Is there a mechanism to ensure employees have access to all relevant safety – related information?						
IV.7.4	Is there a comprehensive system for reporting incidents and other „learning experiences“?						
IV.7.5	Are there clear, documented procedures for reporting?	The reporting system shall define roles and responsibility, and present clear directions and reporting forms					
IV.7.6	Are all employees encouraged by management to report and discussed incidents?						
IV.7.7	Is the reporting system regularly reviewed?	The way of accident / incident reporting shall be regularly inspected					
IV.7.8	Is there a system/procedure for investigation an analysis of incidents?						
IV.7.9	Is there a procedure for taking corrective actions as the result of individual incidents?						
IV.8	**Audit and review**						
IV.8.1	Are audit programme(s) planned, established, implemented and maintained on the results of risk assessments of the organization's activities, and the results of previous audits?.						
IV.8.2	Do audit procedures address the responsibilities, competencies, and requirements for planning and conducting audits?						
IV.8.3	Are audit criteria, scope, frequency and methods determined?						
IV.8.4	Is the audit / review consistent with the organization's commitment to continual improvement?						
IV.8.5	Does the output from the audit /management reviews include recommendations for improvement?						
IV.8.6	Are relevant outputs from audits/ management review available for communication and consultation?						
IV.8.7	Are the audit personnel independent?	e.g. external auditors					
IV.8.8	Is there an independent mechanism of review the whole SMS/policy on a regular basis?						

Evaluation IV		
∑Questions=	Summary	**∑y*F=** **∑n*F=** **∑p*F*D=** **∑not applic. = n_0**

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
V	**2.3.5 SCL Identification and Accidental Risk Analysis and Prevention Measures**						
	Hazard assessment						
V.1	Description of the adopted approach (systematic tools / simplified methods)	Systematic tools apply the analysis to all the single equipment; most diffused techniques: - HAZOP (HAZard and OPerability analysis) - What if? (Analysis of consequences in case of anomalies in the chemical process). Simplified methods apply general criteria to the unit as a whole.	See also SCL SMS	HAZOP [27]			
V.2	Use of historical analysis for identification of accident scenarios	Hazard identification is referred to scenarios occurred in similar plants which have been recorded in references data base	Data bases	[28], [29], [30]			
V.3	Identification of accidents scenarios in correspondence to the units handling larger amount of dangerous substances	Larger amount of dangerous substances (storage vessel, big reactors, etc.) determine a potentially critical scenario in case of loss of containment.	See SCL substances	[31]			
V.4	Evidence of the use of installation data for the application of hazard assessment	The identification of hazards has to clearly refer to installation data (plant lay out, flow schemes, material balances, etc.)	See SCL activities				
V.5	Detailed description of the possible causes that might lead to an accident scenario	Example of typical scenario: Overpressure in the reactor. Possible causes: - process control failure, - error by operator, - external fire.					

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
	Scenarios' likelihood assessment						
V.6	Description of the adopted approach (probabilistic / deterministic)	Probabilistic: - estimate of expected frequencies of scenarios with dedicated tools such as 'Fault Tree Analysis (FTA)', 'Event Tree Analysis'. Deterministic: - use of a pre-determined bounding subset of accidents sequences.	FTA	[32]			
V.7	Evidence of the use of the plant data for the application of scenarios' likelihood assessment	Scenarios' likelihood assessment has to clearly refer to installation data (flow schemes, material balances, safety measures, etc.)	See SCL activities				
V.8	Definition of the different categories of frequency for the classification of the risk	Categorization of the frequency can be a powerful tool for the selection of most representative accident scenario		See Table 8.52 in [39]F.P. Lees "Loss Prevention in the Process Industries" - 2nd Edition, 1996 – table 8.52			
V.9	In case of application of probabilistic approach, references for the adopted numeric data.	Numeric data must have clear references to diffused data bases. Typical numeric data used for scenarios' likelihood: - Failure rate (how many time in a period of time the system is not working properly) - Unavailability (probability that in case of request the system is not working properly) - Optimal results deliver genuine data from the installation in question only	Reliability data	[33]			

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
	Consequences assessment						
V.10	Description of the adopted approach (detailed / simplified)	Detailed: -use of dedicated model for the representation of dynamics of released substances in the atmosphere / environment. Simplified: -use a pre-determined consequence matrix based on type of substance and released amount.	1. Detailed model (free software) 2. Simplified model	1. [34] , [35] 2. [36]			
V.11	Description of input and output data associated to the application of the physical model for evaluation of damage distances	Example of data to be clearly indicated: - Meteorological data (wind speed, temperature, humidity) - Operating condition of the plant; - Type and flow rate of released dangerous substance - Damage distances	See also SCL activities				
V.12	Clear definition of all possible scenario that might be originated from the initial event	In case of immediate ignition: fire In case of ignition of a large cloud: explosion In case of release of chlorine: toxic dispersion A possible powerful tool is the "Event Tree Analysis"	Event Tree Analysis or expert judgement	[37]			
V.13	Definition of criteria for damage assessment of exposed people	Fire: level of heat radiation; Explosion: level of overpressure peak; Toxic dispersion level of concentration		[40]			
V.14	Availability of cartographic maps in suitable scale for the representation of the potential damage distances	The maps have to show the damage areas in the territory surrounding the establishment with indication of vulnerable zones (residential areas, hospitals, etc.)					

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? Yes = y No = n Partly yes = p Not applic. = 0	**Impor-tance?** Factor F (0,1<F<1) default=1	**Portion of "partly yes"?** Factor D (0,3<D<0,7) default=0,5
V.15	Availability of safety measures for prevention of major accidents (technical / operational)	Typical technical preventive safety measures: - alarms, automatic shut down systems, improved design of equipment Typical operational preventive safety measures: - Periodic tests of alarms, programs of inspection of integrity of piping/equipment					
V.16	Availability of safety measures for mitigation of major accidents (technical / operational)	Typical technical mitigating safety measures: - Fire and gas detection systems, containment basins for tanks, fire water network Typical operational mitigating safety measures: - Trained emergency team, internal emergency plan	See also SCL mitigation				
V.17	Details on how the safety measures are controlled and monitored by the plant	Evidence of procedures and recorded documentation regarding: - Periodic tests of alarms; - Periodic inspection of piping / equipment; - Periodic training of emergency team	See also SCL SMS				
V.18	Details on declaration of compliance with relevant national regulations and relevant codes of practice of the safety instruments	Certification of correct installation (when applicable by national law) of: -Fire / gas detectors, -Fire water elements (sprinklers, hydrants, hoses, etc) -Electrical equipment					

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? **Yes = y** **No = n** **Partly yes = p** **Not applic. = 0**	**Impor-tance?** **Factor F (0,1<F<1) default=1**	**Portion of "partly yes"?** **Factor D (0,3<D<0,7) default=0,5**
Evaluation V							
∑Questions=	Summary				**∑y*F=** **∑n*F=** **∑p*F*D=** **∑not applic. = n_0**		

No	Reviewed Items	Explanation, Examples, Reference to Guideline	Reference to other CLs & Guidance	Litera-ture	Evaluation (see SSS) Remarks		
					Complete? **Yes = y** **No = n** **Partly yes = p** **Not applic. = 0**	**Impor-tance?** **Factor F (0,1<F<1) default=1**	**Portion of "partly yes"?** **Factor D (0,3<D<0,7) default=0,5**
VI	**2.3.6 SCL Limitation of Consequences and Mitigation**						
VI.1	Description of the equipment installed in the plant to limit the consequences of major accidents		See SCL Risk Assessment				
VI.2	Organization of alert and intervention		See Guideline for internal emergency plan (TUVBB)	[25]			
VI.3	Description of resources, Organisational provisions, internal or external						
VI.4	Description of resources, Technical provisions, internal or external						
Evaluation VI							
∑Questions=	Summary				**∑y*F=** **∑n*F=** **∑p*F*D=** **∑not applic. = n_0**		

2.4 MASTER CHECKLIST (MCL)

No	Reviewed Items	Explanation	Summary Evaluation	
			Index I of SCL	Remarks
I	SCL DESCRIPTION OF THE SITE AND ENVIRONMENT	Use result of evaluation of SCL I		
II	SCL DANGEROUS SUBSTANCES	Use result of evaluation of SCL II		
III.1	SCL MAIN ACTIVITIES AND PRODUCTS FOR SINGLE INSTALLATION….1	Use result of evaluation of SCL III for installation / activity 1, 2…….m		
III.2	SCL MAIN ACTIVITIES AND PRODUCTS FOR SINGLE INSTALLATION….2			
III.m	SCL MAIN ACTIVITIES AND PRODUCTS FOR SINGLE INSTALLATION….m			
IV	SCL MAJOR ACCIDENT PREVENTION POLICY (MAPP) AND SAFETY MANAGEMENT SYSTEM (SMS)	Use result of evaluation of SCL IV		
V	SCL IDENTIFICATION AND ACCIDENTAL RISK ANALYSIS AND PREVENTION MEASURES	Use result of evaluation of SCL V		
VI	SCL LIMITATION OF CONSEQUENCES AND MITIGATION	Use result of evaluation of SCL VI		
Evaluation				
Summary Performance Index			**(∑ I) /5+m =**	

3 Content of the major accident prevention policy (MAPP)

The operator has to produce MAPP as a written document, which deals specifically with the overall objectives and general principles of his procedures for limiting the risk of hazardous incidents. The document should specifically include the following points:

- Formulation of a company policy, which states that the prevention of hazardous incidents and the limitation of the effects of hazardous incidents which, despite all efforts do occur is a high priority in the company objectives.
- Presentation of the basic approach to implement this objective, for example in the form of guidelines which are part of company policy.

Trust is one of the most important pre-conditions for an effective safety management system. Managers are therefore advised to draw up company policy and the accompanying guidelines in conjunction with staff. The employees' right of co-determination, which can be particularly valid in the case of working conditions regulations contained in the safety management system, must be respected. It is recommended that management signs the relevant documents. In addition to the company policies and any accompanying guidelines, MAPP must also state:

a) what risks of hazardous incidents are present in the establishment;
b) what provisions have been made for preventing these, or limiting their effects; and
c) in which way it is ensured that these measures are implemented properly.

The answers to a) and b) are supplied in other sections of the safety report, particularly in the installation-specific safety analysis. c) Refers to the presentation of the safety management system which is dealt with in section 4.

3.1 CORPORATE/COMPANY POLICIES AND GUIDELINES

The operator should commit in an appropriate manner[9] that the prevention of hazardous incidents and the limitation of their consequences are part of the primary company objectives and have priority in the event of such an incident. The corporate policy is the basis for the measures outlined below. In larger companies, it may be appropriate to complement the corporate policy, which is usually formulated in rather general terms, with guidelines that show predominantly the company's strategy for achieving certain protection goals.

The corporate policy should not only make clear what the company is trying to achieve externally, but above all focus on this towards his own staff. **Therefore it is recommended that staff, or staff representatives, are involved in the policy formulation process from the beginning, and that the policy's validity is confirmed by signatures of the company management.**

3.2 HAZARD POTENTIAL IN THE ESTABLISHMENT

The basis of all considerations is the identification of possible hazards. The regulations emphasise on major accidents (hazardous incidents). Basic details for the identification and evaluation of hazards are supplied in the notification procedure, which should be included as a copy. A reference on this document principally is possible as well.

In this section it should be clarified which hazards can originate in the establishment. To do this, the possible hazards should be specified and evaluated with regard to their relevance to safety.

The following factors in particular should be taken into consideration:

[9] Either by including details in the written document, by referring to the relevant documentation, or by including the documentation with the written document.

3.2.1 Geographical location

Here, particular attention should be given to any neighbouring residential areas, areas of particular sensitivity or interest and to factors specific to the location (earthquakes, floods, etc).

3.2.2 Substances

A **complete list** of the dangerous substances and/or the relevant categories, specifying the quantity and physical form of each substance, is part of the notification procedure. In this notification, the operator should name and describe the substances and their properties which are particularly relevant for the target of preventing major accidents. In addition to information on the quantity involved and the methods of handling, of particular importance are physical properties, technical data regarding safety, reactions properties, information on their effects, and possible threshold limit or assessment values.

3.2.3 Type of process or activity

The main activities in the establishment already form part of the notification. In this document the operator has to describe which installations or parts of those installations and which activities are important under the point of view of major accidents. The following points are important when assessing the hazard potential and can be taken into account:

- The technical purpose of the establishments/installations including basic operations (physical or chemical transformations, interim storage of educts and products, handling of waste materials and waste gases).
- Characteristic process parameters of establishments/installations (pressure, temperature, physical conditions, reaction or kinetic parameters such as data on exothermic reaction enthalpies, autocatalysis, decomposition reactions, etc.) and their assignment to significant substance hold ups and mass flows. The Operators attention is drawn to the guidelines entitled “Recognising and controlling exothermic reactions”.[10]
- The size, layout, type, construction and design of the establishment, for example storage facilities or processing plants, which can be operated continuously or as batch processes. Another important aspect is whether the individual facilities are located in buildings, surrounded by enclosures or are open-air plants.
- Hazardous substances and their maximum quantities in each of the establishments/installations.
- Identification of the establishments/installations which are significant to safety, such as distillation columns, stirred reactors, furnaces, storage tanks, driers, pumps and pipes.

3.3 TECHNICAL AND ORGANISATIONAL MEASURES TO PREVENT OR LIMIT THE CONSEQUENCES OF MAJOR ACCIDENTS

In this section, the operator should explain the basic measures proposed to reduce and control the hazard potential described in the previous section, and to limit the consequences of a hazardous incident. These measures can be of technical and/or organisational nature.

Reference should also be made, if applicable, to other relevant documents, such as licences, permits. It is, however, strongly recommended that the operator makes clear in this section, which priorities are set in applying the safety policy[11] to meet the general obligations of the regulations, namely the prevention of hazardous incidents and the limitation of their consequences.

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[10] TAA-GS-05 produced by the Technical Committee for Plant Safety (*Technischer Ausschuss für Anlagensicherheit*) for evaluating the safety-related aspects of exothermic reactions. www.kas-bmu.de

[11] For example: “single failure principle”, physical distance between the hazardous area and protected goods, inerting

The following factors may be important when determining and presenting technical safety-related measures:

- Safety-related construction and design characteristics of installation components, such as the material used (e.g. steel, glass or graphite), as well as location and overall design of these components.
- Safety-related maintenance at the establishment/installation.
- State-of-the-art of safety technology, regulations, standards, guidelines, etc. which must be observed.

Measures to prevent, and limit the effects of events which could cause major accidents, may include:

- process control systems to prevent excessive pressure or temperatures;
- safe containment of hazardous substances;
- safety valves;
- measures to avoid explosive atmospheres (e.g. inertisation);
- measures to avoid sources of ignition (for example, using electrical installations according to qualified, i.e. standardised, categories of explosion protection, grounding);
- fire prevention measures;
- defensive and constructional fire protection measures;
- equipment of constructional explosion protection, such as rupture disks, explosion flaps and explosion suppression systems;
- rapid closure devices;
- spillage-collection facilities;
- sprinkler systems;
- gas detectors; and
- water/steam curtains.

The structure of the organisational measures is based on the principles for a Safety Management System (SMS), detail see chapter 4 of this guideline.

In general, the technical and organisational measures of the operator have to provide the premises of meeting all legal requirements (laws, ordinances, accident prevention regulations, permits and legal conditions). This particularly includes measures which guarantee that the operator’s documentation is in line with the current situation.

In contrast to the description as required in the SR does not require the operator to provide a detailed description of a safety management system. However, he should clearly describe the fundamental elements of his safety organisation. This is resulting in significant differences between the requirements for larger and smaller companies. The simpler an establishment’s organisational structure, the less information needs to be included in the document.

4 The safety management system (SMS)

A safety management system (SMS) is a set of activities that ensures that hazards are effectively identified, understood and minimised to a tolerable level.

In this sense, it may be regarded as the transposition of the general goals identified in the Major Accident Prevention Policy (MAPP) into specific objectives and procedures.

As safety reports address major accidents deriving from hazardous substances the safety management system is a subset of the overall management system.

In practice a SMS consists of a compilation of written principles, plans, formal organisation charts, responsibility descriptions, procedural recommendations, instructions, data sets etc. This does not mean that all of these documents do not have to be available in case of inspections but with respect to the safety report, most of them have the character of „underlying documents". Therefore for the purpose of a safety report, the description of the SMS is of a summarising character and should address the following subsets. It shall at least consist of:

- the major accident prevention policy (MAPP);
- an explanation of the relationship of the MAPP to the site-specific aims and safety-related objectives; and
- explanations in generic terms concerning how these objectives are met, especially with respect to consistency between the approaches followed and the measures taken.

The main relevance of the SMS is the setting of objectives for the concept of understanding the risk associated with the presence of dangerous substances and the selection of "lines of defence" – the risk analysis in a broad sense. This leads to the image 7 as shown below, where the MAPP is embedded in the overall management system of a company or site. The MAPP sets the general goals for the SMS, the latter serving as basis for the risk/hazard analysis (as far as it concerns major accident hazards).

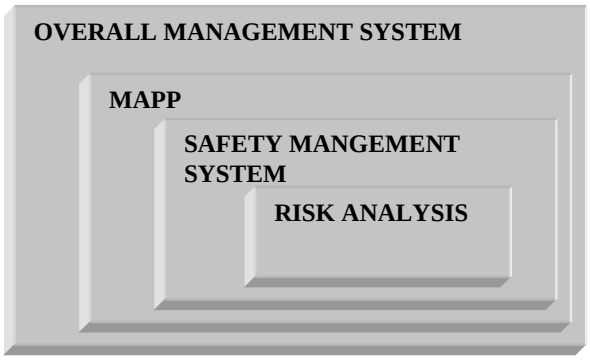

Image 7: Relationship of the different parts of safety documentation

4.1 FUNDAMENTAL PRINCIPLES

The safety management system (SMS) is part of the implementation of the major accident prevention policy (MAPP).

With a view to a holistic management system it is useful to link the SMS to other existing or planned management systems in the company. If a holistic management system is already in place, the SMS should be integrated into it.

This allows the operator to take company specific factors into account, for example, the SMS can be integrated into existing managements systems which comply with e.g. ASCA-based systems, ISO 9000 ff, ISO 14001, EMAS, or can be built onto these, or can make use of other existing management structures. When implementing an installation specific SMS, certain factors can be necessary in order to ensure that implementation takes place throughout the whole establishment. For integration of all management systems see also [20].

The safety report must demonstrate in a way that can be verified that the SMS at least complies with the requirements and procedures given below. Obviously, the SMS also has to meet all the conditions necessary to fulfil all the legal requirements (laws, ordinances, accident prevention regulations, licences and legal conditions).

4.2 ORGANISATION AND STAFF

4.2.1 Establishing the principal responsibility of the operator

The operator, i.e. the management, is responsible for devising the SMS and for ensuring it is adhered to. Responsibility can be delegated where appropriate, and if fully documented, particularly in the area of respecting and fulfilling legal requirements and company regulations. However, delegating responsibility does not release the management from a regular monitoring and up-dating of the SMS.

If the company management comprises several people, a decision must be reached on who carries this responsibility. **This does not affect the management's overall responsibility.**

4.2.2 Structural organisation

The structural organisation of the SMS must be detailed, providing a clear assignation of tasks, functions and competences at the different levels of the company. Organisation charts and job descriptions are particularly suitable for this task.

At all levels of the company hierarchy, staff must know what exactly they are responsible for and what rules apply to the "interfaces" with the areas of responsibility of others. This means defining tasks, areas of responsibility (where necessary with local delimitation), and liability within the organisation, with particular attention given to safety and how to deal with the risk of hazardous incidents. When transferring such responsibilities, it is necessary to verify that the tasks can in fact be accomplished with the transferred authorisation.

Particular tasks which must be covered by the SMS are:

- respect of the legal requirements, including conditions arising from licences, authorisations and permits;
- respect of internal safety, procedural and working instructions;
- ensuring management instructions become establishment practice (e.g. safety principles);
- selection of suitable staff for the job;
- staff training and regular safety-awareness training, involving third party companies and their subcontractors in establishments;
- monitoring behaviour of both internal and contracting staff, to ensure that they are being safe;
- immediate notification of any disruptions or identified hazards in their area of responsibility to the respective superior or any other person/body that may be responsible;
- regular reports to the responsible superior regarding disruptions and hazardous incidents;
- any lack of safety which has been identified in the installation or in the organisation, and the measures planned or already implemented to resolve this; and
- organisation and maintenance of the SMS.

The relevant regulations should include line organisation and the organisation of safety officers, and should also go into detail about how they are to cooperate.

4.2.3 Establishment organisation

Details must be given of the principle used in the SMS to deal with establishment processes in order to comply with the regulations (particularly establishment processes which cover more than one function or department). This covers establishment processes throughout the SMS, so detailed descriptions are not necessary in this section. However, the document must demonstrate that important establishment processes which are directly linked to the structural organisation are dealt with, in particular the question of delegating responsibility, which includes the constant availability of checking which function has been assigned to which management personnel.

4.2.4 Committees

Where committees are set up as part of the SMS, it is necessary to describe their composition and responsibilities, and also to address the issue of how they cooperate with one another and with other committees when necessary.

4.2.5 Qualifications and training

The document should explain how the needs of the various groups for training, specific qualifications (particularly in the case of staff who have a role in plant safety, such as the safety officers), and further training are met within the framework of SMS; what routine procedures have been introduced; the focus of these routines; what is done to ensure that staff attend training, and what record is made of their attendance. Where third parties and subcontractors are used, it is necessary to explain how the contracting staffs are included in the system of training.

4.2.6 Involvement of staff and where appropriate of third parties and subcontractors

Staff and their representatives should be involved in planning and implementing the SMS. The documentation must show in what way staff knowledge has been used in each part of the SMS, and how staff are involved in defining and introducing technical and administrative safety measures (in order to increase the effectiveness and acceptance of these measures). In addition, details are to be given of how to include staff suggestions and advice on safety-related matters.

Where co-determination is affected, employee representatives are to be involved. To increase the efficiency of the measures adopted, they should also be regularly included over and above the legally-required minimum.

The document must explain how the SMS provides for information on risks arising from certain sections of the establishment and safety measures to be passed on to temporarily employed staff, to outside companies and subcontractors if these are used. Procedures must be established which deal with coordination between external and internal staff (for example, release procedures and keeping records), and also with the areas of responsibility and work supervision. It must also explain how subcontractors can put forward suggestions and advise the operator on safety related matters.

4.3 IDENTIFYING AND ASSESSING THE RISK OF HAZARDOUS INCIDENTS

The SMS must ensure that the potential for hazardous incidents is identified and that the probability and severity of these incidents is assessed. Suitable systematic methods should be used to achieve this. All sections of the establishment, and where appropriate external sources of potential hazards, are to be taken into account. **Appropriate measures should be taken on the basis of the risk assessment.** The safety examination for identifying and assessing risks should take place for all relevant planning and establishment stages of sections of the establishment, particularly installations. In doing this, both the establishment

as defined by the normal operation and disruptions are to be considered. **The SMS provides the more detailed definitions on which the identification and assessment of risks of major accidents are based.**

If existing installations already have a system for safety evaluation and analysis, these can be used as a substantial part of the systematic identification and assessment of risks.

The company in question should establish in the SMS the general approach to complying with these obligations. The following points could be particularly significant when doing so:
- At what juncture or what times are procedures to identify and assess the risk of major accidents to be carried out?
- What methods will be used in each case and what will be examined?
- How are the results dealt with basically?

Examples of systematic methods for identifying potential risks are:
- PAAG or HAZOP procedures.
- "What if " procedures.
- Checklists.

Systematic procedures for evaluating incident probability include, among others:
- Matrices (e.g., Zurich, Bützer).
- Indexing (e.g., Dow, MOND).
- Z-factor methods.
- Cause-consequence analysis.
- Analysis of course of events.
- Fault-tree analysis.
- Risk graphs as per German Industry Standards (DIN)19250.
- Metric method.
- In which way is up-dating of the methods ensured?
- Who carries out the examination?

It is advisable to always have a team carrying out the examination. There should be fixed requirements regarding the knowledge and skills of people employed to do this.
- How can staff be involved?
- How can findings and information from relevant breakdowns and hazardous incidents within the plant and at other plants be used in the examination?
- Where does information from audits and other monitoring come in?
- How are the results to be written updated?
- How are the results dealt with basically?

Particular attention should be given to:
- action to be taken as a result of the findings;
- responsibility for implementation;
- follow-up;
- informing staff, and where appropriate other operators and the authorities about the results;
- measures to be taken in the area of training; and
- overall use/application of the findings.

4.4 ESTABLISHMENTAL CONTROL (MONITORING THE OPERATOR)

4.4.1 General remarks

The SMS must ensure that for all safety-related procedures:
- there are written work and operating instructions;
- staff are informed in writing or orally in an appropriate way;
- the work and operating instructions are exercised in practice where necessary; and

- are monitored, to see whether they are reasonable and viable, and whether they are obeyed.

The inclusion of temporarily employed staff, outside companies and subcontractors should be taken into consideration when drawing up work and operating instructions. When drawing up this section of the SMS, it is important to remember that work and operating instructions are required under a number of other national regulations.

4.4.2 Work and operating instructions

Work and operating instructions can be related to the workplace, the activity, or the substances handled. According to context and validity, they should resolve the following issues in particular:

- competence and responsibility;
- start of the installation or facility;
- normal operation of installations, facilities and work materials;
- handling of hazardous substances and preparations;
- recognising disruptions, procedure for establishing the cause and both methods and responsibility for resolving the disruptions (return to normal operation);
- fixed-term or special operating circumstances;
- operation during maintenance and cleaning;
- close down of the installations and facilities under normal conditions;
- procedures for installation stoppages; and
- procedure in the event of operational disruptions and in emergencies, including emergency stoppages, first aid procedures and appropriate disposal of wastes.

Where there are extensive procedures and protection measures, it has always been worthwhile to expand work and operating instructions with checklists or step-by-step lists (where this is not provided for by a process control system).

The SMS has to ensure that work and operating instructions:

- address all the relevant findings from the “Identification and assessment of the risk of hazardous incidents;
- are amended or renewed each time processes, establishments or working arrangements are modified, or when pertinent legal requirements are altered;
- even without this kind of external necessity, are regularly reviewed and updated, making use of operating experience;
- all the necessary information for the safe operation of the installation and facilities are available to staff in comprehensible form and language; and
- are available at all times to all staff who are directly or indirectly affected, and contain regulations for shift handovers in accordance with the legal requirements.

4.4.3 Training

The SMS should ensure that not only there is regular training on the content of the operating and working instructions, but special instructions are provided:

- before new or modified installations, facilities or work materials begin to operate;
- before new or transferred staff take up related functions;
- before processes, establishments or working arrangements are modified;
- before different substances or operating media are used;
- before major disconnections, closures or other activities which are particularly hazardous;
- after incidents involving accidents, damage or emissions;
- when legal requirements have an effect on establishment processes; and
- in the event of any other changes which have to be made to the operating and work instructions, for whatever reason.

In addition to specific instruction, further training activities can be useful, and even necessary.

4.5 SAFE IMPLEMENTATION OF MODIFICATIONS

This section of the SMS includes both modifications in the strict sense of the term (planned, or necessary at short notice because of special circumstances), and the planning of new installations within the establishment. To cover the full establishment life of an installation, a procedure or a storage plant, this should consider construction and commissioning (as the meeting point between planning and establishment), maintenance and also closure and dismantling.

The SMS should resolve the following points in particular:

- The competences/responsibilities and procedure for the safe implementation of modifications in the broader sense of the term, as defined above, are to be established in writing.
- Defining which modifications have an impact on safety. For this purpose an evaluation procedure has to be defined. In doing this, it is advisable to consider all of the modifications in the context of the SMS at first, but to make the effort needed to prepare, approve and implement the modifications dependant on the relevance to safety. For example, a list of modifications could be drawn up, based on operating experience, which the manager, foreman or even the shift leader could authorise themselves.
- Ensuring that modifications during the operating period remain within the limits of the relevant permits, or that appropriate notice of modification or authorisation is given in time.
- Tracking the legal requirements and legislation as well as the state of the art with regard to potential consequences for the planning, establishment or decommissioning of installations, processes or storage facilities. Establishing areas of competence and communication channels.
- Establishing how the findings from the identification and assessment of the risk of hazardous incidents, of near misses and of unsafe circumstances can be taken into account when making new plans, modifications and decommissioning.
- Considering the possible consequences of modifications for general systems, such as pipeline systems for raw materials, energy supplies, disposal facilities and other infrastructural establishments and emergency organisations.
- Ensuring that when the establishment is constructed and taken in operation, the implementation conforms to the plans.
- Establishing safety measures and controls for implementing the modifications and for test runs.
- Providing information and training for staff, and where necessary, for external staff concerned or staff from adjoining installations.
- Documenting the modifications, including revising the operating documentation and any documentation available to the authorities.
- Monitoring possible consequences of the modifications and implementing corrective measures in the event of unforeseen harmful consequences for working conditions and environmental protection.
- Monitoring decommissioned installations until they are disassembled, including retaining expert knowledge regarding the installation and the substances present.
- Proper disposing of the remaining contents of the installation, of any objects created during the disassembly, and of the disassembled installation components.

4.6 EMERGENCY PLANS

4.6.1 General remarks

Internal emergency plans are to be produced in line with the requirements set out in the regulations. The information required for external emergency plans is to be provided to the competent authorities.

Staffs are to be involved in drawing up the internal emergency plans. The public must be involved when devising external emergency plans.

4.6.2 Implementing the emergency plans

This section of the SMS contains a description of the procedure for identifying foreseeable emergencies, and for drawing up, testing and reviewing the internal emergency plans (alert and disaster control plans), and for the identification and passing on of information required from the operator for drawing up external emergency plans.

The SMS should determine the following, in particular:

- The procedure for **identifying foreseeable emergencies, based on a systematic analysis (scenarios)**. This must ensure that all installations and storage facilities are systematically examined for potential technical, organisational or human failures which could cause an emergency situation.
- The group of people who will carry out this analysis. **Teamwork is recommended.** In the event of insufficient internal expertise, outside resources have to be brought in.
- The different competences for carrying out the analysis, and for devising, testing and reviewing the resultant emergency plans.
- The procedure for devising internal emergency plans.

The following issues must be resolved:

- Areas of responsibility, including the procedure for handing over these responsibilities from one person to another.
- Participants (a team is recommended for this as well; staff must be included).
- Documentation.
- Updating documentation.
- Informing and training staff and other workers, and the internal hazard prevention organisations.
- **Providing information to the external hazard prevention organisations and, where appropriate, those inhabitants who are affected.**
- Identifying the safety equipment, resources, communication links needed by staff and by the crisis committee, if there is one.

Testing the emergency plans particular attention should be given to establishing the following:

- Responsibilities for setting up a plan for drills, and for carrying out and evaluating drills.
- Establishing those groups to be involved in the drills, with particular consideration of the staff, external assistance organisations and agencies, hazard prevention organisations and where appropriate, the inhabitants.
- Reviewing the emergency plans.

In doing this, the following issues must be resolved:

- Responsibilities.
- Intervals at which routine review takes place.
- The criteria for an immediate review (for example, based on the experience of drills and real accidents, a change in requirements or resources for external hazard prevention organisations, assistance organisations and agencies, changes in the law).
- Identifying, working on and conveying the information required for drawing up external emergency plans (Planning data).

To do this, the following issues must be resolved:

- A decision regarding co-establishment with the authorities and external hazard prevention organisations by identifying the information needed.
- Responsibilities for identifying, compiling and communicating this information to the authorities.

- Responsibilities for keeping information up-to-date.
- Responsibilities for maintaining constant contact with the authorities regarding this matter.

4.7 QUALITY ASSURANCE (MONITORING THE EFFECTIVENESS OF THE SMS)

4.7.1 General remarks

Part of the SMS's role is to constantly monitor the efficiency of the policy, the SMS and the safety measures. The results of this monitoring are to be compared with the safety targets that had been set. In particular, this includes:

- An active monitoring of whether the plans and targets which had been set were achieved.
- Whether safety measures are implemented so as to be preventative, rather than only being taken after hazardous incidents or accidents.
- Precautions to be taken to record disruptions to normal operation that could endanger the public and the neighbouring area, or where the findings could help to improve establishment safety.
- For notifying the operator as appropriate, and for investigating these accidents (reactive monitoring).

4.7.2 Active monitoring

Active monitoring covers all elements of the SMS. This includes in particular examining the construction and establishment of safety-critical sections of the installation; constant monitoring of installation safety and regular maintenance under safety-technological aspects; taking the required safety precautions to avoid operating errors; preventing wrong action by providing appropriate operating and safety instructions, and by means of training; and also monitoring behaviour to ensure that it is safety compliant.

The examination, monitoring, maintenance and possible reparations are to be documented.

In existing systems for recording suggested improvements, comments on how to increase safety should be particularly encouraged. If appropriate, this kind of system should be introduced.

4.7.3 Reactive monitoring, Learning from Accidents

An effective system for reporting all accidents and other safety-related incidents, including "near misses" is to be provided, and should be initiated in accordance with standardised requirements. An investigation procedure is also necessary, which must be capable of identifying not only the direct causes, but also all the fundamental failures which led to the incident (root causes).

The SMS should contain precautions that give particular attention to disruptions in safety equipment (including establishment disruptions and organisational errors).

These must be investigated and analysed in an appropriate manner, and lead to measures to ensure that the experience gained from the disruption will be used in the future (including making the information available to the staff responsible).

The findings from accidents, near misses, unsafe circumstances and unsafe behaviour should be systematically recorded, evaluated and made available for the purpose of sharing experiences. If appropriate, organisational procedures must be refined under the light of the new experience. Those modifications are to be reviewed. These experiences should not be used within the company only, but should be made available to others. Vice versa experiences from other companies or open sources e.g. accident data basis[12] should be

[12] See [28],[29]

collected regularly and evaluated for the own need. The operator has to establish who is responsible for initiating the investigations and for taking remedial action in the event of a failure to observe SMS principles. In particular, a revision of the instructions or of the system should be considered, if this can prevent a repetition of the incident.

It is necessary to ensure that relevant information gained through the monitoring activities is included as an important element of the audit and evaluation procedure (see below).

4.8 MONITORING AND ANALYSIS (AUDIT AND REVIEW)

4.8.1 General Remarks

In addition to the monitoring detailed in section 4.7, the operator should undertake regular reviews (audits) of his policy and his safety management system. The results of the review are to be evaluated. The policy and the safety management system are to be optimised on the basis of this evaluation.

4.8.2 Audits

The audit aims to ensure that organisation, processes and procedures – regarding their definitions and their actual implementation – are in line with the major-accident prevention policy and the SMS, and also with both external and internal requirements. The audit's results should be used to determine what improvements should be made to the individual sections of the SMS and to their implementation.

In principle, it must be possible for independent third parties to carry out the SMS audit.

4.8.3 Audit plan

The operator should draw up and use an audit plan. This plan should be reviewed at appropriate intervals, and should contain the following:

- Details of the areas and activities to be audited.
- The frequency of the audit for each of the areas in question.
- Who is responsible for each audit.
- Details of resources and staff that are required for each audit, providing for the necessary expertise, independence and technical support (see below).
- The audit protocols to be used (what questionnaires, checklists, open and/or structured interviews, measurements and observations can be included).
- The procedure for reporting the findings of the audit.
- The follow-up procedure (using the audit to improve the SMS).
- Who is responsible for maintaining the audit system?

4.8.4 Requirements to be met by the auditors and their activities

The auditors and their activities are required to comply with adopted national or international standards, e.g. German Industry Standard (DIN) EN ISO 8402 and DIN ISO 10011 sections 1-3 are to be applied as appropriate:

- Unbiased execution of duties.
- Examination of whether safety-related legal requirements are being observed.
- Collection and analysis of sufficient relevant evidence to be able to come to a conclusion regarding the system being audited.
- Attention is to be paid to indications suggesting a factor which may influence the audit findings and which may make further reviews necessary.
- Interviews are to be held with staff from various levels in the company hierarchy and with various functions, to review the implementation of the SMS and the appropriateness of the major-accident prevention policy, paying particular attention to the staff from areas of particular significance when evaluating the SMS, such as worker representatives and company representatives.

The following conditions must be respected when carrying out the audit:

- Adequate documentation and other information must be available for evaluating the effectiveness of the SMS.
- Adequate examination of the system.
- Adequate staff training.
- Adequate participation by the staff/works council.

4.8.5 Review

The review is to be understood as an essential investigation by the company management, in which the major-accident prevention policy and all aspects of the SMS are to be reviewed at appropriate intervals in order to ensure that they are in agreement. The findings of the monitoring) and of the audit are to be specifically included. This review should provide information to determine whether the policy or the objectives themselves need to be modified. It should also resolve the issue of allocating resources for implementing the SMS and should take into account changes in terms of company organisation, technology, standards and legislation.
In particular the SMS should establish:

- areas of responsibility within the management;
- deadlines;
- documentation, including the distribution of the report; and
- action to be taken.

It is advised to carry out the review, the evaluation and the decision whether to continue with the policy and SMS at management level, and to document it.

5 Presentation of the environment of the establishment

5.1 DESCRIPTION OF THE SITE AND ITS ENVIRONMENT[13]

5.1.1 General

The safety report should contain an adequate description of the establishment to enable the authorities to have a clear picture of its purpose, location, activities, hazards, services and technical equipment. The extent of this description should be commensurate to the hazards of the establishments. The description should also aim at clarifying the interrelationship between the different installations and systems within the establishment, with respect to their technical parameters and management aspects.

An introductory section should contain general information on the establishment, i.e.:

- Purpose of the establishment.
- Main activities and production.
- History and development of the activities, including the status of authorisations for operations already agreed and/or granted.
- Number of persons working at the establishments (i.e. internal and contractors' personnel, specifying working times, possibility of visitors, etc.).
- General statements characterising the establishment with respect to its main hazards as regards relevant substances and processes.

5.1.2 Location

The description of the location of the establishment should contain data on topography and accessibility to the site at a degree of detail commensurate with the extent of the hazards and the vulnerability of the surroundings. The description of the natural environment and the surroundings of the establishment should be detailed to an extent proportionate to the hazard. It should demonstrate that the natural environment and surrounding activities have been sufficiently analyzed by the operator to identify both the hazards that they pose to safe operation and the vulnerability of the area to the impact of major accidents.

The topographic maps submitted should be of an adequate scale and should include the establishment as well as all development in the surrounding area within the impact range of the accidents identified. (The scale of the maps must be indicated; different scale maps may be necessary when long distance effects are foreseeable).

On such maps the land-use pattern (i.e., industry, agriculture, urban settlements, environmentally sensitive locations, etc.), the location of the most important buildings, infrastructure elements (i.e., hospitals, schools, other industrial sites, motorway and railway networks, stations and marshalling yards, airports, harbours, etc.) and access routes to and from the establishment must be indicated.

The land-use pattern of the area surrounding the establishment may be presented according to the specification of the official land-use plan of the greater area.

In more detail, relevant information in this respect should be supplied on:

- inhabited (residential) areas (e.g., description of the areas including population densities);
- establishments frequented by the general public, meeting points (regular or occasional), and recreation areas (e.g. swimming beaches, outdoor life areas etc.);

13 With regards to the use of maps, it depends on the individual case if multiple information is given in the same document; in principle it is a matter of the required level of detail but it is probably unwise to use large scale maps (e.g. such for land use patterns) to contain information on installation details.

- sensitive public buildings (schools, hospitals, etc.)
- conservation areas or similar, ecologically vulnerable or sensitive areas (e.g. used for reproduction of specific species);
- public utilities possibly affected (electricity, gas, telephone, water, sewers and treatment plants, groundwater supplies, etc.).
- industrial activities external to the establishment (i.e., relative distance, nature of their activity, limitations they may impose in terms of access in emergency cases or infrastructure etc.); and
- traffic routes and major transportation centres (i.e., roads, railways, waterways, ports, airports, marshalling yards, etc.).

As the natural environment of an establishment may present potential hazard sources and may influence the development and consequences of an accident, data will be needed for the description of these relevant environmental factors. In general, this type of data includes:

Meteorological data, such as:
- average and maximum levels of precipitation (rain, snow, hail);
- thunderstorm severity;
- lightning probability;
- indices or values on humidity, fog, frost;
- winds (values for direction, speed);
- stability classes; and
- maximum and minimum recorded temperatures.

Geological, hydrological and hydrographical site data such as:
- general geological context;
- type and conditions of the ground/underground;
- seismic data; and
- flooding (including run-off water due to flash flooding) and landslide likelihood.

And *other site specific natural factors* such as:
- surface and ground water location values;
- water quality and uses;
- shore and marine environment data; and
- areas of special environmental interest, i.e., natural protected areas, protected fauna and flora species, sensitive ecosystems, areas of outstanding natural beauty, etc.

5.1.3 Lay out of the establishment

The lay-out of the establishment as a whole and of its relevant installations should be clearly presented on adequately scaled plans. Relevant diagrams and/or images of particular sections or equipment should be presented in an appropriately larger scale.

The lay-out should adequately identify installations and other activities of the establishment including:
- main storage facilities;
- process installations;
- location of relevant substances and their quantities;
- relevant equipment (including vessels and pipes);
- spacing of the installations and their main sections;
- utilities, services and internal infrastructure equipment;
- location of key abatement systems;
- location of occupied buildings (with an indication of the numbers of persons likely to be present); and
- other units if relevant for the safety report conclusions.

5.2 IDENTIFICATION OF INSTALLATIONS AND OTHER ACTIVITIES OF THE ESTABLISHMENT WHICH COULD PRESENT A MAJOR ACCIDENT HAZARD

The installations of an establishment to be submitted to risk analysis have to be selected through a screening method. The selection follows the threshold criteria for hazardous substances as given e.g. in German Guideline KAS-1[14] or other suitable methods. The SMS should provide the necessary objectives and approach basics.

Those installations which have not been selected through this preliminary analysis will not be considered as an essential element of the safety report. For this reason, this part of the analysis is particularly sensitive in terms of the following outcome of the safety report study.

The result of this screening process should be indicated in a separate form in the safety report, e. g. a list of the installations and activities of concern or a specific indication in the respective maps.

5.3 DESCRIPTION OF THE INSTALLATION

5.3.1 Hazardous installations and activities and processes

Sufficient information should be provided in the safety report to permit the competent authority to assess the adequacy of the controls in place or foreseen in the hazardous installations identified through the screening process. Reference can be made to other, more detailed documents available to the authority on request and/or on-site (the „underlying documents" already mentioned in the section about the SMS).

The safety report does not need to contain detailed information on structural characteristics and other design data of the storage or process installation handling the dangerous substances but only summarising descriptions, covering certain relevant topics, such as:

- choice of materials important to safety;
- foundations;
- design of equipment under high pressure or temperature and their supports;
- size;
- stability (static calculations, conditions and load-bearing capacity of the ground); and
- design against external events.

Where equipment is built to a specific standard, this standard should be named, together with its date and an indication of the validity for the intended purpose made where this is not evident.

The descriptive part of the safety report with respect to the safety relevant sections of the establishment (the identified hazardous installations) should mainly provide an outline description of the procedures for safe operation in all process stages, which includes:

- measures for operations (e.g., normal running, shut-down and start-up, exceptional operations, emergency and safety procedures); and
- specific precautions during storage, transport or handling because of specific characteristic of the substance (e.g., protection from vibration or from ambient humidity).

5.3.1.1 Identification

A preliminary analysis should identify the safety relevant sections of the establishment. These sections (installations) are usually characterized by the quantity and the intrinsic

[14] KAS-1 "Richtwerte für sicherheitsrelevante Anlagenteile (SRA) und sicherheitrelevante Teile eines Betriebsbereiches (SRB), www.kas-bmu.de

properties of dangerous substances and/or the processes involved and hence constitute the parts of the establishment requiring more detailed hazard analysis. The analysis can be accomplished using a variety of hazard screening methods.

The safety report should in this respect contain a detailed description of the safety relevant sections and of the systems and components that are important for safety. The description should allow easy identification of:

- those parts of the process or installation containing dangerous substances and their location;
- those parts of the establishment involving hazardous processes;
- elements serving safety relevant functions, i.e., prevention, control and mitigation measures;
- elements capable of initiating a major accident; and
- inter relationship between different installations/parts of installations.

5.3.1.2 Description

The description of hazardous activities (processes/storage) and equipment parts shall indicate the purpose and the basic features of the related operations within the establishment which are important to safety and may be sources of major risks. This should cover:

- basic operations;
- chemical reactions, physical and biological conversions and transformations;
- on-site interim storage;
- other storage related activities i.e. loading-unloading, transport including pipe work, etc.;
- discharge, retention, re-use and recycling or disposal of residues and wastes including discharge and treatment of waste gases; and
- other process stages, especially treatment and processing operations.

5.3.2 Dangerous Substances

The safety report should give information on types and quantities of dangerous substances to which the Convention or the Directive applies at the establishment. The substances can fall into any of the following categories:

- raw materials;
- intermediate products;
- finished products;
- by-products, wastes and auxiliary products; or
- products formed as a result of loss of control of chemical processes.

For the eligible dangerous substances, data to be provided should include:

- *Type and origin of the substance* (i.e. CAS Number, IUPAC Name, GHS classification, commercial name, empirical formula, chemical composition, degree of purity if relevant, the most important contamination, etc.).
- *Physical and chemical properties* (i.e. characteristic temperatures and pressures, concentration and phases at normal and at the onset of abnormal conditions, equilibrium data and operation curves if relevant, thermodynamic and transport properties, data on phase changes, flash points, ignition temperatures, combustibility of solids, spontaneous- ignition temperatures, explosion limits, thermal stability data, data on reactions and their rates, decomposition etc.).
- *Toxicological, flammability and explosive characteristics* (i.e. toxicity, persistence, irritant effects, long-term effects, synergistic effects, warning symptoms, effects to the environment, ecotoxic data, etc.).
- *Substance characteristics under loss of control of process or storage conditions* (e. g. information on possible transformation into new substances with other properties of toxicity, degradability etc.).
- *Others* (e.g. corrosion characteristics in particular relating to the containment. material).

The latter two only when relevant for the safety report conclusions or specifically addressed there.

Some information may be found in safety data-sheets (including maximum permissible working concentrations, reference to guidelines for health at the work place, methods and means to detect their presence in the workplace and/or in the case of loss of containment, etc.). Data on accidental release threshold levels may be taken from literature, national recommendations or dedicated studies.

The selection of the appropriate category of substances according to Annex 1 of the Convention or the SEVESO II is sometimes not easy and should be addressed in the SR.

The estimation of the quantity of substances present in the installation has to be shown in the SR, including the application of the summation rule if required.

5.4 IDENTIFICATION AND ACCIDENTAL RISKS ANALYSIS AND PREVENTION METHODS

5.4.1 Introduction

The main elements in any risk analysis process are as follows:

- hazard identification;
- accident scenario selection;
- scenarios' likelihood assessment;
- scenarios' consequence assessment;
- risk ranking; and
- reliability and availability of safety systems.

Hazard identification

With regard to the hazard identification, a range of tools exists for systematic assessments, which are selected depending on the complexity of the individual case. Furthermore the level of detail required **depends on the intended use of the accident scenario.**
Essential parts of the hazard identification are indications on the identification methods used, the scope of the analysis and related constraints. The identification of hazards is followed by designation of reference accidence scenarios which form the basis for determining whether the safety measures in place or foreseen are appropriate.

Accident scenario selection

Major accident scenarios may serve different purposes, for example:

- to demonstrate that, in practice, a particular scenario no longer presents a major-accident hazard due to the measures in place;
- to demonstrate that the extent of the effects of a particular scenario have been limited due to the protective measures in place;
- to demonstrate the efficiency and the effectiveness of mitigation measures put in place;
- to establish whether the activity should be considered as unacceptable; or
- to establish whether further mitigating measures, which are specifically relevant within the safety report's scope, are necessary.

Scenarios' likelihood assessment

For the scenarios' likelihood and consequence assessment, which are essential steps in the risk analysis process, quite different approaches can be followed. These assessments make use of methodologies that are generally subdivided into different categories, in particular:

- qualitative - quantitative

- deterministic - probabilistic

Qualitative/Quantitative:

The likelihood of occurrence and the consequences of a major accident scenario could be assessed either:

- in qualitative terms using ranges, for example highly likely to extremely unlikely for likelihood, and very severe to negligible for consequences; or
- in (semi) quantitative terms by providing numerical figures (e.g. occurrence per year, number of fatalities per year).

In general, the choice of either a qualitative or quantitative approach is strongly influenced by the specific safety culture philosophy within each individual country. Moreover, it is based on the level of detailed information and data available and the level of rigour and confidence required for regulatory acceptance. The depth and type of risk assessment is likely to be proportionate to the nature of the major accident hazards presented by the site, the extent of the possible damage, the complexity of the process and activities and the difficulty in deciding and justifying the adequacy of the risk control measures adopted.

The nature of the simpler qualitative approach is that it can act as an indicator of risk but does not constitute its numerical characterisation. A detailed quantitative analysis requires correct and reliable data which are often not available. In this circumstance, the adoption of a phased approach could be a reasonable strategy. Such an approach usually starts with a qualitative assessment at a system/installation level which is then used as the initial screening process. Once this assessment has been performed, the results could be analysed to decide whether or not a more thorough quantitative analysis would be necessary.

For consequence assessment, normal practice suggests that, certain quantitative considerations are virtually indispensable (e.g., threshold limits, isorisk curves etc.), especially in the case of high risk/consequence scenarios. This often is necessary for activities related to emergency planning and land-use planning.

Deterministic/Probabilistic:

In the *deterministic* approach the safety assessment assumes that a scenario has been selected and all necessary facts about the scenario are known. The uncertainty associated with the likelihood of the occurrence is implicitly considered in the scenario selection process.

The deterministic approach is associated with consequence-based decision criteria and it is often related to the use of *qualitative* terms.

The *probabilistic* approach is associated with a numerical account for the likelihood and consequences of possible accident sequences in an integrated fashion (“risk-based” methodology).

The methodologies currently in use do not always fall under one of these two general categories, but might belong to a combination of the two. For instance, for some methodologies, a deterministic approach can be used for the selection of significant scenarios (“worst case” approach) whilst a probabilistic approach could be used for the assessment of safety measures’ efficiency and for the definition of a risk reduction strategy. Especially some considerations concerning rare initiating events (e.g. intentional attacks) or specific forms of consequence (e.g. environmental) may be subject to qualitative description only.

A proposed identification of qualitative description a possible (semi) quantitative classification is given by frequency classification from F.P. Lees “Loss prevention in the process industries.[15]”

Please note that those classifications are a common convention by the scientific community only. **The value classification should be settled by national regulation.**

EVENT CLASSIFICATION	FREQUENCY (EV/YEAR)
Probable	$> 10^{-1}$
Fairly Probable	$10^{-2} \div 10^{-1}$
Somewhat Unlikely	$10^{-3} \div 10^{-2}$
Quite Unlikely	$10^{-4} \div 10^{-3}$
Unlikely	$10^{-5} \div 10^{-4}$
Very Unlikely	$10^{-6} \div 10^{-5}$
Extremely Unlikely	$< 10^{-6}$

Table: Qualitative / quantitative probability relation, see [39]

5.4.2 Description of major-accident scenarios

The safety report shall demonstrate the adequateness of the measures taken by the systematic identification of possible major-accident scenarios and their initiating events (causes). The scenarios are normally based on the assumption of loss of the safe containment (LOC). However, not all scenarios are necessarily of the LOC – type, e. g. self-decomposition, and the subsequent start of fire or explosion may also be of relevance in such cases.

A structured approach to scenario selection is a crucial step in the overall analysis. The safety report should, therefore, outline the principles and procedures followed (see SMS) to determine the scenarios. In doing so, events which are documented in accident databases, near-miss recording, safety alerts and similar literature must be reviewed when drawing up the list of scenarios and appropriate lessons learnt incorporated (historical accident analysis).

A major-accident scenario for the purposes of the safety report usually describes the form of the loss of containment specified by its technical type e.g.:

- vessel rupture;
- pipe rupture; or
- vessel leak etc.

And the triggered event, namely:

- fire;
- explosion; or
- release of hazardous substance(s).

The “bow –tie” diagram (image 8) can be used to describe major-accident scenarios to include underlying causes:

[15] [39]

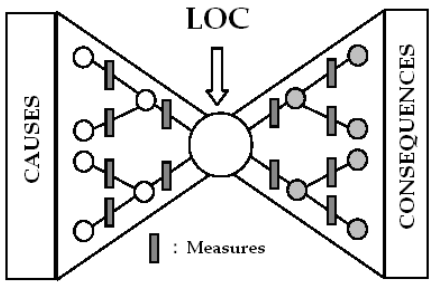

Image 8: Bow tie diagram

The centre of the diagram is the loss of containment event ('top event'). The bow-tie left depicts the overall possible causes, which could lead to the occurrence of the top event. The vertical bars refer to the measures that are put in place to prevent the release of dangerous substances by including also measures to control escalation factors. The bow-tie right side describes the development of possible outcomes resulting from the top event. The vertical bars in the bow-tie right side refer to the measures to prevent/mitigate that the top event could not cause harm too the men, the environment and the installations.

The following non-exhaustive list provides the most relevant event types that describe the consequences of the top event development (outcome):

- pool fire;
- flash fire;
- tank fire;
- jet fire;
- VCE (vapour cloud explosion);
- toxic cloud ;
- BLEVE (boiling liquid expanding vapour explosion); or
- soil/air/water pollution.

A point to note is that these events may occur in:

- process units;
- storage units;
- pipe work;
- loading/unloading facilities; or
- on-site transport of hazardous substances.

The hazardous substances may be present under various physical conditions (temperature, pressure, aggregate form). The safety report must demonstrate that, of these possible scenario elements, the relevant scenarios were chosen. The selection may follow strategies such as:

- event likelihood;
- consequences; and
- how comprehensive or representative the scenario is.

5.4.3 Initiating causes

For some types of scenarios it is necessary to consider the ***causes*** of the potential accident, like:

5.4.3.1 Operational causes

Operational causes are determined according to the methodology chosen, at least the following should be considered:

- physical and chemical process parameters limits;

- hazards during specific operation modes (i.e., start up/shut down);
- failure of containment;
- malfunctions and technical failures of equipment and systems;
- knock-on effects from other equipment;
- faults of utilities supply;
- human factors involving operation, testing and maintenance;
- chemical incompatibility and contamination; and
- ignition sources (electrostatic charge, etc.).

5.4.3.2 Internal causes

Internal causes may be related to fires, explosions or releases of dangerous substances at installations within the establishment which the safety report covers and affecting other installations leading to a disruption of normal operation. (e.g. the fracture of a water pipe in a cooling tower, thus leading to a disruption in the cooling capacity on site).

5.4.3.3 External causes

External causes to be considered are mainly:

- impact of accidents (fire, explosions, toxic release) in neighbouring establishments (Domino effects) and other third party activities and transportation networks;
- transportation of dangerous substances off site (i.e. roads, railways, pipelines, shipping, oil or gas ports, air, etc.);
- functional interdependence with the installations of neighbouring activities;
- pipelines or other common utilities;
- transport networks and centres (public roads, railway lines or airports close to the installation and/, or establishment; and
- natural hazard sources like precipitation (extreme) (rain, snow, hail), wind, thunderstorms, lightning, floods, landslide, seismic activity, etc. (Natural Hazard Triggering Technological Disasters - NATECH).

5.4.3.4 Plant security

The effect of possible intentional acts that could affect plant safety should also be taken in the proper consideration. In a first screening step the possibility of intentional act are assessed. If this gives a positive result a full security analysis may be carried out. For screening and security analysis see e.g. German Guideline on Combating Interference by Unauthorised Persons[16]

5.4.3.5 Other accident causes

Other accident causes may be related to design, construction and safety management; these causes may concern also plant life cycle management, commissioning, decommissioning, equipment or process modifications, work permit system, maintenance, etc.

5.4.4 The conditions under which accidents occur

The 'top event' and the related causes constitute what is often called the "fault tree" or left-hand side of the "bow –tie" (see image 8). In the image 9 below this is shown in a schematic form:

[16] SFK-GS-38 Combating Interference by Unauthorised Persons, www.kas-bmu.de

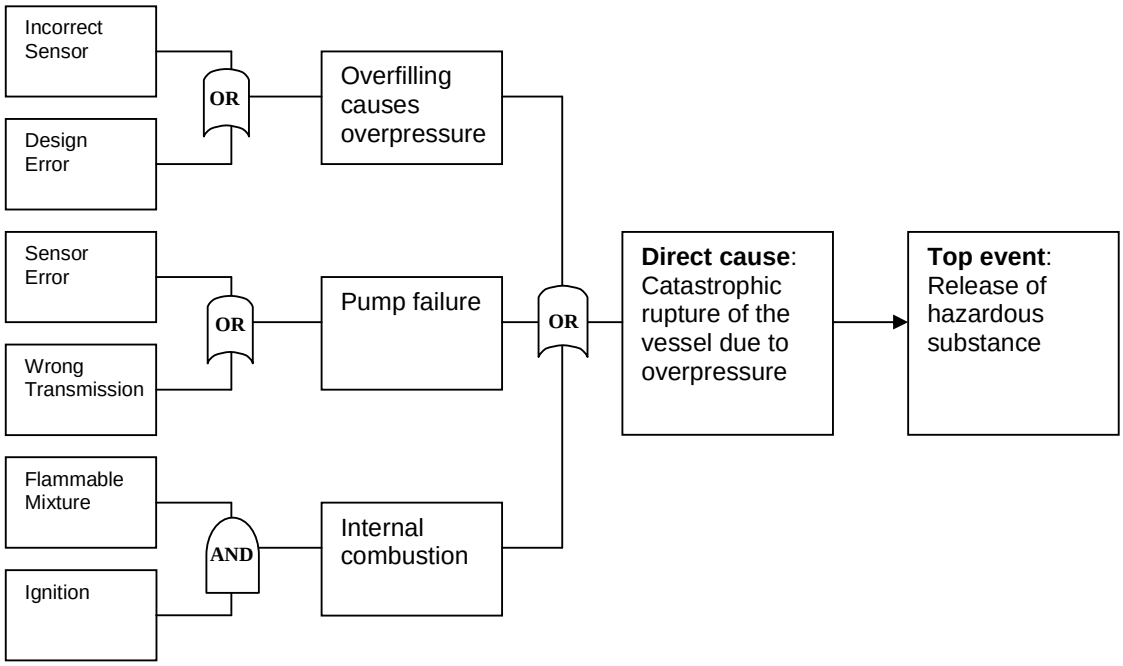

Image 9: Example of fault tree

The example shows a hypothetical “unrestricted” event. To decide on the scenario likelihood usually the efficiency of technical measures and human intervention (‘measures’) is taken into account.

An overall typology of measures could distinguish between those being (functioning) permanent, independent of the state of the process (all passive measures are permanent), and those being activated by the state of the process. The latter measures can either disable actions (interlock systems, preventing certain actions from being performed, e.g. safe operating envelopes for processes) or initiate one or more actions (e.g. opening of a relief valve or emergency shut down).

Activated measures always require a sequence of detection – diagnosis – action. Using hardware, software and human action as building blocks alone or in combination can perform this sequence.

A more detailed classification can be specified as follows:

- **Passive hardware measures** (no actuation mechanism required to fulfil its safety function; e.g., a retention bund round a tank, enclosure designed for total containment or with elevated stack); passive hardware measures have a relatively high level of availability.
- **Active hardware measures** require external source of energy to fulfil the safety function but operating without human intervention, e.g. automatic shutdowns, emergency cooling systems.
- **Passive behavioural measures** behaviour consisting of staying away from defined areas, refraining from touching or modifying parts of the plant, and this behaviour alone constitutes the measure without any hardware being involved e.g. safety distances, exclusion areas, no smoking area.
- **Active behavioural measures** behaviour consists of acting in defined ways whilst interacting with the dangerous part of the plant, and this behaviour alone constitutes the measure without any hardware being involved, e.g. evacuation in case of toxic or fire alarm, safe working methods when handling chemicals.

The following image 10 shows the schematic role of measures in the fault tree:

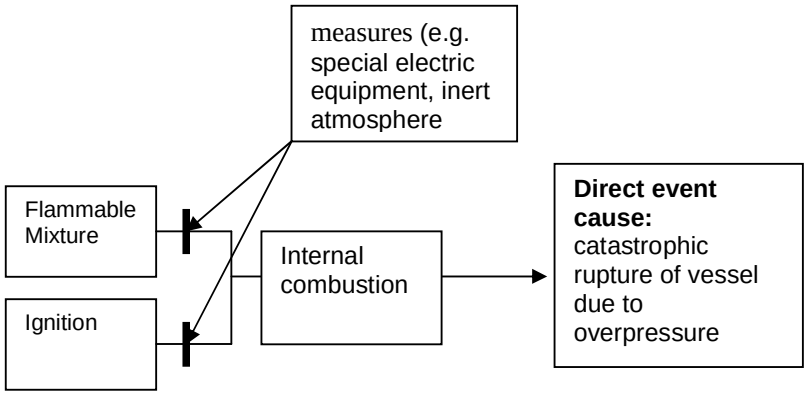

Image 10: Schematic role of measures in the fault tree

There is no common approach concerning which type of measures should be taken into account for the selection of scenarios and passive measures are almost always considered to be effective. In principle, active hardware or mixed measures may be taken into account as well, when demonstration is made through the safety report of good effectiveness and reliability. The decision may also relate to a legal framework that mandates the presence of certain measures. Human intervention (=behavioural measures) as the only means of protection usually is not given credit in this respect.

5.4.5 Assessment of the extent and severity of the consequences of identified major accidents

The assessment of accident consequences to people and the environment is essential in several steps of the overall risk assessment process and the safety report should summarise and document the conclusions of this assessment step.

Within a safety report, the consequence assessment will be used for two different types of decision processes:

1. Consequence assessment constitutes an indispensable part of the systematic risk assessment aimed at the identification and establishment of technical/organisational safeguards to prevent major-accident hazards and to mitigate accident consequences, or to evaluate the efficiency and adequacy of the protective measures taken.
2. Consequence assessment also describes the outcomes of specific accident scenarios selected in order to provide information especially for external emergency planning and land use planning around establishments. The results of this assessment should be presented in the form of “maps, images and descriptions”.

For the first type of process, the assessment may be carried out in a qualitative way only and without any calculation (in the strict sense, not in the meaning of “estimation”) of effects. Such an approach is often adopted for assessing the adequacy of existing or proposed measures or safeguards; for this type of approach only in exceptional situations (e.g. if the measure is very expensive) would a more comprehensive consequence assessment be considered.

If the consequence assessment has the character of a more complete calculation it requires a procedure that is some form of detailed modelling. In general, modelling the consequences of major accidents is based on several inputs such as for instance:

- the physical and hazardous properties of the substances in question (flammability, toxicology, etc.);

- emission potential (thermal radiation, overpressure);
- release characteristics (amount, phases, conditions etc.); and
- weather conditions.

The foundation of modelling of this type is again a specific set of reference scenarios. In this case it is the right side of the “bow-tie” that serves as the starting point. For this assessment measures to limit the consequences (= mitigation measures) are taken into account (and mitigation measures may also be identified as a result of the assessment).

The following image 11 shows this part of the bow-tie, usually called the “event tree”:

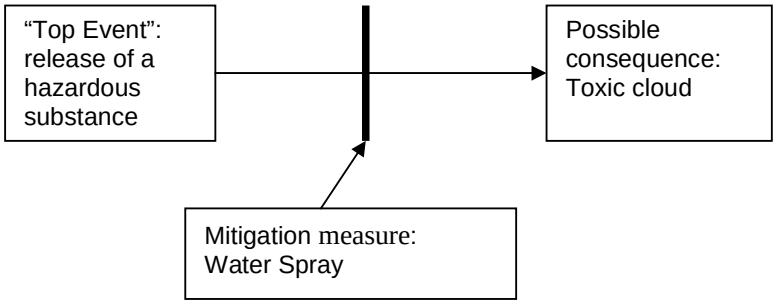

Image 11: Event Tree

Results of this modelling exercise are expressed in terms of severity of (potential) impact. For safety reports, potential impact is commonly defined in terms of human health, although relative property or environmental damage may also be presented.

Two main approaches are used to measure severity of impact:

1. The damage probit curve
2. Fixed damage thresholds

The probit curve approach considers the impact on a vulnerable receptor (e.g. a human being) over time and relates this impact to a probability that certain damage (physiological or material) will occur, given a specific level and time of exposure. In contrast, the fixed threshold approach links specific impacts, such as the onset of death or serious injury, to specific level and time of exposure. The thresholds are usually established, using probabilistic methods, as levels at which or above which particular effects are expected to occur. Threshold levels for accidental airborne releases of toxic substances, static or dynamic thermal radiation, and overpressure have been calculated by various expert groups.

An overview is given in e.g. German report SFK-GS-28.[17] Their settlement is a matter of convention in every particular community.

For the purpose of safety report scenarios the following endpoints may be used:

Hazard	Endpoint value
Toxic load	ERPG - 2
Heat radiation	3 KW/m^2
Explosion pressure	0,1 bar

[17] SFK-GS-28 Toxicological Data for scenario Endpoints , www.kas-bmu.de

5.4.6 Description of technical parameters and equipment used for the safety of installations

In connection with the risk assessment the technical parameters, the equipment used for safety and their fitness for purpose need to be justified. This activity is usually performed together with the identification of scenarios and the initiating events.

The safety report should discuss general criteria assumed (i.e. best available technology, good engineering practice, qualitative or quantitative risk criteria), should give the reason why a method of presentation has been selected over and above other possible options, and in particular should describe:

- the criteria used to decide the degree of *redundancy, diversity* and *separation* required for the prevention, control and mitigation measures;
- the reliability of components and systems and the efficiency of organizational measures;
- the functional calculations needed to confirm the capability of the measures to cope with the design-basis accidents (design criteria and load assumptions according to the relevant good engineering practice; time and order in which the measures become effective in relation to the process/accident evolution and the man-machine interface etc.);
- feedback from measures to the system as a whole; and
- declaration of compliance with relevant national regulations and relevant codes of practice.

Prevention, control and mitigation measures of a hazardous installation may include:

- process control system including back ups;
- fire and explosion protection systems;
- devices for limiting the size of accidental releases, e.g. scrubbing systems, water spray;
- vapour screens, emergency catch pots or collection vessels, and emergency shut-of valves;
- alarm systems including gas detection;
- automatic shut down systems;
- inerting systems;
- fail-safe instrumentation;
- emergency venting including explosion panels;
- fast shut-down and other emergency procedures; and
- special precautions against unauthorized actions related to the plant security.

Further details may be required of the safety relevant sections in accordance with the actual risk assessment. This description should thus include a substantial amount of data significant from the process engineering and technical safety standpoint; and cover the safety systems as well. This may include:

- flow charts and Piping and Instrumentation (P&I) diagrams[18];
- flow patterns and machinery/equipment needed in the processes; inventories and key dimensions of the containers and pipes shall be available if relevant;
- process conditions, i.e., pressure, temperature, concentration (their safe operation ranges) and any relevant thermodynamic and transport properties at the successive steps of the process such as:
    - normal and maximum flows, consumption of reactants, production of intermediate/end-by-products (e.g. overall and substance mass balances);
    - average or typical quantities normally or accidentally possible to be present, stored or in process;
    - formation conditions of by-products and unplanned accident products;

18 Please give regard to the generic character of this term; there are various levels of information provided by P&I-diagrams of which not all may be suitable for safety report purposes

    - conditioning of the final products;
- instrumentation, control/alarm and other safety systems;
- relevant qualitative and quantitative information on energy and mass transport in the processes, i.e., material and energy balances:
    - in normal running;
    - in start-up or shut-down periods;
    - during abnormal operations;
- characteristic process conditions and substance state parameters (i.e., temperature/pressure / concentration/boil-off fluctuation etc.).

5.5 MEASURES OF PROTECTION AND INTERVENTION TO LIMIT THE CONSEQUENCES OF AN ACCIDENT

The safety report should also clearly include information which identifies any key mitigation measures resulting from the analysis that are necessary to limit the consequences of major accidents, namely:

- description of the equipment installed in the plant to limit the consequences of major accidents;
- organisation of alert and intervention;
- description of resources that can be mobilised, internal or external;
- summary of elements described above necessary for drawing up the internal emergency plan; and
- it is very important that there is a clear link between the consequences of scenarios identified and the measures of protection and intervention to limit the consequences of an accident.

5.5.1 Description of equipment

A description of equipment installed in the plant to limit the consequences of major accidents should be provided. This list should include an adequate description of the circumstances under which the equipment is intended for use.

5.5.2 Organisation of alert and intervention

The organisation for alert and intervention should be adequately described. This description should include:

- organisation, responsibilities, and procedures for emergency response;
- training and information for personnel and emergency response crews;
- activation of warnings and alarms for site personnel, external authorities, neighbouring installations, and where necessary for the public;
- identification of installations which need protection or rescue interventions;
- identification of rescue & escape routes, emergency refuges, sheltered buildings, and control centres;
- provision for shut-off of processes, utilities and plants with the potential to aggravate the consequences.

5.5.3 Description of resources that can be mobilised

The report should contain an adequate description of all relevant resources which will need to be mobilised in the event of a major accident. This report should include:

- activation of external emergency response and co-ordination with internal response;
- mutual aid agreements with neighbouring operators and mobilisation of external resources;
- resources available on-site or by agreement (i.e., technical, organizational, informational, first aid, specialized medical services, etc.).

5.5.4 Summary of elements for the internal emergency plan

The report should include a summary of elements described above that are necessary for the preparation of the internal emergency plan to deal with major accidents, or for foreseeable conditions or events that could be significant in bringing about a major accident. It may be useful to include or refer to the internal emergency plan which has been drawn up to comply with the regulations.

6. Literature

Please note that internet addresses can change over time.

No	Title	Content	Language	Source
[1]	Guidance on the Preparation of a Safety Report to meet the Requirements of Directive 96/82/EC as amended by Directive 2003/105/EC (Seveso II)	Safety reports	English	http://mahbsrv.jrc.it/downloads-pdf/guidance-amended-by-2003-105-EC.pdf
[2]	GUIDANCE ON INSPECTIONS AS REQUIRED BY ARTICLE 18 OF THE COUNCIL DIRECTIVE 96/82/EC (SEVESO II)	Inspections of SEVESO establishments	English	http://mahbsrv.jrc.it/downloads-pdf/inspecf.pdf
[3]	GENERAL GUIDELINES FOR CONTENT OF INFORMATION TO THE PUBLIC DIRECTIVE 82/501/EEC - ANNEX VII	Information of the public	English	http://mahbsrv.jrc.it/downloads-pdf/EN-info.pdf
[4]	Guidelines on a Major Accident Prevention Policy and Safety Management System, as Required by Council Directive 96/82/EC (Seveso II)	MAPP, SMS	English	http://mahbsrv.jrc.it/GuidanceDocs-SafetyManagementSystems.html
[5]	OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response, 2003		English	http://www.oecd.org/document/61/0,3343,en_2649_34369_2789821_1_1_1_1,00.html
[6]	A Checklist for Inherently Safer Chemical Reaction Process Design and Operation	Inherent safety	English	http://www.aiche.org/uploadedFiles/CCPS/Publications/SafetyAlerts/CCPSAlertChecklist.pdf
[7]	CCPS Guidelines on Process Safety Management - Auditing Process Safety Management Systems - Implementing Process Safety Management Systems - Process Safety Documentation - Contractor and Client Relations to Assure Process Safety - Integrating Process Safety Management,	diverse	English	http://www.aiche.org/ccps/webknowledge/PSM.aspx

No	Title	Content	Language	Source
	Environment, Safety, Health and Quality - Process Safety in Batch Reaction Systems - Process Safety in Outsourced Manufacturing Operations Investigating Chemical Process Incidents			
[8]	Quantification of real risk, A element of a UNDP/GEF Danube regional project "Activities for Accident Prevention - Pilot Project -Refineries" (RER/03/G31/A/1G/31), September 2006 Checklists for Refineries - Part 1: Safety management system - Part 2: Requirements on the structure and equipment of production plants	Refineries checklists	English	http://www.icpdr.org/icpdr-files/14141
[9]	ENFORCEMENT OF SEVESO II: AN ANALYSIS OF COMPLIANCE DRIVERS AND BARRIERS IN FIVE INDUSTRIAL SECTORS	Different sectors	English	http://139.191.1.51/typo3/index.php?id=78
[10]	Necessary Measures for Preventing Major Accidents at Petroleum Storage Depots	Petroleum storage		
[11]	IMPROVING MAJOR HAZARD CONTROL AT PETROLEUM OIL REFINERIES	Refineries		
[12]	ILO Guidelines on OSH&E	Various topics	English	http://www.ilo.org/safework/normative/codes/lang--en/index.htm
[13]	ILO Workplace Fire Protection Checklist	Fire protection	English	http://www.ilo.org/public/english/protection/safework/hazardwk/fire/fir02.htm
[14]	R&D-Project “Technology transfer for plant-related water protection in Romania, Moldavia and the Ukraine”	16 Checklists for functional units in process plants	German	http://www.umweltbundesamt.de/anlagen/Checklistenmethode/html/functional_units1.html
[15]			English	http://home.arcor.de/platkowski/Raffinerie/Site/
[16]	Checklist Nr. 12, Basic structure of safety reports	SR	English	http://www.umweltbundesamt.de/anlagen/Checklistenmet

No	Title	Content	Language	Source
	concerning Hazards to water			hode/Check12_SafetyReport3.pdf
[17]	Checkliste zur Prüfung des Konzeptes zur Verhinderung von Störfällen	MAPP	German	internal
[18]	SFK-GS-23, Guideline issued by the SFK Management Systems Working Group to explain the major-accident prevention policy in accordance with Article 7 in conjunction with Annex III of the "Seveso II" Directive	SMS & MAPP		
[19]	SFK-GS-24, Guideline issued by the SFK Management Systems Working Group to outline a major- accident prevention policy and a safety management system pursuant to Article 9 (1) a and Annex III of the "Seveso II" Directive	MAPP	English	http://www.kas-bmu.de/publikationen/pub_gb.htm
[20]	SFK-GS-31, Aid for integration of a safety management system pursuant to Annex III of the Hazardous Incident Ordinance 2000 within existing management systems issued by the SFK Management Systems Working Group	SMS	English	
[21]	KAS-7, Bericht des Arbeitskreises Texas City Empfehlungen der KAS für eine Weiterentwicklung der Sicherheitskultur Lehren nach Texas City 2005	Safety culture	German	http://www.kas-bmu.de/publikationen/kas_pub.htm
[22]	Met technical Evaluation System (M.E.S.) Manual, April 2002 FEDERAL MINISTRY OF EMPLOYMENT AND LABOUR ADMINISTRATION OF LABOUR SAFETY TECHNICAL INSPECTORATE CHEMICAL RISKS, Belgium	SMS, MAPP	English	http://www.employment.belgium.be/WorkArea/showcontent.aspx?id=6642
[23]	SFK-GS-38 Leitfaden Maßnahmen gegen Eingriffe Unbefugter der ad hoc-Arbeitsgruppe Eingriffe Unbefugter	Security Analysis	German	

No	Title	Content	Language	Source
[24]	KAS-1"Richtwerte für sicherheitsrelevante Anlagenteile (SRA) und sicherheitsrelevante Teile eines Betriebsbereiches (SRB)"	Screening method	German	
[25]	Preparation of an Internal Emergency Plan- Instructions on Methods in accordance with Directive 96/82/EU (Seveso II Directive)	Internal emergency plan according to SEVESO II	English	TÜV Ostdeutschland Sicherheit und Umweltschutz GmbH Safety Analysis and Disaster Protection Division Müggelseedamm 109-111 D 12587 Berlin
[26]	LAND USE PLANNING GUIDELINES IN THE CONTEXT OF ARTICLE 12 OF THE SEVESO II DIRECTIVE 96/82/EC	LUP	English	http://mahbsrv.jrc.it/downloads-pdf/LUP%20Guidance-2006.pdf
[27]	HAZOP: Hazard and Operability Studies	Description of method	English	http://slp.icheme.org/hazops.html http://en.wikipedia.org/wiki/Hazard_and_operability_study
[28]	Major Accident Reporting System (MARS)	Accident data	English	http://mahbsrv.jrc.it/mars/default.html
[29]	ZEMA - Zentrale Melde- und Auswertestelle für Störfälle und Störungen in verfahrenstechnischen Anlagen	Accident data	german	http://www.umweltbundesamt.de/zema/
[30]	US Chemical Safety Board - CSB	Accident data	English	http://www.csb.gov/
[31]	IAEA Manual for the classification and prioritization of risks due to major accidents in process and related industries	Risk Assessment method	English	http://www-pub.iaea.org/MTCD/publications/PDF/te_727r1_web.pdf
[32]	Fault tree analysis	Description of method	English	http://en.wikipedia.org/wiki/Fault_tree_analysis
[33]	OREDA -Offshore Reliability Data	Data	English	http://www.oreda.com/
[34]	EPA CAMEO, Collection of free software components for Accident scenario modelling	Free Software	English	http://www.epa.gov/emergencies/content/cameo/cameo.htm
[35]	DEGADIS Dispersion model	Software	English	http://www.epa.gov/scram001/dispersion_alt.htm#degadis

No	Title	Content	Language	Source
[36]	WHO Rapid environment and health risk assessment (REHRA)	Simple Risk Assessment method	English	http://www.euro.who.int/watsan/CountryActivities/20030729_10
[37]	Event Tree Analysis	Description of method	English	http://www.fault-tree.net/papers/clemens-event-tree.pdf
[38]	"Water, Drinking Water, and Water Protection Substances hazardous to waters" Section of the Federal Environment Agency (Umweltbundesamt)	Classification system	English	http://www.umweltbundesamt.de/wgs-e/index.htm
[39]	Lees' Loss Prevention in the Process Industries, Volumes 1-3 (2nd Edition), Edited by: Mannan, Sam	Monography	English	http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=1470
[40]	"Green Book - Methods for determination possible damages to people" - TNO, 1992	Description of method	English	http://www.tno.nl/content.cfm?context=markten&content=product&laag1=186&laag2=151&item_id=445&Taal=2