Abstract of the expertise for the KAS (Commission on Plant Safety):

Demands of the process industry for human factors competences

Abstract of the expertise translated by Dr. Babette Fahlbruch and Dr. Günter Horn:
Ausarbeitung eines Gutachtens für eine Entscheidung über einen KAS Leitfaden „Kompetenzanforderungen im Bereich menschlicher Faktoren für die verfahrenstechnische Industrie“
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1 Summary

The present expertise is meant to support the decision making process of the commission on plant safety (KAS) regarding the composition of a guideline “recommendation for required competences of employees in the process industry, regulators and assessors regarding human factors to improve plant safety”. The expertise focuses on process industry.

In a first step the necessity of a KAS-handbook was examined based on an inquiry of relevant laws, orders, regulations and guidelines. Overall 98 documents were identified with at least one search term corresponding. Eleven documents were appropriate in content regarding the research topic. Content comparison between these documents and the recommendations of the OECD-workshop “Human Factors in Chemical Accidents and Incidents” /2/ showed no or rather little congruence between the requirements of the identified regulations and the recommendations of the OECD. Thus it becomes clear that the recommendations are not implemented sufficiently in laws, orders, regulations or guidelines. Moreover, the few requirements named explicitly are not described in a sufficiently precise manner. A detailed description of our approach is to be found in chapter 3 of this report.

Therefore, a strong need for a KAS-guideline concerning competence in human factors to improve plant safety can be derived. From our point of view the following reasons point out the necessity of a KAS-Handbook:

1. Results of the analysis

Our analysis showed that in the regulations requirements for competences regarding human factors are missing or formulated very generally, i.e. with one or two keywords, like “social competence” (chapter 3 and attachment A and B1). These general requirements have to be specified in content and scope in a way that they can be implemented.

Therefore, in the expertise a systematic composition was developed to show the necessary competences in human factors depending on the group of persons concerned and regarding educational objectives, learning topics and methods.

2. Accident avoidance

Several accidents in the process industry show, that they are caused at least partly by deficits in considering human factors. This is due to the fact that existing findings regarding the influence of human factors on safety were not taken into account sufficiently during planning and operation. Thus the training of competences will indirectly contribute decisively to accident prevention, stressing the requirement of a KAS guideline. For example: In 1998 two persons died in an explosion in the Australian Longford plant which caused the interruption of the Melbourne gas delivery for two weeks. Beside other contributing factors the accident investigation showed that operators in the control room routinely ignored alarms. This was due to the fact that the daily alarm rate was 300-400 alarms, during incidents even 8500 alarms per day – meaning 120 alarms per minute /10/.

This example shows that the knowledge and the implementation of ergonomic design criteria and the consideration of findings regarding the capacity of human to process information can help to detect shortcomings in the alarm system especially during incidents. Thus preventive actions could have been implemented.

The explosion and the resulting fire in a petrochemical plant can be used as second example. During operation a reaction vessel burst due to overpressure caused by a surplus of water influencing the reaction. One more explosion followed after the content of the reaction vessel caught fire. Six persons were injured, one of whom died later. The available gauge did not indicate the pressure inside the reaction vessel otherwise the operators would have discovered the necessity for counteractive measures /11/.

A critical review regarding ergonomic principles and their practical implementation would have helped to detect and to correct the lack of the display of pressure.

3. Comparison of industries

In aircraft industry trainings on human factors are required by law for all employees. The European Aviation Safety Agency (EASA) requires in order Nr. 2042/2003, attachment II, part-145.A.30 and the associated regulatory statutes (AMC), that employees involved in maintenance, administration or quality control must have knowledge concerning human factors and human performance in working processes. For

the concerned employees a two year refresher in human factors is mandatory. (see also attachement B2).

Furthermore, she demands controls that this knowledge really exists. Advanced trainings on human factors have to be done by the time of two years on the hole personal which is concerned with clearing or supporting processes (see attachment B2).

4. Systematization

For single professional categories as for example specialists on safety the requirements for competences in human factors are defined in training programs and are conveyed during training. According to our knowledge for all other professional categories no comparable mandatory requirements specified in training programs and on the job training (professional training) schedules exist.

In respective companies optional/voluntary training measures to specific aspects can be found. However an industry wide systematization comprising all businesses for the required competences in human factors is not available. Thus, a guideline would present a qualitative new approach.

Having constituted the requirement for a KAS guideline the relevant groups of concerned persons were identified in a second step. In the OECD-recommendations six groups, four major and two subgroups have been named /2/. For this expertise 56 groups were identified by interviews and analyses of job descriptions. According to their tasks and activities 25 major tasks were identified. With the help of a systematic comparison of the tasks the 56 groups could be categorized into four groups with similar fields of duties. This classification was done due to tasks comparisons, not according functions, positions or organisations. The argument for this procedure is the fact that specific competences are needed to fulfil certain tasks, meaning comparable tasks require similar competences. By competences all capabilities, skills, knowledge (know how) and experiences are understood that render a person capable to act and react.

Concerning the pragmatic requirements and to enhance the implementation the following steps aim to make the results as simple as possible without omitting any important aspects. Thus a technician, i.e. (also from a producer) was categorized into the management group since the tasks are comparable concerning the issue (see chapter 4.1). Executives are also allocated to the management group. Four groups have been identified in total: management, operators, internal inspectors and external inspecting agents. The description of the approach and the results of the study can be found in chapter 4. In the following table the groups of persons concerned and the allocation is displayed.

Table 1: Groups of Persons Concerned

Original Group of Persons Concerned	Resulting Group
Strategic Management:	Management
Chairman of Board, Board Members	
CEO, Head of Business Unit ,	
Head of Production/Production Manager	
Head of Plant Safety	
Head of Environment Protection	
Company Physician	
Plant/Unit:	
Plant Manager/Unit Manager	
Production Assistant	
Plant Engineer	
Plant Foreman	
Dayshift Worker	
Shifts:	
Shift Foreman	
Deputy Shift Foreman	
Supporting Plant Functions:	
Head of Plant Laboratory	
Maintenance	
Head of Technical Department	
Workshop Manager (Electric-, Mechanical)	
Head of Maintenance Team, (Ad Hoc Maintenance)	
Maintenance Planer	
Maintenance Foreman	
Maintenance Team Leader	
Engineering	
Project Manager	
Planning Specialist	
Detailed Engineering Specialist	
External Engineering Specialists (also from Producer)/ Engineering Company	
Research and Development (Operational R&D, field tests)	
Head of Research and Development (R&D)	
Laboratory Foreman	
Marketing/Sales (modified product spec., special products, short term changes in manufacturing specification)	
Purchasing (Raw Material Procurement)	

Original Group of Persons Concerned	Resulting Group
Shifts:	Operators
Control Room Personal	
Shift Workers (i.e. Outside Operator, Loading Specialist, Raw Material Specialist, etc.)	
Shift Electrician	
Supporting Plant Functions:	
Laboratory Specialists	
Loaders	
Logistics Personal (Production Planning)	
Maintenance:	
Documentation	
Mechanics	
Electricians	
Scaffolding Specialists	
Isolation Specialists	
R&D (field tests):	
R&D Workers	
Laboratory Workers	
Inspecting Departments (internal):	Internal Inspecting Employees
Environment Protection	
Plant Safety, Occupational Safety	
Safety Engineer (s. inspecting Departments)	
Hazardous incidents officer (s. Inspect. Dep.)	
Company Physician	
Emergency Management:	
Fire Department	
Plant Security	
Auditing / Regulatory Agencies (external):	External Auditing Personal
Federal Agencies:	
Consulting, Advising	
Committees (Technical Regulations)	
Sate and Communal Units (RP, Communes):	
Enforcement (Auditing)	
Supporting/ Consulting	
Experts (also external sources)	
Accident Prevention & Insurance Association:	
Technical Supervision	

Original Group of Persons Concerned	Resulting Group
Experts (Medical, Occupational Psychologists)	

After the groups had been identified the necessary fields of competences were determined. Based on 12 fields of competences stated in the OECD recommendations /2/ and a literature research 18 fields of competence were determined. These were concentrated into four main groups: “man /human”, “group”, “workplace” as well as “organization and management”. The description of the approach and the results are listed in chapter 4. The table below displays the correspondence:

Table 2: Allocation of the fields of competences

Original field of competence	Resulting fields
Human performance and limitations	Man /Human
Human error	
Individual performance influencing factor	
Motivation and Demotivation	
Risk perception / Recognition and Prevention of hazards	
Complex problem solving	
Self critical attitude, individual responsibility	
Physical environment	Work Place
Tasks	
Ergonometric	
Performance influencing factors at the work place	
Social psychology	Group
Communication	
Human Resource Management	Organisation and Management
Crisis Management (Emergency Management)	
Supervising, coaching and feed back	
Experience feed back and organisational learning (OL)	
Rewarding and sanctioning	

After having identified the groups of persons concerned and the field of competences the required levels of competences were determined. Two levels of knowledge resulted from this step basic knowledge and detailed knowledge. Depending on the tasks of the different groups the required competence level was determined. Table 3 shows the results of the definition of competence levels.

Table 3: Levels of Competences

Groups	Fields of Competence			
	Man	**Work Place**	**Group**	**Organisation and Management**
Management	B	B D (Tasks, Ergo-nometric)	B	B D (Supervising, Coaching, Feed Back)
Operators	B (Motivation) D	B	(N/A)	(N/A)
Intern Inspecting Departments	B (Motivation) D	D	B	B D (Experience Exchange, Super-vision)
External Agencies	B	B	B	(N/A)

Caption: G: Basic Knowledge, D: Detailed Knowledge, (N/A): no extra training requirement

Having determined the groups of persons concerned, the required fields of competences and levels of competences the learning targets, learning content, the methods and the criteria for evaluation were determined (chapter 5). As an example for the competence field “group” and the aspect “social psychology” the following learning objectives were defined to be relevant for the process industry:

- Knowledge of miscellaneous group mechanisms
- Understanding of structures and interrelations in organizations
- Knowledge about negative influences of groups

Following learning contents were derived from these targets:

- Team work
- Diffusion of responsibility and delegation of responsibility
- Group think, group pressure, in-group-out-group phenomenon, implicit norms
- Safety culture

Since basic knowledge demands the acquisition of theoretical and methodic aspects as well as pragmatic relevance as methods for knowledge transfer were recommended instruction, seminars and group exercises. For the evaluation of the training the following tools should be used: questionnaires to determine the reception, examinations to determine the learning success and interviews after 6 – 12 months to determine the achieved change

For the detailed knowledge - in comparison to the basic knowledge - additionally aspects were central to the training: knowledge of practical relevance and methods as well as the ability to implement and conduct them. Therefore, other methods should be used, as described in the following example: For the competence field “organization and management” and the aspect “experience feed back and organizational learning” according to detailed knowledge the objective identification of optimization potential” was identified. Following learning contents were derived:

Learning contents:

- Tools for analysis of incidents
- Conduction of event analysis
- From analysis to recommendation
- Knowledge management

The proposed methods are workshops, group exercises, self reflections, group feed back methods, case studies and simulations.

In chapter 5 a complete overview can be found in table 9 and 10, showing the learning objectives, learning contents, methods and evaluation criteria. Table 11 to 14 show the proposed learning contents for the group of persons concerned.

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