

Safety Culture Assessment - Methods and Indicators, Results of a German Research Project

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Abstract

The method for development of practical criteria for safety culture assessment - based on event orientated safety culture assessment - is a promising approach in the current situation. The event orientated assessment of the root causes of real events is based on the assumption that events in a nuclear power plant are indicators for deficiencies in safety culture.

1 Introduction

Safety culture as a dominant factor of nuclear power plant safety has become a high issue in Germany due the current state of international discussion and a number of plant events in German nuclear power plants (NPP) indicating safety culture impact. Different activities about safety culture in German NPP are on the way.

The Federal Ministry for Environment, Nature Conservation and Nuclear Safety has sponsored the project:

"Development of Practical Criteria for Safety Culture Assessment in German Nuclear Power Plants".

Main results of the research project are presented in this paper.

The work on this project commenced in November, 2001 and will be finished in spring 2004.

The primary objective of the project is to develop practical instruments for measuring the contribution of individuals and the organization to safety culture for the operation of NPP, by means of suitable yardsticks, evaluation criteria, and indicators. The results are aimed at making it possible to derive measures to advance and promote safety culture. What is desired is the development of a method which permits registering the safety culture of a plant in a manner that reflects plant operation.

The project is focused on the following topics:

- Evaluation of national and international approaches of safety culture assessment in the nuclear field as well as in other industries.
- Development of evaluation criteria for integrating and registering safety culture, trials and verification of the results in two nuclear power plants.

2 National and international approaches of safety culture assessment

International publications indicate comprehensive activities on safety culture but there are still differences in interpretation and definition. The definition given in /INSAG 4/ is mostly referred in publications.

Methods of evaluation, which are in use can be divided into two main groups:

- The approach mainly based on interviews with plant management and operators to get direct information about the plant safety culture, called "*direct assessment*".
- The approach that uses information derived from the plant operation (e.g. incidents and accidents), called "*indirect assessment*".

The question appears how we can identify good and weak safety management systems and how to learn from the good and improve the weak? What are the indicators and mechanisms before an accident will happen to make poor safety management transparent for the responsible (management and authority), e. g. what we can learn from the Piper Alpha and Tokai-Mura accidents /Piper Alpha/, / Tokai-Mura/.

A collaborative approach where safety is implicitly represented in open exchange of safety issues is the one that appears to make aviation safe.

2.1 Examples of direct assessment:

An example of this approach is the "Safety culture evaluation system - VGB-SBS" /VGB-SBS-01, -02/ which is created by the utilities. This system has been introduced in all German NPP and will be described here due to its main characteristics and state of application.

The core of the system comprises a comprehensive list of questions assigned to a set of 20 defined processes. The main issue of quantification is to gain indicators to see any development as positive or negative.

The system is focused on self-assessment by the utility. Its argument is to foster the plant internal process of safety culture, concerning an understanding about its meaning by the plant staff and how to work with this subject.

The role of the authority within this application process is under discussion in Germany. The aim is to find a balance between to be informed about the current state of application and results of safety culture assessment and the assurance of the confidence of the internal plant information process.

Further it is being discussed whether the authority should have its own instrument for assessing plant safety culture as it is introduced in an approach of HSK in Swiss /HSK/.

In the petrochemical industry safety management is a main issue to foster safety culture. In the framework of optimisation of plant processes "Risk-based inspection" (RBI) a tool of safety management assessment was developed by the American Petroleum Institute /API/ to support the risk based decision making process.

The API-Concept comprises two parts, a qualitative assessment of safety management factors by interviews to be compared with a set of industrial standard values and a quantitative part by integrating the numerical results (as weighting factor of risk) into the probabilistic safety assessment (PSA) of the petrochemical plant under consideration.

These approaches, which are based on interviews of plant managers and operators, we call the "direct assessment" of safety culture.

2.2 Example of indirect assessment:

An alternative way to get into the complex subject of safety culture is the root cause analysis of incidents and accidents focussing on organisational and management factors.

All known severe industrial accidents indicate a high impact of management and organisational factors caused by an eroding safety culture. /Reason/ as well as /Perrow/ indicates:

"Most we can learn about the impact of safety culture is from accidents".

The inquiring report of Piper Alpha Explosion /Piper Alpha/ describes the accident scenario by multiple technical as well as organisational deficiencies, which were unnoticed - in the pre-accident phase by safety management and inspectors.

Compared with other industrial accidents we can find typical pattern of accident causes, such as sets of latent failures rooted by design, quality as well as organisational and management deficiencies. The incidents and accidents make them visible.

Due to this subject we can find many promising applications of root cause analysis for identification and improving safety culture e. g. in the nuclear field as well as in other industries, especially the airplane industry. This approach we call the "indirect assessment" of plant safety culture.

There are different types of root cause analysis supporting tools available, such as

- „Safety through Organizational Learning“ /SOL/
- „Connectionism Assessment of Human Reliability“ /CAHR/
- "Event-based Safety Culture Assessment" /Balfanz 10-02, 12-02/ (see below).

3 Event-based Safety Culture Assessment

In the frame work of the research project "*Development of Practical Criteria for Safety Culture Assessment in German Nuclear Power Plants*" we have developed a method named "Event-based Safety Culture Assessment". It is based on the assumption that the root causes of incidents or occurrences in complex industries such as NPP give indications of deficiencies in safety culture.

For this method we have created a specific procedure of analysis and a coding system for identifying organisational and management deficiencies, taking into account the organisational and management characteristics of other approaches, such as /VGB-SBS/ and /API/.

The analysis of the basic causes of an event represents the core of this examination. It is aimed at identifying organisational and management factors concerning the failure causes. The so-called "cause complexes" are classified and quantified due to their frequencies. In association with the meaning of the assigned events, the valences of organisation and management factors are determinable with regard to possible weak points.

The approach is subdivided into the following steps (Figure. 1):

- Selection of events which should be investigated due to organisational and management factors, e. g. the set of safety significant events of a plant operational year.
- Collection and analysis of available and accessible data, by event reports.
- Interviews with plant experts for further details and background information about the events and for clarification of the underlying causes.
- Assessment and classification of the identified causes due the predefined cause complexes, which should give indications about the organisational and management impact.
- Expert rating about the relevance of events and the identified cause complexes.
- Summarising the type and frequencies of identified cause complexes which base on the set of events to be investigated and drawing the resulting frequency distributions (see examples below).
- Interpretation of the summary results such as indication of possible out layers (cluster of cause complexes) or trends and indications of organisational and management deficiencies / safety culture.

The comparison of results of different sets of evaluation (e. g. trend analysis from several years of observation or from different plants) makes the interpretation of result more rational.

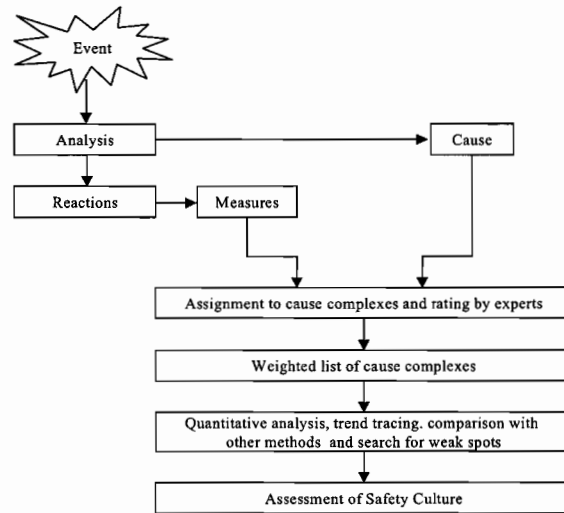


Figure 1: Event-orientated assessment of safety culture

3.1 Example Event Analysis

The example shows the event-orientated assessment of safety culture by a specific failure event:

Event description: During a reactor start-up after maintenance work, a failure in the turbine hydraulic control system caused an automatic turbine trip. The turbine protection system indicated this failure by a pressure difference at a hydraulic fluid filter.

Causes: The operators did not notice this pressure difference before the turbine was automatically tripped. The filter blocked due to normally increased oil pollution at restart of the unit. A check of the filter unit showed that one of the four filter cartridges was incorrectly installed by external staff. **Measure:** Replacing of the filter cartridge and check for function.

Precaution against repetition: Specified regular filter controls during start-up process.

Table 1: Expert rating of cause complexes

Identified Causes	Coding	Rating
Inadequate pressure indication	PE (d)	0,5
Known oil pollution at restart	OE (o)	0,1
Repeated occurrence	OE (o)	0,5
Quality control of external staff work	OF (m)	0,5
Incorrect operation procedure	PD (c)	0,5

PE(d): Plan/Ergonomic (design phase), OE(o): O&M/Experience (operation phase), OF(m): O&M/Foreign Personal (maintenance), PD(c): Plan/Specification (change)

The frequency distribution of cause complexes derived from a representative set of events of a NPP - as shown in Figure 2 - can be seen as reflection of the safety culture in the plant and as an indicator for improvement. Based on the distribution main subjects of emphasis as well as trend analyses can be carried out.

Processes in which causes for events lie within two years.

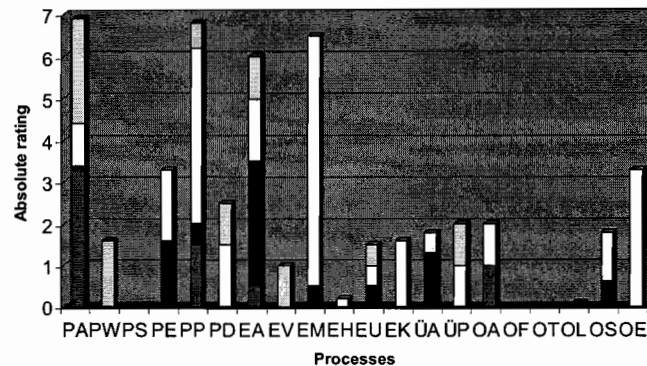


Figure 2: Frequency distribution of cause complexes derived from a representative set of events of a NPP (P: Plan, E: Do, Ü: Check, O: Organisation & Management)

The assessed frequencies and meaning of the events / causes reflect the characteristics of the risk assessment and give a qualitative picture of the risk relevance of organization and management impact of the events, which have actually happened.

4 Conclusions

Experiences on accidents have led to a new understanding about complex systems and created a new discipline "Safety culture".

In many cases only incidents and accidents of complex systems - such as NPP - reveal complex and hidden interrelationships between man- machine - organisation. In this paper we have described two alternative ways to get behind the complex issue of plant safety culture:

- The assessment by interviews with plant management and operators to get direct (subjective) information about the plant safety culture ("Safety Culture Evaluation System"), called "*direct-subjective assessment*".
- The assessment of plant operation by root cause analysis of real events ("Event-orientated Safety Culture Assessment"), called "*indirect-fact driven assessment*".

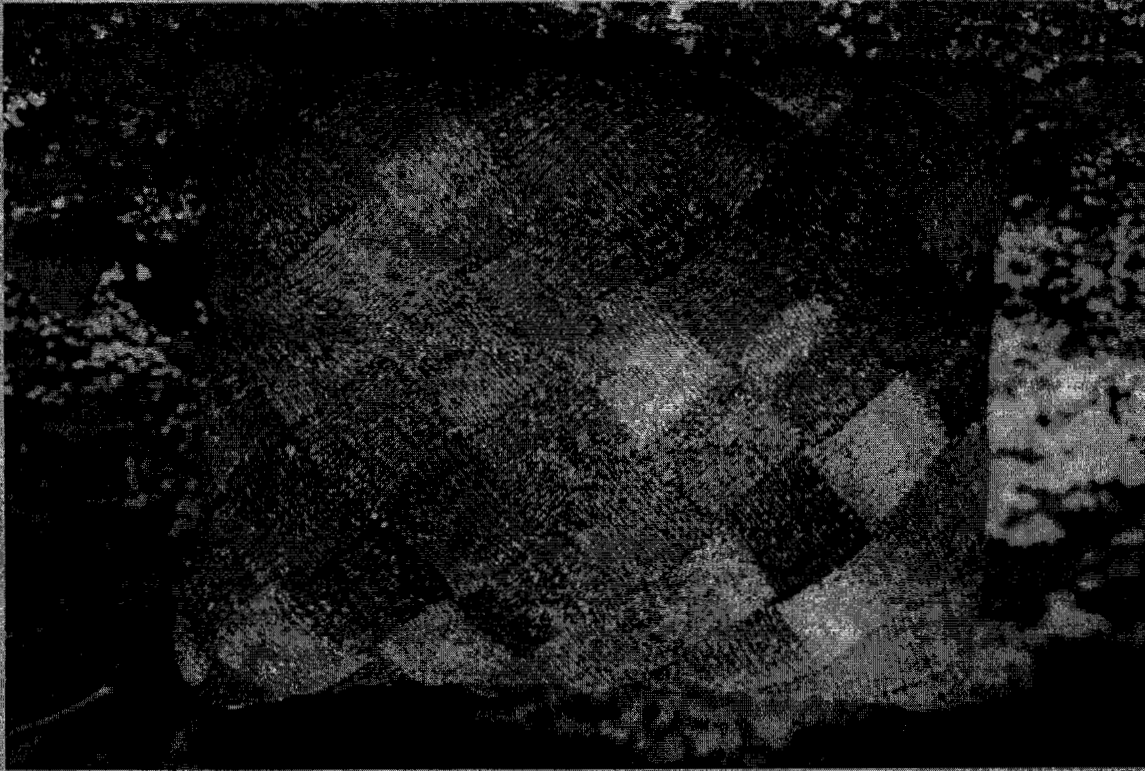
Both approaches are in principle different in the applied methods and are accompanied with high uncertainties but of different types.

By this nature both approaches can complement each other and will give us a more realistic picture of the state of safety culture respectively reduces the uncertainties of the general approach.

Its systematic application will result in a so-called "Learning Organisation".

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