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TECHNICAL REPORT

COMPARISON OF RULES-MAKING AND PRACTICES
CONCERNING SAFETY CULTURE OVERSIGHT

CONTENTS

1 SCOPE

This technical report addresses different ways to consider safety culture oversight. Recent developments in that domain provided more insight for understanding the impact of safety culture on safety. Some challenges still remain in defining and capturing safety culture but decisive progresses have been made in the last years. In contrast, analysing or assessing safety culture still requests the attention of practitioners, academics, regulators and TSOs.

The primary goal is then to provide some guidance regarding the way to perform a field oversight in the domain of safety culture. This means that this report will address the needed theoretical elements to understand the concept of safety culture but above all to tackle methodological issues for capturing and assessing safety culture.

In that regard, this technical report relies on practical experience considering safety culture oversight within some ETSON members. Obviously, safety culture oversight is also a domain under the responsibility of nuclear authorities. Therefore, this technical report addresses methods explicitly developed and used by TSOs. In other words the technical report does not intend to cover all practices within ETSON members' countries but to focus on available methods within some ETSON members.

The technical report is structured as follows:
- The chapter 2 reminds some fundamental concepts;
- The chapter 3 addresses the question of the observation of safety culture;
- The chapter 4 presents practical examples of method developed and implemented within some ETSON members.

2 INTRODUCTION

Traced back to the Chernobyl Accident analysis (INSAG-1), the concept of safety culture is regarded as a central phenomenon influencing behaviours and values within high-risk organisations. Culture has a strong and deep impact on individuals' standard of behaviours, professional groups' practices and organisational performance. Exerting a considerable influence on people, safety culture is then considered as a major element of an effective safety management system (Grote and Kunzler, 2000).

Safety culture has therefore generated a great attention in recent years. Since 1986, the concept of nuclear safety culture has been expanded and imposed by regulatory bodies on the organisations and the management of nuclear facilities as an essential tool for the improvement of nuclear safety performance. A growing interest in the concept has been witnessed in the nuclear field but also in high-risk activities as, among other, air traffic control (Ek *et al.*, 2007; Gordon *et al.*, 2007), maintenance (Farrington-Darby *et al.*, 2005; McDonald *et al.*, 2000), offshore drilling (Naevestad, 2008; Haukelid, 2008), construction (Choudhry, 2007; Gherardi *et al.*, 1998) or shipping (Havold, 2010). As mentioned, the attractiveness of culture for safety matters is obviously linked to the assumed relation between safety culture and safety operations (Morrow *et al.,* 2014).

Nuclear safety culture is characterized by two aspects. It is both structural (organisational structure, processes roles and responsibilities, management and steering, documentation and communication, nuclear safety policy statement…) and attitudinal (perceptions, social norms, way of thinking and patterns of behaviours). In other words, nuclear safety culture is a combination of values, standards, morals, and norms of acceptable behaviour. These elements are the building blocks of a mind-set giving the utmost importance to safety beyond legislative and regulatory requirements. In this line of thought, nuclear safety culture has to be embedded in the perceptions and actions of all the individuals at every level in an organisation.

Therefore, from a safety perspective, culture could be defined as the deeply rooted and shared interpretations, assumptions and beliefs guiding behaviours towards risks: critical to success or failure in high-risk organisations, safety culture could thus be a cause of blindness (because a culture could limit or narrow your perceptions) but, in the same token, in the case of a "healthy" safety culture, enables people to be sensitive to early warning signals.

Leadership provided by management in that matter is crucial. Leaders can create or at least support a culture that promotes *e.g.* open communication, questioning attitude or participation. They play therefore a pivotal role in shaping workplace safety (Clarke, 2013), in particular through trust, recognition or

feedback. According to the seminal work of Reason (1997: 196), leadership is a central piece integrating a reporting culture, a just culture, a flexible culture and a learning culture in order to build a safety culture.

Nevertheless safety culture is not a topic framed by detailed regulations or generic tools. Much interpretation may be required to understand the nature, roots and impacts of cultural factors on safety: in other words, safety culture oversight cannot be reduced to checking and evaluating licensee's compliance with relevant rules, regulations or managerial expectations.

Nuclear safety culture assessment focuses heavily on the perceptions, views and behaviours of nuclear safety issues from people at all levels of the organisation. The main purpose is to gain a better understanding of how these affect day-to-day work and managerial practices. Hence, in order to access to all these data, nuclear safety culture assessment requires a methodology that provides relevant information about staff perceptions and behaviours regarding the cultural and organisational dimensions that demonstrate awareness about nuclear safety.

However, capturing nuclear safety culture is not an easy task. Safety culture is a complex evolving phenomenon that covers all aspects of external and internal relationships at the level of individuals and within groups, communities and organisations. In addition, safety culture assessments have to be performed over a long period of time. According to the experience gained in social sciences (sociology, psychology, anthropology) the methods to be adopted for cultural assessment should be based on an ethnographic observation of "field work".

This technical report will therefore consider the way to capture and assess safety culture dimensions.

2.1
Why is safety culture important?

The introduction of the safety culture concept was an important contribution to risk management, like the "total quality" concept was in the 80s as a managerial tool for on-going improvement.

In particular, the safety culture concept emphasises the fact that risk management is built at all levels of the organisation, whereas previously the focus was on the operators, especially from the point of view of human error. The IAEA INSAG-4 thus presents requirements directed to those in charge of the risk management policy (regulatory authorities, nuclear operator management structures, etc.), to those in charge of risk management and to the staff in charge of safety-relevant tasks.

The concept also emphasises the more informal aspects of the organisation, in addition to the technological and procedural aspects that had dominated until then. The values, habits, business standards, and local contexts, etc., now appear as elements to be considered when studying the risk management construction methods within an organisation. Safety culture as a concept therefore opens up if not unlocks our way of considering safety (Le Coze, 2019).

Moreover, the safety culture concept, in its various developments, had the merit of promoting a "systemic approach" to risk management issues. Similarly, the safety culture concept introduced the idea that it is possible to influence the culture of a group, making it evolve by acting on the characteristics of the organisation. The role played by the explanation of the strategic objectives assigned to a group and the associated values and criteria, as well as the feedback and the discussion of the implementation of work practices have also been emphasised.

Finally, the safety culture concept has served the "human factors" approach more broadly, both among operators (Lagrange, 2011) and within safety authorities. The concept has been used to position the organisational and human factors, giving them legitimacy at a time when organisational and human factors were still emerging in the field of risk management. The

IAEA, through the various INSAG documents and safety standards that refer to them, has helped to give it the status of a standard in the world of high risk industries[1].

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[1] *The concept was first introduced in the IAEA INSAG-1 (1986) and further expanded in INSAG-3 (1988) and INSAG-4 (1991). Following these IAEA publications, several other documents have been published in order to enhance safety culture through key issues to be observed (INSAG-15, 2002), surveys or self-assessment methods to be implemented (TECDOC-1321, 2002; TECDOC-1329, 2002) or the identification of safety culture development stages (SRS-11, 1998). In addition, the GS-R-3 (2006) and the GS-G-3.1 (2006) standards draw out the five main characteristics describing safety culture. According to the GSR Part 2 (2016), safety culture assessment is now a requirement. We can also note the WANO and INPO position (INPO 12-012, rev.1, 2013) concerning the safety culture key dimensions.*

2.2
Recent challenges

The concept is also contested. Some authors suggested that safety culture presents the risk of avoiding technical issues or downplaying the importance of technology design (Rollenhagen, 2010). Likewise it is pointed out that safety culture discards deeper organizational analyses taking into account interactions between culture, technology and structure (Naevestad, 2009), power relations (Antonsen, 2009; Silbey, 2009) or actual meanings behind observable behaviors (Guldenmund, 2010). Moreover, a universal vision of safety culture could have a negative impact when implemented in a particular national culture without adaptation (Chikudade, 2009).

In addition this term is also often used in a negative form (*e.g.* a lack of safety culture), particularly in incident reports made by nuclear operators, thereby indicating a lack, a void that remains difficult to fully define. These critical views on safety culture lead some authors to promote the abandonment of the concept (Hopkins, 2016) and, in particular, for regulatory bodies (Grote and Weichbrodt, 2013).

The criticism relates also to the vagueness of the safety culture concept. This vagueness concerns the concept of culture itself. Indeed, the INSAG-4 states that "Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance". Therefore INSAG-4 associates safety culture with a number of attitudes and expected behaviours that actors should develop to ensure the safe management of the facilities. However, the way in which they can be linked and combined to form a culture is not defined. We find, for example, the expectation of adherence of individuals to the common "safety objective", which raises more questions than it answers: What does it mean to have a common objective? Can the safety objective be the same for all of the staff, whether they are in charge of maintenance, independent control, or management? How can staff adherence to this general objective be designed, when at the same time INSAG-4 stresses the need for a possible "systematic questioning" of the rules? Shouldn't divergent objectives be, on the contrary, allowed to intersect and compete to foster debate and cause a clarification of the values and criteria for each, including those concerning safety?

This vagueness also concerns the concept of "safety". The INSAG-4 frequently uses this concept, without ever defining its meaning (safety appears as a given "data item") and without ever indicating that this concept is precisely and continuously at the core of staff activities.

Some elements of the IAEA definition suggest that safety culture can be decreed "from above" and embodied in managerial messages. This approach may conflict with the way in which the effective safety culture is expressed daily in the organization: it refers to the world of practice. It is in practice that culture is forged and transformed (way of working, way of speaking, managerial attitudes, sharing of good practices...). It also refers to history: it is with time and the many experiences in common that collective culture is forged.

As a result there is often a gap between the decreed (or expected) culture by the management and the cultures created by the practices and carried by the members of the organization. There are even phenomena of rejection when the culture promoted by the company does not correspond to the real practices of operators (for example, the culture of solidarity and mutual aid is often harmed by individual assessment practices).

3 HOW TO OBSERVE SAFETY CULTURE?

3.1
What to observe?

Culture is considered within this document as an emerging entity, *i.e.* a social construction of beliefs, norms and practices through interaction and communication over time. The method to be adopted for its study is therefore based on ethnographic "field work" observations. In other words, observing safety culture is about gathering facts, behaviours, points of view regarding these facts and behaviours (interpretations), representations, discussions, etc., striving to reveal the meaning and value systems underlying the activity of the actors and the group cohesion. The data gathering methods as well as the assessor's use of the methods are related to this perspective[2].

Addressing cultural issues in this perspective is characterized by:

- An open-minded, self-critical, systematic, exhaustive, respectful, and learning-driven investigation of as many features of a safety culture as possible;

- Assessors aware of their cultural biases, "blind spots", and interests and take steps to avoid them as far as possible (*e.g.* by cross-checking and discussing her/his information and insights with those of other assessors);

- An inductive approach. Proceed in a systematic way by using as many sources of information as possible and by trying to collect information by which an assessor can confirm, rectify or falsify her/his insights which should always be considered as open to change and revision;

- Multiple methods for gathering qualitative ethnographic data (through observations and interviews rather than with questionnaires);

- Collecting as many pieces of information as possible about (1) the communications and behaviours of people (addressed to other members of the culture or to the assessor), (2) equipment and documents, (3) the relationships between the people, behaviors, artefacts etc. under investigation and the other members etc. of the culture (*e.g.* how does the maintenance department under investigation interact with

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[2] *Regarding the overall prerequisites of the investigation, it must be considered that the assessor approaches a culture to be investigated (1) with his own, specific cultural background, (2) by interacting with specific members of the culture in the context of specific situations to get relevant information, and (3) with the goal of understanding (i.e. making sense) what she/he observes (4) by use of her/his prior knowledge about the culture to be investigated and* *about the methods of investigation with their respective strengths and limits. Most of these points are self-explaining, but a comment on the interactive nature of observation is require: in fieldwork, the assessor will be present and himself be observed by members of the culture wondering what she/he is doing and interested in and why. This is particularly true, if the assessors present themselves as "pure observers" (vs participants).*

and value the members and (or) work of other departments), and (4) cultural aspects which need further investigations.

3.2
How to capture safety culture?

Based on this ethnographic method, Antonsen (2009) formalised several characteristics concerning this inductive way of working. They are summarized here:

- Preferably conducting the study in a "natural working environment": in other words, the observation of the activity "in situ" and interviews on the field are preferable to interviews in researcher's office, disconnected from the action;
- Giving full attention to the interpretation, the meanings by the persons concerned by a work activity;
- Using induction: make sense of the behaviors and beliefs studied. This means that understanding comes from reading and interpreting the data related to the analytical frameworks or models, cross analyzed against the views of individuals, following an iterative approach. The analyst contrasts his view and his interpretation with those of the actors;
- Cross-referencing the data sources or "triangulating data": in order to limit the risk of arbitrariness and to increase the reliability, the analyst must use several methods to cross-check data and must also vary the gathering situations in order to gain access to the differences and patterns. The various data sources can include the following: interviews, observations, documentary collection of all kinds, and gathering traces of activity;
- Taking into account the context, the situation in which the observed phenomena occur ("in situ" action): an activity is always connected to a specific context.

To these generic principles, we can also add according to D. Vaughan (2001) that insofar as culture is not visible, it is necessary to focus on the "events" that will lead to discussions, conflicts of interpretation, decision making modes,

arbitration, etc. All these observables will help us to learn about the culture.

Therefore the purpose of assessing nuclear safety culture is to understand how nuclear safety manifests itself in everyday discussions, decisions and actions. Hence, nuclear safety culture assessment allows organisations to understand their practical treatment of nuclear safety, and to identify areas and actions for improvement.

3.2.1 METHODS

Each method has its limits (IAEA, 2016). Assessors should therefore use (as far as possible) different methods to compensate the respective shortcomings or drawbacks of the individual methods. The application of questionnaires is tempting, because they support the quick collection of many data, simple frequency counts, and rapid statistical analyses. In the light of such advantages, the user of questionnaire must be aware of drawbacks like the tendency to avoid extreme answers (especially, if the source of such answers is easy to identify and the respondents might be afraid of negative consequences of answers that management does not want to hear).

In addition, the subsample of personnel completing the questionnaire might not be representative (*e.g.* dissatisfied people may be less likely than satisfied people to fill in the questionnaire or provide valid information). Without additional information, the assessor has no means of clarifying how her/his respondents did understand the questions in the questionnaire and (or) which particular, culture-specific meaning terms (jargon) used by respondents in their answers do have (as compared with an in-depth interview and the possibilities to ask interviewees for further information, more details, explanations etc.).

In contrast face-to-face interviews can be conducted with top-management and senior managers in order to understand the nuclear safety policy, how it is steered, managed and organised. Aiming to capture cultural aspects of nuclear safety, interviews can also be conducted with members of the Nuclear Safety department in order to gain a deeper understanding of how nuclear safety is experienced, and of their practices and ways to improve nuclear safety.

Collective meetings (Focus Groups) can also be used. This method does not pursue the search for consensus. It allows the collection of perceptions, attitudes, beliefs, and the areas of resistance. It is adapted to the evaluation of the safety culture because its objective is not to prove (explanatory hypothesis), but to understand the why.

Indeed, focus groups are a way of getting people to interact with each other and thus to obtain opinions on collective issues. This dynamic cannot be captured in a face-to-face interview. Focusing on collective issues (and not on individual responses), those work groups rely on free speech and discussion on day-to-day work focused on nuclear safety related topics, practices and ways to improve nuclear safety. The participants are invited to express themselves freely about their work and nuclear safety, about what is going on and what is not in terms of nuclear safety in their work, about their perception of what is important or not (shared prioritization for nuclear safety in daily work, sharing of experiences including interfaces).

For each of these steps, the methodology is based on two fundamental ethical principles: respect of the anonymity of each participant, and confidentiality of all data collected.

3.2.2 CAPTURING VISIBLE AND INVISIBLE ELEMENTS

As already mentioned, the INSAG-4 states that "Safety culture is that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance" (1986).

As a main strength, this definition highlights an important feature of safety culture, *i.e.* its two fundamental sides: safety culture is both structural (organisational structure, roles and responsibilities, documentation, policy statement...) and attitudinal (perceptions, social norms, way of thinking, and patterns of behaviour). Therefore, this means that safety culture observations must take into account different types of activities at different levels:

■ Individual level: *e.g.* questioning attitude, individual awareness, accountability, reporting, rigorous and prudent approach;
■ Group level: *e.g.* communication,

teamwork, decision making, supervision, peer check;
■ Organizational level: *e.g.* definition of responsibilities, definition and control of resources, qualification and training, review functions, management commitment, procedures, safety policies, resources.

In addition, according to Schein's model (1985), this implies also that safety culture observations must take into account visible "artefacts" (system or material elements and behaviours), tacit "espoused values" (guiding principles as goals, beliefs, norms) and deep-seated "basic assumptions" (basis on which people act upon). Using the iceberg metaphor (Figure 1), we can easily understand that culture shows visible and invisible sides.

First, "Artefacts" are material representations as safety guidance pocket books, charters, workspace and other manifestations that include behaviours, rituals, dress code or the manner in which people interact.

Second, "Espoused values" are defined as values adopted and supported by an organisation through general statements – such as "Safety first" or concerning teamwork, decision-making or reporting practices.

Third, according to the Schein model, the deepest layer of culture is the underlying assumptions, *i.e.* the taken-for-granted, unquestioned and often unconscious beliefs that influence perceptions and behaviours. These shared assumptions are implicitly understood within an organisation, often unquestioned and deeply grounded on practices that resulted from a learning process. Bearing this in mind, the tacit and invisible dimensions cannot be observed directly and are complex to address. Since cultural aspects are "submerged" most of the time, safety culture is mainly observed through artefacts and espoused values. Nevertheless, out of the

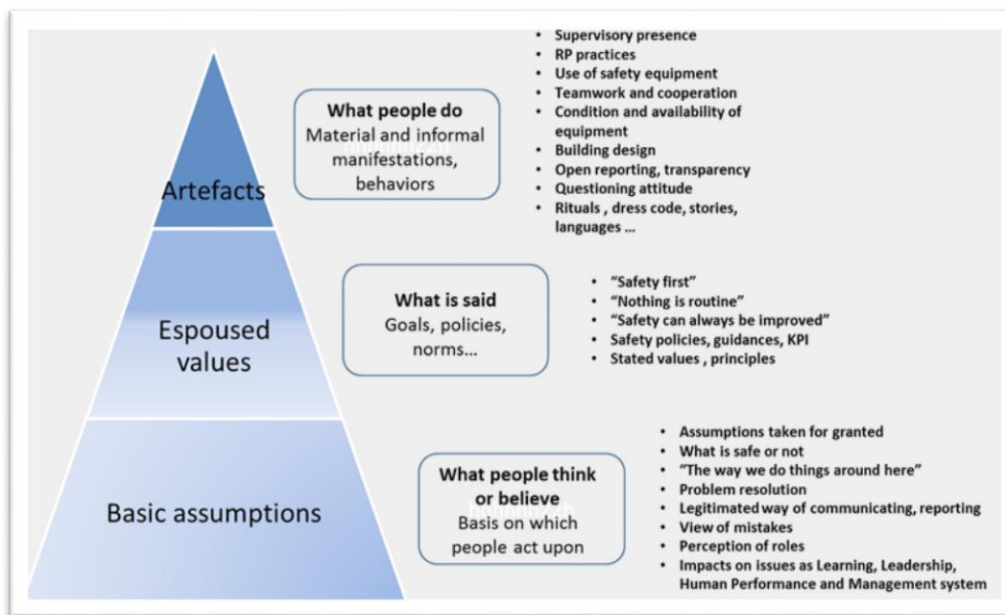safety culture observations, clues about deepest layers can be drawn out.

Figure 1: *Adapted depiction of Schein's (1985) layered model*

As a challenge, the closer we can consider submerged layers of safety culture the deeper we can explore safety culture.

3.2.3 OBSERVATIONS ARE RATHER DESCRIPTIVE THAN NORMATIVE

The meaning of a safety culture artefacts and espoused value does not appear spontaneously. To some extent the positive or negative sides of an observation are not interpretable at first sight.

Standards and guidelines in the field develop different lists of key attributes indicating what a good safety culture is. Many statements such as questioning attitude trust between management and operators or cross-functional teamwork are attributes commonly considered as characteristics of a strong safety culture. Conversely, warning signs of a weak safety culture could be identified such as a lack of systematic approach, insufficient reporting practices or resource mismatch.

The normative view of safety culture gives a useful framework defining what safety culture should be. However, a good or a bad safety culture is not so clear-cut at the workplace. For instance, a statement such

as a lack of "compliance with regulations, rules and procedures" is obviously significant but, adopting a safety culture point of view, it is more important to understand why people did not follow the rule: are we facing a bad behaviour, a lack of knowledge of the rules or rather a bad rule?

We have then to go further. A question could arise as to know why operators did not comply: does it mean that we are facing an understanding problem (lack of training, knowledge of work process) or a procedure fitness problem (adaptation of the procedure to a specific task)? Relating to the group level we can raise issues concerning the legitimized level of compliance within a group (department, team, plant). In terms of management, the questions could be oriented towards the commitment of management, the leadership style or the supervision practices.

Adopting a "why approach", safety culture observations are therefore not black or white. As an illustration, the following example shows that the positive or negative sides have to be evaluated carefully.

"*A manager of the Operation department goes into the field after work hours in order to check all work in progress. Some gaps are observed and reported by the manager to the team.*"

In the first instance, this fact reflects the commitment of this manager and the

continuous improvement capacity of the system but at the same time this observation raises the issue of the effective field presence of the management during the period when daily work is carried out. An observation is an entry point for questioning practices, in this case, regarding the leadership style, the work overload of managers, the capacity to ensure face to face communication.

Thus, safety culture observations provide valuable data, but mostly make sense when they are considered in the context of other safety culture elements. Observations should be provided by detailed and repeated questions about why something happened in a given situation and (or) why something is designed or used as it is for the given situation (observations should therefore be "thick descriptions" in the sense of C. Geertz): They should not be treated as isolated, "stand-alone" facts, but as a system of interrelated statements about cultural aspects.

HOW TO ANALYSE SAFETY CULTURE?

4.1
Theoretical approaches for analyzing safety culture

Two different approaches, respectively called "functionalist" and "interpretive" (Glendon and Stanton, 2000; Richter and Koch, 2004; Naevestad, 2009), are two useful perspectives helping to understand how to analyse cultural data.

From a functionalist perspective, culture is something the organisation has. Safety culture is then a set of behaviours, attributes, processes or policies assuring that safety is an overriding priority. Considered as an ideal to which organisations should aspire, (a good) safety culture is established when a set of features are implemented. On the one hand, this ideal should be adapted to serve the organisation. On the other hand, it implies that the management plays a major role as initiators

of safety culture shaping.

Within this top-down approach, safety culture can be then managed and engineered[3]. A common approach to assess safety culture using this approach is to apply survey methods such as questionnaires (Smith-Crowe et al., 2003) and to identify the general attributes of a strong or good safety culture. Self-completion questionnaires are useful tools to capture perceptions about safety (safety climate) and to explore differences between groups or organisational levels (IAEA, 2016). These instruments are also appropriate in order to provide a baseline for further comparison over time. However, results obtained through quantitative methods could be limited to an organisation's safety climate snapshot (Guldenmund, 2007), *i.e.* to explicit measures influenced by a set of factors such as organisational circumstances or socially desirable response strategies (Marquardt et al., 2012).

Conversely, from an interpretive perspective, culture is something the organisation is. Safety culture is considered as a social construct, as a

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[3] *We could find here the approaches defined as "analytical" (i.e. based on the statistical treatment of quantitative data) and "pragmatic" (i.e. with a managerial purpose) by Guldenmund (2010). According to the view developed by Edwards et al.* (2013), a connection has to be made with the so-call "normative" and "pragmatist" approaches. These authors identified a similar third category called respectively the "academic" and the "anthropological" approaches.

shared pattern of meanings constructed within social groupings: safety culture then defines beliefs – what is safe or dangerous (Vaughan, 1996) – motivates and legitimizes behaviourc through a shared repertoire of positively and negatively-loaded meanings (Reiman and Oedewald, 2004) or enables collective identity (Gherardi et al., 1998). In contrast with the previous perspective, culture is a bottom-up phenomenon emerging through interactions within groups grounded in a specific context of technology (Rochlin, 1999).

Interpretive studies on safety culture focus on thick descriptions of work activities, actors' meanings and occupational culture (Atak and Kingma, 2011; Antonsen, 2009; Naevestad, 2008; Farrington-Darby et al., 2005; Brooks, 2005). However, except for some scholars (Perin, 2005; Bourrier, 1996), there have been few attempts to adopt this kind of ethnographic approach in the nuclear field. As a main pitfall, observations could lead to an overgeneralisation from a small number of findings or to remain focused on the area of expertise of the observer.

In other words, data gathering methods strive to reveal the meaning and value systems underlying the activity of actors and the group cohesion. This way of analysing is opposed to the traditional hypothetical-deductive approach that builds hypotheses and then in an orderly way gathers items of information that will enable a response to these. Here, the analyst is rather in the position of being surprised by what emerges; he listens, watches and then puts in order the information and interpretations gathered to make sense of them.

4.2
Practical approaches for analyzing safety culture

In order to highlight the diversity of methodological approaches for analysing safety culture, this chapter will describe three different approaches respectively developed and applied within IRSN, GRS and Bel V. The three approaches seem to be quite different, but the concluding chapter will show that they can be combined to form a coherent framework of safety culture oversight, analysis, and assessment.

4.2.1 EXPLORING CULTURAL ASPECTS OF SAFETY

Taking into account cultural aspects of safety may give access to phenomena that are difficult to deal with. On this basis, four analysis levels are proposed, which provide a breakdown of the overall "culture" topic: organisational cultures, professional cultures, social cultures and relations, and national cultures.

Influence of national culture

A number of studies seek to identify managerial modes, or types of social relations, which are specific to certain countries and could be associated with national cultures. P. D'Iribarne (1989, 2005) in particular emphasises the impact of national culture on corporate culture from a comparative study between 3 countries (France, USA and the Netherlands). For him, it is a matter of traditions that are rooted in the texture of our social relations throughout collective life (inside and outside of organisations).

Although there is necessarily a reciprocal influence between the traditions of a country and the modes of organisation of companies, it is however difficult to characterise this link. The work by Bourrier (1999 and 2005) calls for caution with regard to a cultural interpretation that would neglect the influence of the role of local organisations.

As part of the safety assessments performed by the IRSN, the identification of the traits of national culture and the study of their influence on the organisation of operators presents the pitfall of stumbling into the obvious or into clichés about national or regional behaviour, and may not allow ways for improvement to be identified.

However, it is necessary to identify the cyclical and contextual variables that can permeate the global culture of the organisations of operators, and explain the strategic choices involving the actors:

- Environment, institutional and regulatory policy: type of risk governance, regulatory changes and prescriptive force of the latter,

etc.;

- Economic environment that may influence the strategic choices: restructuring;
- Social construction of risks: place of risks in the company, consideration for the nuclear industry, etc. (coupled with the mobilization of civil society actors);
- National/regional traditions in social relationships (employer-employee relations) and hierarchical relationships (management design);

Organisational cultures

The following issues may be retained to fuel the study of organisational culture:

- Historical elements: the circumstances of the creation of the organization, founders, milestones, stages of its development (with regard to the activities, technologies, structures, scope of the organization, strategies, etc.). All of this contributes to structuring myths that often persist long after the founding and evolution of the organization;
- Activity: the core business, specific and distinctive know-how, and technologies.
- Values: generic values of the organization (distinguishing "declared values" - or "espoused values according to Schein - those in the texts, institutional discourses and "operating" values, those that are found in the management systems, decision making methods, procedures in general - recruitment, budget, etc.); safety-related values (what is considered "good" risk management / "bad" risk management, etc.);
- Signs and Symbols: behaviour codes, space planning, captions, etc.;
- Structure type (entrepreneurial, professional, bureaucratic, mechanistic, innovative, missionary, or politicized organisation), work division arrangements (versatility/specialization, etc.) and coordination (internal/external contracts);
- Management style: *e.g.* authoritarian/directive style, paternalistic/benevolent style, consultative style, or participative style);
- Management tools and processes: distinguishing management tools (action oriented) and assessment tools (reporting);

identifying the tools as such, as well as the discussions and the underlying value systems (Boussard, 2008). Discussions give meaning to the tool;

- Among the devices, the following can be distinguished: processes aimed at optimization, rationalization (operating procedures, quality processes, etc.); managerial arrangements aimed at regulating social relations, commitment and motivation of actors (performance contracts, HR systems in general); measuring devices and the reporting of results (charts, etc.); procurement processes;
- Rapport with the rules: latitude to change the rules, degree of involvement of the actors in the process of creating rules;
- Event management arrangements: decision making process, arbitration criteria and methods, etc. (Vaughan, 1996).

It is not a question, of course, of exploring all of these aspects, but rather of identifying those that are relevant to the context and the problems to be dealt with.

Professional cultures and identities at work

The consideration of cultural aspects can enrich risk management system assessments, in particular:

- The professionalization process: these can be addressed through the consideration of the organizational provisions implemented (training, tutoring, retraining, etc.) and in terms of the technical skills acquired. However, this process goes beyond just these aspects if we take into account the fact that professionalization also enables the sharing of professional knowledge specific to a given community, thereby fostering a common "culture" for this community and contributing to its cohesion. This secondary type of socialization is particularly important insofar as it helps to understand how work standards are built, transmitted and made sustainable. Professional "culture" constitutes here a method for integrating young entrants, as well as building skills,
- Inter-group cooperation: this can be addressed from the perspective of the different places and coordination support

tools considered purely on a "functional" level for performing the tasks. However, the quality of cooperation also depends on the way in which these sites and tools take into account the pivotal role of the social group recognized as being of the same occupation or same profession, as well as shared values (*e.g.*, operation, maintenance, logistics, dismantling, etc.). The group imposes standards, rules, ways of doing things, and values of its own, and thus plays a role of leadership and control over its members that will affect cooperation.

Based on the work of F. Osty (2003), the following aspects to study the professional and occupational cultures may be retained:

- The social groups belonged to a formal professional line (referring to the officially used nomenclature), as well as a reference group (the one that makes sense to the actor). The study may involve various levels: the company; the plant or site, and the related features (values, operating modes, atmosphere, etc.); the professional line (operation, maintenance, etc.); the occupation (electromechanic, valve repairman, etc.); etc. The goal is not to carry out an exhaustive exploration, but rather to identify and prioritize the 2 or 3 reference groups to which an individual, or a community refers, on which it relies to the extent that it is both an identity resource and also a knowledge resource and a milestone for work standards;
- Professional socialization modes provided by the company (training, career paths, etc.), peers (tutoring practices, buddy system, rotating implications), hierarchy (training sessions, tutored simulations);
- Collective life and exchange spaces for trust and cooperation, and ways to regulate potential tensions or conflicts: collective life (rituals, meals, etc.), solidarity/cohesion within a professional group (degree of cohesion, support modes, hierarchical role in collective life in general, informal leaders), for exchanges (meetings, informal exchange times, time spent on them, etc.) method for managing tensions and conflicts (arbitration modes);
- Skill recognition mechanisms, and more generally (salary, classification, compensation, bonuses, various benefits,

overtime pay, participation in projects, autonomy, room to manoeuvre, etc.);
Work well done criteria and the quality of work, which may in particular emerge from events to be managed, uncertainties and dilemmas, sparking debates that enable the implementation of these criteria to be observed. At this time, different professional practices may also emerge within a same occupational family.

The consideration of the cultural aspects that contribute to the cohesion of professional groups is especially important when work is increasingly performed by actors associated with various organisations, e.g. working in project mode in relation to sustainable entities, resorting to subcontracting.

Cultures and social relations

The work in sociology of organisations conducted in the nuclear field are scarce. M. Bourrier appears to be a key author from this point of view. She provides a strategic approach to reliability: "Reliability should be analysed as the product of choice, decisions and successive, parallel and concurrent regulations, congruent or conflicting as appropriate", and thus proposes to analyse high-risk organisations "from the point of view of the actors, of their strategies and of how they negotiate their participation in a very demanding organisation". She is particularly interested in strategic games, games that take place around the "prescription", the rules and the procedures, and deduces "reliability plans" from them (specific organisational configurations). Indeed, these are particularly determined by an individual's social place within the organisation; places that are different for different plants. Comparing the operation of four nuclear power plants (2 in France and 2 in the US) during the 90s, she identifies various "regimes".
For example, in Bugey, circumventing rules would be relatively common and can be explained by the fact that technicians would not participate either in the development or in the changes to the rules and, similarly, would not forward information up the command chain with a view to improving them. This would be accompanied by a specific socialisation, belonging to a particular community that

defines "how far one can go too far". This model, which would promote "DIY", is effective from a certain point of view, but by increasing the gap between what is prescribed and what is real it risks stretching limits of acceptability and would promote opacity, encouraging partitioning and "turfs".

Another example of a reliability scheme, is that of Diablo Canyon in the USA: a form of bureaucracy (division of tasks, long hierarchy line, excess of procedures, etc.) that nevertheless "would work". The unexpected would be limited, through planning, to the support that technicians would benefit from, to a lack of appreciation of initiative, etc. In other words, M. Bourrier demolishes the idea of "too much" or "not enough" procedures, and supports the idea that reliability is built upon the quality of the social relationships and interactions that develop in relation to these rules and procedures. However, the latter is determined by the relative positions of the various social groups, the opportunities to exchange and negotiate where applicable, the absence of sterile power games that would lead to hiding information or to not cooperate, etc.

She thus makes the connection between the way personnel or subgroups of personnel actually behave in the organization ("social reading of the organisation") and reliability with which personnel follow formal rules and procedures: this reliability depends on social factors and interpersonal interactions. This "social reading" can be in line or at variance with how members of the organization or of organizational units within the organization are formally expected to work, cooperate, and communicate. Thus, for example, beyond the traditional division between "operation" and "maintenance", there may be rivalries between maintenance teams related to their different histories.

Similarly, the manner of exercising the supervising function can be different for different plants, depending on whether it is embodied by a technical expert who draws his legitimacy from his knowledge of the field, or by a "manager" who has a distinctive way of leading the collectives. She also shows how organisational reforms jostle alliances between social groups, transforming social regulation methods. Indeed, new organizational arrangements may have impacts on the modes of operation within a collective, especially if these provisions affect the managerial functions (profile, legitimacy) and the modalities of collaboration and management.

The approach proposed by M. Bourrier thus appears particularly fruitful for understanding what is at stake in social balances, which may constitute barriers or, on the contrary, levers in the cooperation and co-construction of risk management.

Such factors can also be captured by the distinction between formal and informal organization: The "formal organization" is the officially issued body of procedures, instructions, prescriptions orders etc. which people are required to observe. The term of "informal organization" is used in a narrow and in a broad sense: Some scholars define the informal organization as the behaviours which are useful and necessary in order to maintain and develop the organisation (Lang, 2004).

Specifically, it is a case of finding the fine balances that develop between social groups within work organisations, beyond the formal aspects. In methodological terms, it may be useful to build upon the work carried out in classical sociology of organisations (Bernoux, 2014) which gather data on the following aspects:

- Formal elements relating to the ways of exercising power and to the division of work: hierarchical strata, classification and recognition system, horizontal division of work, social data (age, gender, seniority, etc.);

- Symbolic aspects related to the roles and places within the organisation. It is particularly a case of identifying: the prestige associated with a particular function, how to participate in the development/modification of rules and procedures, autonomy, decision latitude and control of areas of uncertainty. These aspects can be understood from the analysis of work meetings; for example, the decision-making modes (who decides what and by what process - see in particular the issue of developing and changing rules), the autonomy margins associated with a particular function, respecting the rules, etc.;

- Elements related to the interactions between actors and groups of actors: analysis of actor games, alliances,

cooperation, and the conflicts that are forged. This strategic reading of the organisation and the actors helps to understand both the levers and the potential bottlenecks, for example, in the implementation of a reorganization, since any change indeed modifies the grey areas controlled by the actors, resulting in a change in the power balances.

These different levels of analysis support the break-down of the global topic "safety culture" which appears to be too complex to be addressed directly. These different levels are intended to complement each other and to enable a comprehensive understanding of the cultural aspects of an organization and their potential impact on safety.

4.2.2 FOCUSING ON LEADERSHIP INFLUENCE ON SAFETY CULTURE

MESKA[4] intends to support the qualitative evaluation of the safety culture at licensee companies. MESKA is also used in order to collect the information required for these assessments and to trigger the appropriate responses of safety authorities. The steps of gathering and processing of information, evaluation, and response to evaluation-outcomes shall be continuously iterated during the entire life-cycle of a licensee company.

MESKA was developed for use by safety authorities but it can also be applied by licensees for self-assessments or peer reviews, by technical support organizations, and by other institutions, which are working on safety culture analyses and assessments. The following description focuses on the use by safety authorities. The term "inspector" will be used to designate members of the safety authority in charge of oversight activities.

The IAEA definition, characteristics, and attributes of safety culture were used as a conceptual framework for MESKA development.

In MESKA, the safety culture in a licensee company is conceived to be composed of safety subcultures whose number and differences may vary to a greater or lesser extent. Different sites, organizational units, management hierarchy levels, and other groups of members of a licensee company may develop their specific subcultures with respect to safety. A safety subculture may be shared by people who are not members of the licensee company: for example, there may be mixed teams of plant and contractor personnel who have been developing common values, norms, mentalities, and patterns of behaviour during their co-operations. In general, there will be many interactions between safety subcultures at the licensee company and the socio-economic, political, and cultural environment of the company. There may be an overarching, company-wide safety culture which is common to each safety subculture (like a common backbone or core), but such an overarching company-wide safety culture need not exist. And if it exists, it may not be a strong one in the sense of the IAEA definition. The methodology of MESKA is fit to capture such diversities of safety subcultures[5].

MESKA uses primarily information which results from oversight activities by safety authorities. Principal information sources are: observations and conversations during plant visits, inspections, meetings *e.g.* with top management, and other occasions of interpersonal information exchange with the personnel of the licensee company, including contractors; documents to be submitted to safety authorities; event reports, and any other information safety authorities can request from or about the licensee.

MESKA thus does NOT require information collected with specific instruments such as safety culture questionnaires or investigation methods whose application necessitates a scientific background and training in anthropology, psychology, sociology etc. Nevertheless, it is possible to use information from such sources, if this information is available to the safety authorities. This means

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[4]*MESKA is an acronym for the German title "Methode für die Erfassung der Sicherheitskultur durch Aufsichtsbehörden". A neat English translation would be "Method for the Evaluation of Safety Culture by Safety Authorities". MESKA was*

developed on behalf of the German Federal Safety Authorities.
[5] *In the following the term of safety culture will be used for the sake of simplicity. But the reader shall keep in mind that "safety culture" essentially refers to a system of safety subcultures.*

that the safety authorities can easily include safety culture in their oversight activities.

MESKA is focused on leadership for safety culture *i.e.* the actions and measures taken by leaders to foster safety culture. This focus on leaders' actions and measures requires a comment on what is meant by "leader" and "leadership for safety culture", why this focus was adopted, and to which extent this focus causes gaps or biases in safety culture oversight. The term "leader" is used for all members of a licensee company from top managers down to front-line managers and personnel to whom a leadership function is assigned only for a specific task and a specified, normally short period of time[6].

MESKA is then applicable and shall be applied to leaders on all levels. It therefore supports the gathering and analysis of information about cooperation and information flow between levels of the company hierarchy. In MESKA, leadership for safety culture is defined broadly and covers several areas. Based on scholarly research, a breakdown of the leadership task into five areas of activity was performed in MESKA development. These areas[7] are the following:

- Create conditions of work;
- Direct subordinates' work activities;
- Work on mistakes, improvements, preventive measures;
- Recognize and sanction;
- Cultivate fair interpersonal relationships.

MESKA also defines which actions and measures leaders should perform in each activity area to properly fulfil their leadership task. Annex 2 table presents these actions and measures of an ideal, efficient leader. By use of scholarly literature and expert judgement it was concluded that the leadership areas as well as the required actions and measures provide a generic and exhaustive description of the leadership task and of what efficient leaders shall do. All actions and measures are considered equally important, *i.e.* there is no ranking or differential weighting of the individual actions and measures.

As an important point, note that the actions and measures in Annex 2 table are observable. As shown by ample empirical evidence from scholarly research, they promote subordinates' high performance by providing best possible conditions of task performance and by strengthening the psychological factors underlying high performance such as knowledge, motivation, values, feeling and wellbeing, work satisfaction, etc. Annex 2 table thus presents leaders' action and measures which are both observable and have empirically well-established positive effects on psyche and performance of personnel.

In MESKA development, it was also checked and verified, that the leadership activity areas, actions and measures cover the observable (or "tangible") attributes of a strong safety culture listed in Appendix I of IAEA GS-G-3.5. It was therefore concluded that leaders' actions and measures will promote personnel's safety-relevant attitudes and performance. Since these observable generic actions and measures and their effects on unobservable psychological factors like attitudes, values, motivation, knowledge etc. cover the safety culture attributes as defined by IAEA, MESKA does not neglect important aspects of safety culture. Although MESKA is focused on leadership for safety culture, it thus supports the analysis and assessment of the safety culture in a licensee company.

Users of MESKA are thus directed to collect and analyse information about actions and measures of those members of a licensee company who have the power, the resources, and a specific responsibility for safety culture promotion. This has the advantage of focusing not only on what safety culture "is" but, in addition, on how and to which extent it is (loosely speaking) "produced" by people in charge of leadership and management in the licensee company.

MESKA supports two oversight approaches which are called *en passant*- and *en bloc*-approach.

The *en passant*-approach was developed to use as many as possible oversight activities by safety authorities - in particular plant visits - as a

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[6] *This broad use is due to the German language in which "leader" can be used as a quite general term, which covers "manager". In other languages, leader and manager may have more distinct, less overlapping meanings. The reader should therefore keep in mind that MESKA does not draw a neat distinction between*

managers and leaders. Rather, "manager" is subsumed to "leader".

[7] *Task-area descriptions are presented in a table in appendix.*

source of information which could provide insights into how safety culture is fostered by licensee personnel in charge of leadership tasks. The philosophy of this approach is the following one: Even if the primary goal of oversight activities is not the collection of information about "leadership for safety culture" (but *e.g.* a technical inspection), it may provide relevant information as a by-product. An inspector may observe that a team leader does not act as a role model for the subordinates because that leader does not wear a helmet even though wearing a helmet is mandatory in that situation or for the specific task. The inspectors may, for example, make such observations on the way to the place where they will perform the task for which they visit the plant.

The idea of MESKA is to get and use these many pieces of safety culturally relevant information by increasing inspectors' awareness for such details and supporting their reporting of such information to the safety authorities. If many or, ideally, all inspectors participate in this approach, safety authorities will be provided with a constant flow of many pieces of information about leadership for safety culture from all parts of a licensee company which are subject to oversight activities.

The *en passant*-approach must be applied in such a way that the licensee is practically unable to anticipate the specific actions and measures of leadership for safety culture an inspector or inspector team will look at on occasion of his/her/their oversight activity. This counteracts licensee's impression that inspectors are only interested in specific aspects of leadership for safety culture. This impression may lead in turn to licensee's concentration on the promotion of these aspects and (or) preparations which may bias the information to be collected by inspectors.

The *en bloc*-approach supports the gathering of information about leadership for safety culture in the context of an investigation which is dedicated to this leadership. It is called *en bloc*, because it is practically organized as a study of leadership for safety culture with

defined scope, time-frames, and resources. The scope of an *en bloc*-investigation may vary: the safety authority may conduct a company-wide investigation of leadership for safety culture or it may limit the study to *e.g.* organizational units of the company like the maintenance department[8].

In both approaches, inspectors in charge of information collection shall:

- Collect as many pieces of information as possible;
- Observe not only leaders and (or) limit their conversations to leaders, but (as far as possible) also try to get information from subordinates, superiors, colleagues, and other members of the licensee company as well as the contractors on the leader and use this information to cross-check the information from observations and (or) conversations with leaders;
- Collect information about the human and organizational factors which are relevant to task performance by leaders and personnel;
- Keep asking question to better understand what is observed and (or) learned from members of the licensee company;
- Collect information which helps cross-check other pieces of information;
- Collect information not only about weaknesses but also about strengths of leadership for safety culture;
- Avoid self-censorship and do not throw away any piece of information because it seems to be irrelevant, etc.

Note that the *en passant*-approach is not only a means of information collection. It could be considered as an integral part of safety culture oversight, if collection and processing of information, as well as feedback to the licensee are performed extensively, continuously, and with minimal delays, and if these activities trigger licensees' prompt and, at best, proactive promotion of safety culture without compromising licensees' full responsibility for safety culture and its enhancement.

Since in both approaches the information obtained consists of a considerable number of possibly heterogeneous individual pieces, a

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[8] *It is in principle also possible to include several licensee companies in the investigation. MESKA is sufficiently flexible to support varying scopes of the* en bloc-*investigation. As compared with the (ideally continuous, never-ending)* en passant-*approach,* en-bloc *investigations will be performed in a short period*

of time (e.g. several days or weeks). MESKA recommends that such studies are performed with the support of experts in human, organizational, and safety cultural factors to properly guide such in-depth investigations.

synthesis must be produced by which the pieces will be coherently put together. Guiding questions of this synthesis are the following: Are the individual pieces of information correct or do they contain errors (*e.g.* an inspector may commit an error regarding the correct designation of a component)? Do correct pieces of information reveal a systematic, to a larger or lesser extent wide-spread phenomenon or trend or are they "outliers" (*i.e.* nothing that is valid for other people, situations, equipment etc.)? How wide-spread are the phenomena, which are no outliers, do these phenomena reveal something which characterizes the entire company or only safety subcultures within the company (*i.e.* reluctance of members of one organizational unit to communicate with other units)?

The synthesis shall address causes, consequences, and interactions between leadership actions and measures. Safety authorities thus can react quickly, if these pieces of information provide enough evidence on degradations in the areas of safety, safety culture, and related leadership activities. Even a single piece of information can be sufficient to trigger safety authorities' responses.

In both approaches, evaluations are based on the same criterion. Each leadership action and measure must be evaluated individually. Inspectors can evaluate observed leadership actions and measures with three categories:

"Leadership action or measure in question requires promotion because of unacceptable discrepancies from the leadership action or measure that should be practiced";

"Leadership action or measure in question requires more promotion because without additional promotion unacceptable discrepancy from leadership that should be practiced have to be expected";

"No such discrepancies were found, leadership action or measure in question has to be promoted with at least the same effort which has been invested until now".

These categories can be visualized by the red, yellow and green light of a traffic light.

Each leadership action or measure evaluated as (A) or (B) must be considered as an issue which requires improvement by the licensee. It is not possible to balance deficits with respect

to specific leadership actions or measures and leadership actions and measures which do not reveal or a need of increased promotion. Users must not evaluate the safety culture of a licensee as a strong one, because the number of leadership actions and measures which were evaluated according to category (C) is higher than the number of the leadership activities with a category-(A) or category-(B) evaluation. The underlying reason is the following one: if the licensee tolerates degradation in a specific area of leadership for safety culture, personnel and leaders may feel free or even encouraged to neglect adequate promotion of safety culture not only in this, but in more and more other areas.

After an evaluation, safety authorities may either continue the collection and processing of information without providing feedback to the licensee to get more evidence or they may provide feedback, evaluate licensee's response and explanations to the feedback, and trigger necessary planning and implementation of corrective measures by the licensee. Due to the licensee's responsibility for safety and safety culture, safety authorities will only indicate the need for corrective measures. It is entirely up to the licensee to define and apply appropriate measures.

4.2.3 ASSESSING SAFETY CULTURE OBSERVATIONS

The model proposed in this chapter is based on a "Safety Culture Observations" (SCO) process applied for several years within Bel V. This model is fed by field observations – as described in 2.2. – provided by inspectors or safety analysts during any contact with a licensee (inspections, meetings, phone calls…). These observations are recorded within an observation sheet (*e.g.*, excel) aimed at describing factual and contextual issues. These observations are thereafter linked to safety culture attributes based on IAEA standards[9].

Operationally speaking, the applied observation sheet template gives a homogenous framework to introduce information about the facility, the type of intervention during which the observation has

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[9] *A similar approach is used in the Romanian approach.*

been made (inspection, meeting, etc.), the topic (matter of inspection/discussion) and the date of observation. More fundamentally, a safety culture observation also implies the description of the context, the identification of safety culture attributes, and an argumentation developing the reasons why the observed fact is linked to safety culture. As an important feature, observations can be positive or negative.

In other words, safety culture observations are fully integrated into the inspectors' daily practices. Actually, performing an observation is an opportunity to capture and record Human and Organisational Factors (HOF) issues which are not always addressed within an inspection report. As an illustration, the following example shows that an observation can raise issues related to human performance. More precisely, according to this example, the SCO identifies what is called a "confirmation bias", *i.e.*, the tendency to search for information in a way that confirms one's pre-existing beliefs or hypotheses.

"During an inspection within the main control room, an alarm occurs. The Main Control Room operator directly clears the alarm without checking the alarm card. The operator explains to the inspector that the alarm was related to maintenance works on a system. Nevertheless, the operator is unable to describe the technical links between the maintenance intervention and the alarm. After a short investigation the inspector found that the link between the maintenance intervention and the alarm was not relevant".

Performing an observation is also an opportunity to gain more insights into a situation. As an illustration, the following example shows that an observation helps to make assumptions about "the way people do things around here".

"Requested checklists related to the use of hot cells are not systematically completed. That remark has already been made several times to operators by the nuclear authority".

Obviously, a single observation is not enough to provide an overall cultural picture, but in that last case, we can observe some shortcomings regarding procedure adherence and use, and the capacity of the organisation to take into account comments from the authority. In addition, this observation also gives an indirect insight in the way the management line or the health physics department fulfil their respective roles. These gaps are therefore valuable findings to be further investigated during future inspections.

According to the assessment model developed, safety culture observations are analysed through a four-dimension model structured by two axis (see Figure 2). First, safety culture observations could concern "organisational processes" (processes, procedures and documentation, the interfaces between departments, etc.) or "behavioural" issues (way of doing, norms, attitude, etc.). This axis is therefore in line with the two sides of safety culture as defined by the INSAG-4. Second, safety culture observations could concern "managerial" issues (what is said and done by managers) or "workplace practices" (what is done in the field).
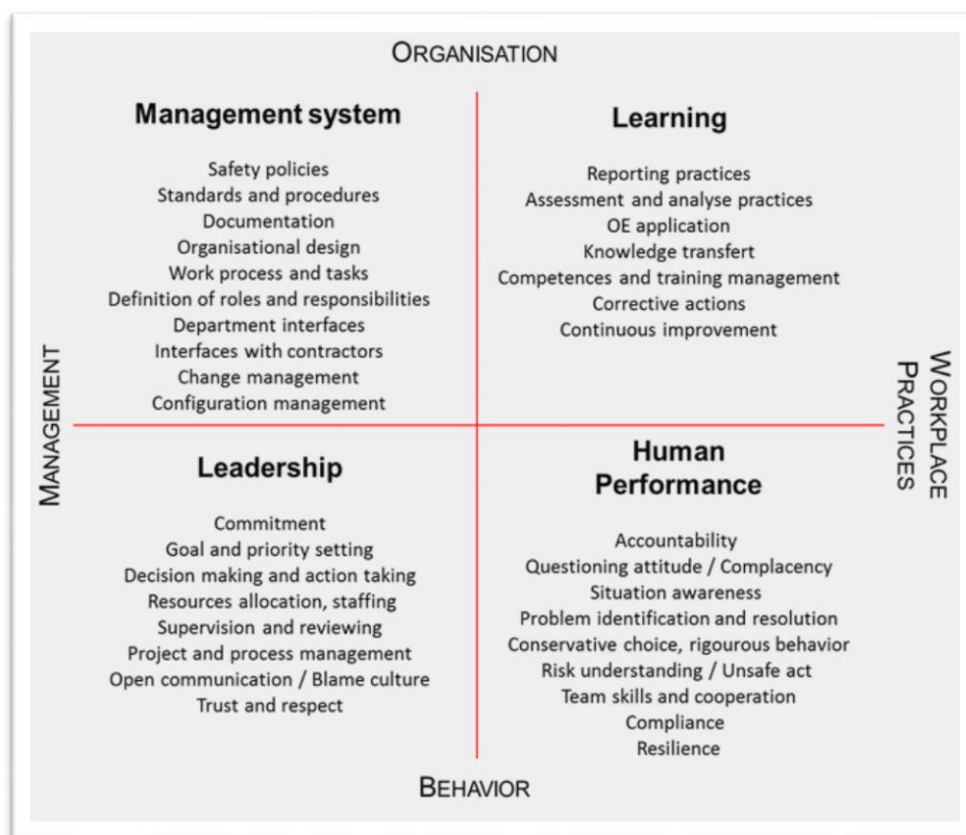
Then, at the intersection of these two axes, we found four dimensions - Management system, Leadership, Human Performance and Learning - that reflect the different "building blocks" of safety culture:

- ▪ Management system: within this dimension we can find safety culture elements such as safety policies, work process, procedures, and interfaces. The main issue here is to assess the level of integration of safety within the management system and related documentation;
- ▪ Leadership: within this dimension we can find safety culture elements such as commitment, decision making, and supervision. The main issue here is to assess the level of managers' involvement regarding operations management;
- ▪ Human performance: within this dimension we can find safety culture elements such as a questioning attitude, compliance, team skills, and situation awareness. The main issue here is to assess the consistency between field practices and human performance principles as well as the adaptation capabilities of field operators;
- ▪ Learning: within this dimension we can find safety culture elements such as reporting or assessment practices, knowledge transfer, continuous improvement. The main issue here is to assess the learning capabilities of the organisation.

During the assessment step, the four dimensions are used to gather observations showing similarities (clustering step). For instance, safety culture observations related to

the managers' commitment are taken together in order to understand how deep commitment

a three-year basis an in-depth safety culture assessment report is performed in order to

ORGANISATION

Management system
Safety policies
Standards and procedures
Documentation
Organisational design
Work process and tasks
Definition of roles and responsibilities
Department interfaces
Interfaces with contractors
Change management
Configuration management

Learning
Reporting practices
Assessment and analyse practices
OE application
Knowledge transfert
Competences and training management
Corrective actions
Continuous improvement

MANAGEMENT

WORKPLACE PRACTICES

Leadership
Commitment
Goal and priority setting
Decision making and action taking
Resources allocation, staffing
Supervision and reviewing
Project and process management
Open communication / Blame culture
Trust and respect

Human Performance
Accountability
Questioning attitude / Complacency
Situation awareness
Problem identification and resolution
Conservative choice, rigorous behavior
Risk understanding / Unsafe act
Team skills and cooperation
Compliance
Resilience

BEHAVIOR

is demonstrated.   **Figure 2.** *Key dimensions for safety culture assessment.*

Considering all the observations related to the behaviours of the management line, we can build up an overall view of leadership. The same process is then applied for the other dimensions. It is worth mentioning that some observations could be used in several dimensions.

Regarding the assessment side, a "Safety Culture Coordinator" (SCC) provides a set of evaluations aimed at identifying early signs of safety problems (through a quarterly monitoring) and deep-rooted cultural issues (through annual and plurennial assessments).

As a result of these evaluations, it could be decided to analyse a plant's performance in more detail in order to understand the underlying causes of a problem or to focus inspections on specific aspects. On a yearly basis, a detailed safety culture assessment report is released (addressing the main safety culture observations) and a synthesis is presented and discussed with the licensee. On

consider deep-rooted cultural issues (Bernard, 2014).

Safety culture observations are then assessed through these four key dimensions which allow for placing the emphasis on specific safety culture attributes, and, adopting an overall view, to identify the major cultural traits of a nuclear installation. As a holistic approach, the main issue is to understand the connections: firstly, the connections between observations in order to provide relevant clusters at the level of each dimension; secondly, the connections between clusters in order to draw a cultural picture at the level of a nuclear installation.

As an illustration, the following case study could be presented. This case concerns an NPP characterised by several occurrences of infringement of nuclear regulations related to compliance with the Plant Technical Specifications (Operational Limits & Conditions). For example, some of the violated conditions were related to time delay for performing tests or to bring the systems back in

full compliance with the plant Technical Specifications. Some other events were also related to erroneous position of valves.

Several of these events triggered reactive inspections by the Regulatory Body. The licensee had been requested to provide immediate and short-term actions supporting compliance and as well as a longer term action plan aimed at achieving a cultural change. These plans validated by the Regulatory Body covered a large set of dimensions, including HOF issues such as leadership, training management or ergonomics of procedures. In essence, the actions taken were dedicated to increasing the operator's vigilance, the reinforcement of the leaders' presence on the field and the improvement of methods addressing HOF in event analysis. In short, this set of measures aimed at reinforcing safety culture. The Regulatory Body followed up the implementation phase and performed a set of dedicated inspections aimed at assessing the effectiveness of scheduled actions. Among these inspections, two specific safety culture inspections (within two years) were conducted based on qualitative interviews techniques in order to evaluate the depth of the undertaken changes.

To some extent, this case shows strong similarities with a recent situation that occurred within the "Arkansas Nuclear One" (ANO) NPP in 2014[10]. For instance, in terms of safety culture, it was identified within ANO that the most significant causes for declining performance were ineffective change management with respect to resource reductions, and leadership behaviours. Actually, the licensee reduced resources across its fleet in 2007 and 2013, but it did not adequately consider the unique staffing needs for ANO created by having two units with different designs. Additionally, an unexpected increase in employee attrition between 2012 and 2014 caused a loss in experienced personnel, which led to a reduced capacity to accomplish work, and an increased need for training and supervision. In both cases, the regulator ensured a follow-up of the licensee action plans, conducted a set of inspections and performed a safety culture assessment.

Coming back to our study case, we performed a safety culture assessment on the basis of 199

safety culture observations gathered during a three-year period and following the method described in previous chapters. As explained, these safety culture observations have been grouped according to their belonging to the four dimensions presented. Then "Artefacts" and manifestations as "Espoused values" have been interpreted in order to arrive at a description of shared underlying assumptions. The following elements synthesize the main findings of the assessment.

Through the lens of the management system, most of the observations are related to a lack of adherence to procedures and to some discrepancies related to major work processes. In addition, a large set of observations shows a poor use of prescribed forms and a lack of rigor in document management as well.

Concerning the leadership dimension, positive observations demonstrate the involvement of the upper management in the improvement of safety. Besides, some examples of conservative decision-making or transparency to the regulator reflect the safety commitment of field managers. Nevertheless, a set of observations raises the question of the effectiveness of the managers' field presence. Actually, managers were in the field but mainly when problems occurred. This implies a management style that could be considered as "management by exception".

As regards the human performance dimension, a set of observations shows weaknesses in rules compliance, in questioning attitude and in the quality of work interventions. Underlying reasons of these weaknesses are grounded in a lack of ownership - *i.e.*, regarding processes, corrective actions, respect of time delay or peer-check - and in a routinisation process - *i.e.*, the force of habits and the normalisation of long-standing practices.

Regarding the learning dimension, some positive observations are related to the licensee's capacity to investigate technical root causes and to perform deep analysis. However, some reluctance was also observed to tackle recurrent events, particularly when they are rooted in organisational or human issues. More significantly, a large set of observations show weaknesses in the implementation of effective corrective actions,

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[10] *USNRC. ANO-NRC Supplemental Inspection Report:*

https://www.nrc.gov/docs/ML1616/ML16161B279.pdf *(retrieved on 6 September 2019).*

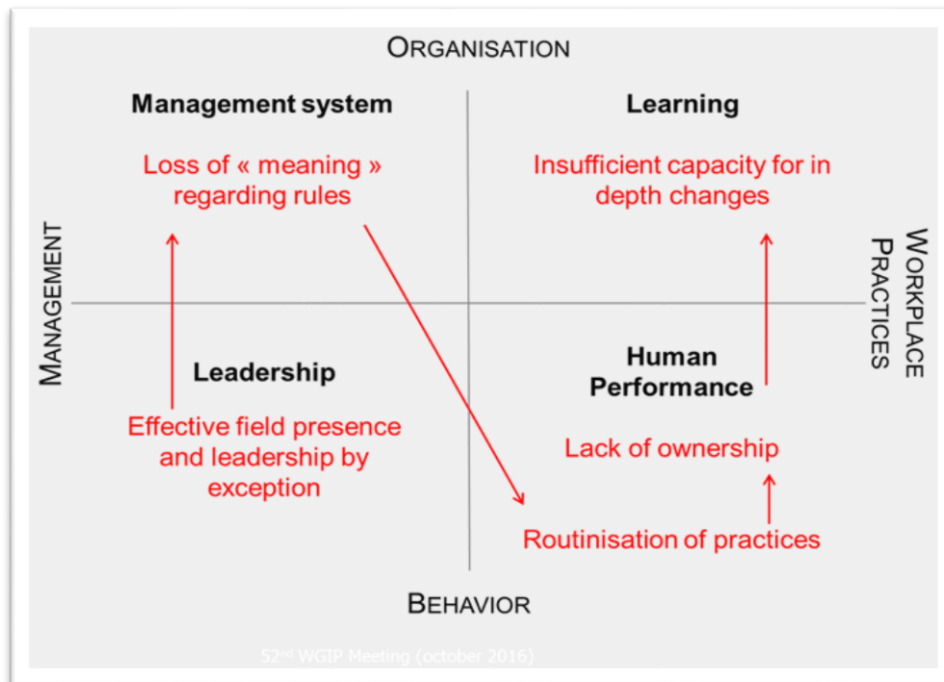questioning the capacity of the licensee to conduct in-depth changes.

Figure 3. *Cultural picture of the installation.*

It is also important to notice that these findings emerge recurrently after several assessments, indicating deep-seated issues. Therefore, adopting a holistic view, we can draw out cultural traits for each of the four dimensions (see Figure 3).

- Management system: Loss of meaning regarding rules;
- Leadership: Lack of effective field presence and leadership by exception;
- Human performance: Lack of ownership and routinization of practices;
- Learning: Insufficient capacity for in depth changes.

In other words, these four dimensions are not isolated features, but rather, tightly connected elements of a larger cultural system influencing the way people think and act within an installation. Regarding our case study, we can see that the four dimensions are strongly linked: in a nutshell, the lack of an effective field presence by managers contributed to a loss of meaning regarding rules. Slowly, people considered work activities as routines and did no longer demonstrate a strong sense of ownership. This also implies some weaknesses regarding the capacity of the organisation to ensure continuous improvement.

In other words, the identified traits demonstrate an internal consistency (*i.e.*, strong links between dimensions) in order to draw a relevant cultural picture. It is also important to note that this picture is not only a snapshot but could also be used to "anticipate", as a far as possible, potential evolutions or consequences. For instance, these findings could be connected to the work of Snook who identified four states in the life of socio-technical systems that entail a specific safety situation:

- "Designed organization": firstly, the global rules are followed;
- "Engineered organization": these rules can be considered as not necessary because their usefulness is no longer perceived;
- "Applied organization": it appears that local rules take precedence in daily practices;
- "Failure": ultimately it is the whole system that becomes vulnerable.

In the same way, the cultural picture identified could lead to adverse effects. If the traits are not under control, these discrepancies can lead to what Snook called a "Practical drift", a slow and insidious drift causing the uncoupling between the written rules and the actual practices in the field.

5 SAFETY CULTURE ADDED VALUE FOR RBs AND TSOs

Many research projects have been already conducted on safety culture within nuclear installations[11]. Despite this large amount of studies, few of them focused on regulatory bodies' / TSOs' strategy needs. In other words, little guidance is provided on how regulatory bodies and TSOs might provide a safety culture oversight.

This technical report showed that safety culture assessment contributes to open new avenues for regulatory practices. Through cultural analyses as described within this document, a regulatory body/TSO can obtain valuable insights in critical safety issues to be addressed by the licensee and, therefore, verify the capability of the licensee to provide appropriate actions to tackle these issues. Licensees obviously retain the prime responsibility for safety but a regulator or a TSO has an opportunity to promote safety culture enhancements, identify topics to be improved and monitor the directions taken by a licensee. Therefore, safety culture assessment findings are no longer intangible, but have rather become tangible safety aspects to be managed (Naevestad et al., 2019).

This present document tried also to demonstrate that the implementation of a safety culture oversight is an opportunity to capture safety issues that are sometimes poorly addressed (*e.g.* leadership style, capacity to change, workforce perceptions). As a result, Human and Organisational Factors topics could be better integrated within the technical inspection programme. In other words, according to the findings of a safety culture analysis, a regulatory body / TSO has a better view on strengths and weaknesses of a nuclear installation. As said, the provided assessment highlights areas (practices, competences, equipment, departments) in need of attention.

It is worthwhile mentioning that safety strengths and weaknesses are not only related to the operation phase but to the whole lifecycle of a nuclear installation, from design to decommissioning.

The technical report described also a diversity of approaches: the IRSN approach intends to analyse safety culture through a multi-level perspective whereas the GRS approach assesses leadership practices through a set of expectations and the Bel V approach aims at identifying an overall cultural picture on the basis of observations. In order to address safety culture issues, we have therefore at

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[11] *See Lee, 1998; Lee and Harrison, 2000; Wilpert and Itoigawa, 2001; Harvey, 2002; Findley et al., 2007; Mengolini and Debarberis, 2007; Reiman et al., 2012; Mariscal et al., 2012; Garcia-Herrero et al., 2013; Rollenhagen et al., 2013, Schöbel et al., 2017.*

disposal "normative-oriented" methods (based on safety culture attributes to be assessed) and "ethnographic-oriented" approaches (where safety culture has to be explored). In that sense, the document reflects the diversity of perspectives and definitions that characterised the field of safety culture.

Nevertheless, as a commonality between approaches, the analysis of safety culture outcomes implies to adopt a global (*i.e.* holistic) point of view: facts or statements drawn out during specific interactions with licensees (meetings, inspections, assessments, walk-down, informal contacts…) are part of a broader system of humans, technology, and organization. The three approaches unanimously advocate the methodological principle, that observations should trigger an in-depth evaluation which addresses as far as possible: (1) the reasons underlying behaviours in a work situation; (2) the human, organizational, social, and technological factors, which influence this situation from a cultural point of view; (3) the relationships ("cultural picture") between these behaviours and these factors; (4) the consequences for safety.

The three approaches described within this technical report share then the objective to capture and decipher cultural items according to their deep meanings for individuals, groups and organisations.

From this perspective, the concept of safety culture is considered useful for safety. However, the "political dimension" and the "technical dimension" of the concept should be highlighted. In its political dimension, safety culture is mainly an element of language aiming at communicating the importance of safety. In its technical dimension, the concept is mainly an "object" to be addressed through statistical and engineering methods. In both cases, safety culture analyses should go beyond these simplifications in order to avoid a strictly managerial and superficial sense of the concept.

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7 ANNEXES

ACTIONS AND MEASURES ON THE PART OF THE EXECUTIVES PER AREA OF ACTIVITY

Area of activity		Keyword	Target actions and measures of leaders
	#		Leaders on all levels of the company hierarchy should in their respective areas of responsibility ...
Create conditions of work	1	Priority of safety	Clearly explain the policies and objectives of the company and plant, the operating regulations and their importance for reliable, safety-oriented actions.
	2	Performance shaping factors	Create the best possible conditions of reliable, safety-oriented actions regarding man, organization and technology (including no time pressure, good work equipment).
	3	Personnel development	Objectively assess competence, actions and performance of subordinates and provide suitable development opportunities.
Direct subordinates' work activities	4	Clear specifications	Make clear decisions, give precise instructions, and provide accurate information, especially in regard to safety and reliability.
	5	Role model	Be a role model for subordinates by taking only reliable, safety-oriented actions.
	6	Facilitate asking questions	Encourage and support subordinates, to ask questions and to raise concerns about work, safety and reliability without delay, reserve or self-censorship.
	7	Reactions to questions	Answer questions and resolve concerns of subordinates regarding work, safety, and reliability appropriately, validly, and before subordinates start the tasks in question.
	8	Supervision	Effectively monitor reliable and safety-oriented actions of subordinates at the workplace, provide support and perform, if necessary, corrective actions.

Area of activity	#	Keyword	Target actions and measures of leaders
			Leaders... should ...
Work on mistakes, improvements, preventive measures	9	Subordinates' mindfulness	Encourage and support subordinates to pay attention to actions, near-misses and circumstances that adversely affect safety and reliability, and where necessary: to intervene to correct, and to report their findings completely, promptly and clearly.
	10	Leaders' own errors	Assume responsibility for their own actions, own errors, and consequences of these actions/errors.
	11	Error handling	Objectively investigate errors and needs for improvement, accurately identify causes of errors/issues in need of improvement, and take suitable measures in due time.
	12	Suggestions for improvement	Encourage and support subordinates to fully and openly express their ideas on how safety and reliability can be improved.
	13	Continuously learning organization	Use in due time findings from comments/responses/statements of subordinates (questions, concerns, reports, proposals, etc.), operational experiences, own observations, and other sources for the improvement of safety and reliability.
Recognize and sanction	14	Recognition	Recognize the performance of subordinates in due time, in reasonable proportion to the actual performance, and in such a way that safety and reliability are strengthened.
	15	Sanctioning	Sanction in due time and adequately actions that are to be sanctioned for sound reasons.
Cultivate fair interpersonal relationships	16	Work climate	Promote a work climate with and between subordinates that supports reliable, safety-oriented actions.
	17	Trustworthiness	Implement their announcements and keep their promises, explain in time if realization turns out to be impossible.

BREAKDOWN OF THE LEADERSHIP TASK INTO AREA OF ACTIVITY

Area of activity	Explanation
Create conditions of work	Conditions of work are the provisions of the company policy and of the plant policy, the objectives of the company and of the plant as well as the human, organizational and technical factors under which the subordinates must act. Company leadership, plant management and managers must create these provisions and conditions and ensure their implementation.
Direct subordinates' work activities	Leaders direct, depending on their position in the company hierarchy, the activities of a more or less large number of individuals who they instruct, control and assess.
Work on mistakes, improvements, preventive measures	The safe operation of a plant also requires support for reliable performance of safety-oriented tasks in the best way possible. For this it is necessary to properly examine mistakes, to develop and implement preventive measures, and to make other improvements. The responsibility of leaders for safe operation includes the responsibility for these steps to further increase safety.
Recognize and sanction	Recognition and sanctioning are essential activities on the part of the leaders to promote desired actions or to counter unwanted behavior. "Sanction" is to be understood as the justified, impartial infliction of adequate, clearly predefined negative consequences on a person for verifiably inacceptable, work-related behavior by responsible people ("punishment"), not as an approval of an action. The necessary condition of a sanction is that the acting individual did not follow an instruction or did not comply with a standard. To avoid arbitrariness and injustice, the instructions and standards as well as the consequences of their non-compliance must be specified in advance.

	Also, the investigation of the deviation from the instructions or standards must clearly show, that the acting individual could have obeyed them (compliance was not prevented by external circumstances such as lack of time or other unsuitable working conditions). Sanctioning belongs to the legal sphere: if necessary, the operating company must contact the competent authorities. Part of the sanctioning must be an instruction on how to act in compliance with the instructions and standards. For the operating company the challenges in sanctioning consist, on the one hand, of preventing the actions that occurred and which are punishable by sanctions, without branding the sanctioned individuals and reducing their willingness to act in accordance with standards and instructions. The company, on the other hand, must also consider the possible consequences of not sanctioning, and thereby sending a strong signal that laxness regarding compliance with standards and instructions does not necessarily lead to negative consequences in the case of non-compliance.
	Recognition and sanctioning are closely linked: Both the lack of recognition and the lack of sanctions signal to the subordinates that their commitment to safety does not really matter and that violations of safety requirements do not have any consequences. For recognition in a broader sense, it is also necessary to create the best possible support for the actions subordinates have to perform. This includes remuneration, job security and development opportunities. In this way, the leaders show that they respect the subordinates as human beings with their capabilities and limits.
Cultivate fair interpersonal relationships	Leadership is also an interpersonal relationship, the quality of which can have a significant impact on safety and reliability. Condescending behavior, for example, can lessen the willingness of subordinates to ask questions, the clarification of which is important for the correct performance of a task. Another negative example is unjustified blaming, which compromises an objective analysis of errors and the development of appropriate countermeasures. Positive examples are the respect leaders demonstrate for the subordinates and the latter's decent treatment.

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