SIGNALLED AND SILENCED ASPECTS OF NUCLEAR SAFETY

CHARACTERISTICS OF FINNISH NUCLEAR SAFETY REGULATIONS

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SAFIR2014 FINAL REPORT

Finnish Research Programme on Nuclear Power Plant Safety (SAFIR) 2011-2014.

SISIANS PROJECT

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ABSTRACT

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This report synthesises the results of a two-year research project on Signalled and Silenced Aspects of Nuclear Safety (SISIANS). Signalled refers to well-articulated aspects of safety and silenced indicates the underdeveloped or downplayed sides of safety. The two-year research project focuses on international and national safety regimes and national cultural features, which may either enhance or hamper nuclear safety. Nuclear safety is by nature, international, national and socio-technical. The more new challenges nuclear safety and the regulatory field encounter in the form of accidents, new nuclear power countries, several subcontractors and workers, the more important an understanding of cultural aspects becomes. In addition, the ongoing harmonisation efforts in the field of nuclear safety (e.g., by the WENRA) require understanding of national cultures.

In 2013, research tasks included 1) identification of international and national nuclear safety regimes after the Fukushima accident, 2) identification of national cultural features that could affect safety, and 3) analysis of the concept of safety based on IAEA Safety Standards. The data consist of IAEA's Safety Standards, The WENRA Reference Levels, reforms of the Finnish Nuclear Energy Act and YVL-guides. Moreover, the European Social Surveys (2010 and 2012) are deployed as data for identifying Finnish cultural features at a general level. Document analysis is carried out through content analysis. In 2014, the research task was to further analyse the Finnish nuclear safety regulation and identify cultural characteristics and their implications on safety. The research was based on 18 interviews with personnel of the Radiation and Nuclear Safety Authority (STUK).

Main findings (of 2013 research) indicate that the international nuclear safety regime is constructed through mechanisms that increase homogeneity of the regime and similar orientations to safety among the main organisations. Namely, the regime is characterised by safety-intensified, technical and co-regulatory features. Safety Fundamentals (IAEA, SF-1 2006) include an emphasis on the operation and also a delicate balance between the operation and safety. One could call this a win-win situation, in which both operation and safety shall be taken into consideration in the protection of humans and the environment. Such a balance is not easily achieved and that is somewhat reflected in the different accents posed by the Safety Requirements (Leadership and Management) and the Safety Fundamentals. The latter emphasises that protecting humans and the environment from harmful radiation should not unduly limit the operation of nuclear power plants (IAEA, SF-1 2006), while the former stresses that

safety should not be compromised by other requirements or demands (IAEA, GS-R-3 2006). These different accents do not necessarily mean a contradiction of principles, but the simultaneous presence of two equally relevant perspectives that need to be concretely harmonised to the best of the technical and organisational possibilities. If this does not occur, the presence of double standards is possible, with a delicate balance between safety and operation. Homogeneity of approaches, such as the defence-in-depth, within the regime is beneficial to safety but the technical nature of the regime may restrict learning and provide patterned replies to safety, as the analysis of the safety concept and Safety Standards show. The safety concept is based on the distinction between safety (e.g., harms caused by the biophysical world, technical deficiencies, system disturbances) and security (e.g., harms caused by malicious intents). These concepts are not able to deal with safety critical aspects that derive from society and inter-organisational aspects, or from the good intentions of humans, even though good intentions have been seen as causing the majority of organisational deviance.

The Finnish national nuclear safety regime is constrained by the international nuclear safety regime. Still, Finnish cultural features, such as generalised trust in other people, trust in institutions (e.g., education, science, technology), obedience to the law, and appreciation of diligence, promptness and honesty are present in nuclear safety regulations. The norm of trust is a corner stone in safety regulation and, at the same time, it is a double-edged sword. It may be beneficial to safety as it saves extra work, but trust can also reduce safety in a multinational context if the actors do not share a similar cultural framework. Interviews with the safety inspectors in 2014 gave further insights into the idea of trust and showed that Finnish safety regulation is based on functional trust and functional distrust, not on blind trust.

With regard to characteristics of Finnish nuclear safety regulations, there are two types of inspectors: those who have internalised their role as public servant and therefore reflect their action within the framework of neutrality and those that are more open and informal in their interaction with the operators. This second type of inspector sees their role as guaranteed by their technical professionalism and pertinence.

Furthermore, four additional roles of inspectors were identified: two desirable roles of controller and a motivator and two undesirable roles of an advisor and quality controller. Inspectors identified themselves most often with the role of a controller; the role of a motivator did not come out explicitly in the interviews, even though it was indirectly referred to. Space opens for motivation when inspectors work closely with operators by following modernisation projects in the facilities. At the same time, inspectors maintain their high competence and knowledge about what is happening in the facilities. However, at a grass-root-level, in interactions there is a temptation to act as a consultant or quality controller. These roles do not belong to the inspectors and they have made efforts to avoid such roles. The risk is that if inspectors act as consultants, they take responsibility for safety from the licensees.

Finnish safety regulation is characterised by trust and can also be depicted as control-based, risk-informed, ambitious, technical and professional, relatively detailed and proceduralised. Grass-roots level regulation plays an important role, which makes it both rigid and flexible. In addition, there are currently strong efforts to unify regulatory work so that it would be based on the safety-significance of the target more than earlier. Now, in some cases, regulatory responses may focus too much on details that are not relevant such as those regarding safety and risks.

There are isomorphic mechanisms, such as close co-operation and exchange of knowledge, between international and national safety organisations that promote harmonisation of nuclear safety. However, within a regulatory body, there are also mechanisms related to organisational structure, such as different offices and safety areas, which may have maintained different normative and cognitive understandings of safety and safety regulation among the inspectors. Problems may arise when there are different understandings of what is relevant regarding safety. Therefore, efforts have been made to streamline safety regulations and to get it focused on safety-significant matters. However, in a situation where there are two main types of inspectors, some coordination challenges may emerge.

Findings from this study point to a need to find a delicate balance between the following counterparts: the collectivistic and neutrality oriented public servant type of inspector versus the individually and technical fact–oriented, open and informal type of inspector; adequately close versus adequately distant safety regulations; individual versus uniform regulation; proceduralisation versus adequate space for the industry's own developments; and command and control-based versus self-regulation based activities.

CONTENTS

1 INTRODUCTION – GENERAL CULTURE

Nuclear safety is by nature a societal, cultural, organisational and technical phenomenon. In addition, the Fukushima accident and the subsequent international reviews of relevant safety standards indicate the multinational features of nuclear safety. The International Atomic Energy Agency's safety principles and standards represent the minimum internationally acceptable level of safety. They have also been used on the basis of the Western European Nuclear Regulators' Association's attempts to harmonise reactor safety in its 17 member countries by creating Reference Levels for existing nuclear power plants (WENRA 2013). However, the national aspects also play a role in nuclear safety as international conventions and the IAEA safety principles and requirements are complemented by each country's governmental practices and national laws (IAEA 2002, 1–4). There has recently been growing international interest in the impact of national culture on safety attitudes and safety performance or safety culture within the nuclear sector. The IAEA's workshop on Global Safety Culture – National Cultural Impact on Safety Culture (IAEA 2014), to which the author of this report also attended, is indication of this shift. In addition, in other industrial sectors, such as the oil, gas and shipping industries, interest in national culture has been expressed (Havold 2005; Mearns and Yule 2009).

Furthermore, cultural aspects become all the more important when the regulatory field has to face new challenges. For instance, new countries, which come to play a role in peaceful or potential military use of nuclear power, set challenges to international nuclear safety regulation and global safety regimes, and give rise to the need to understand specific cultural aspects that may either hinder or contribute to safety. In the Finnish context, the amount of regulated nuclear operators and power plants has been low (4 nuclear power units, one under construction). However, the picture has changed and is changing because of the Council of State's decision-in-principle in 2010 to allow construction of two new nuclear power plants. Recently, in 2014, the Parliament allowed changes in the Fennovoima project so that it can proceed. Hence, the future nuclear power construction and the continuation of Olkiluoto 3, mean that several foreign subcontractors, designers and workers will participate in the projects. In these cases, it is of great importance to understand the specific national cultural features that contribute to safety or the features that need to be addressed for their problematic implications.

A basic assumption is that the national culture understood as deeply held values, knowledge and material features, such as how organisations work, affect people's attitudes regarding risks and safety (Mearns 2013, 64–69) and related behaviours. It is assumed that people in a certain nation have "a broad tendency to prefer certain state of affairs over others" (Hofstede 1991). Here culture is understood as institutional networks, such as organisations with their normative, cognitive, social (hierarchies and power structures) and material dimensions.

Cultural analysis may address relevant critical factors for safety, such as acceptance of risks, different constraints on and incentives to adopt safe practices, which are typical for a nation or an organisation. However, there is no direct causal link between general cultural patterns, such as values, and individual behaviours. On the contrary, there are multiple intervening factors between attitudes that are affected by cultural patterns, and behaviours.

Culture can be considered both an enabling and a constraining factor regarding safety (cf. DiMaggio 1997). However, the way culture enables or constraints safety is not immediately evident. When one looks at Finnish cultural features, which may impact nuclear safety and safety culture, one often makes assumptions about culture (e.g., values, norms, beliefs, material devices) as a causal factor. One assumes that relatively stable cultural elements that affect action exist. There are several problems with this assumption. For instance, culture is understood as a static phenomenon, as a relatively stable set of values, norms and material devices that can be detected. However, in a changing, globalised society it may be difficult to find stable cultural features. Or it may be difficult to specify features in the general culture that affect a particular safety culture. Even though one could identify some cultural features relevant to safety, it may be difficult to detail the mechanisms through which these affect human behaviour. It has been noticed that values do not necessarily affect people's action (Uusitalo 1991; Kollmus and Agyeman 2002). The link from values to action is more complex and influenced by intervening social mechanisms. In short, the problem of this assumption of culture as a causal attitude is that it reduces culture to very few chosen features. A restricted understanding of culture does not contribute to a dynamic understanding of features which affect safety. In this sense, the results of this study cannot be taken as pointing to causal mechanisms rather than to tendentious patterns, the actual role of which can be detected only through detailed analyses of practices that are beyond the scope of this study.

Geert Hofstede presented psychological theories about national culture in the 1960s and 1970s based on his comparative study of IBM employees' values and attitudes in different countries. He distinguished between five dimensions that characterise national cultures: power distance, individualism vs. collectivism, masculinity vs. femininity, uncertainty avoidance and long-term orientation. Even though there are differences between countries and organisations, in general Scandinavian countries have been characterised as having a low power distance, low masculinity (not willing to take risks) and high collectivism (Mearns 2013, 76).

It would be possible to look at the Finnish general cultural orientation on the basis of Hofstede's model, but it seems that Hofstede's model is not able to capture some relevant aspects, identified from recent value surveys that communicate with safety and are typical for Finns. For this reason, Hofstede's model is not deployed here. In addition to cultural norms, the way society is organised, i.e., national institutional features, and

economic and power structures also affect safety attitudes and acceptance of nuclear risks, and thus can be seen as cultural features.[1]

The objective of the research is to complement a technical understanding of safety by analysing cultural norms and societal features that have implications on safety. In this way, the study deepens the understanding of safety as a culturally and socially embedded phenomenon, and enables reflections on current safety standards and harmonisation of safety by the Western European Nuclear Regulators' Association (WENRA). One can ponder whether national practice can be effectively transferred to other cultural contexts. In the end, relevant safety related themes are discussed.

The report consists of five sections. First, a theoretical and conceptual framework for analysing national cultural patterns is provided. Second, data and research methods are described. Third, an overview of findings concerning the year 2013 is outlined. Fourth, characteristics of Finnish nuclear safety regulations and the national nuclear safety regime are identified. Finally, conclusions are drawn and the relevant literature on safety regulations is discussed, suggestions for future studies are also provided.

2 THEORETICAL FRAMEWORK – SAFETY REGULATION AND INSTITUTIONAL ISOMORPHISM

Studies on regulation[2] have shown that over the last three decades there has been a gradual shift from a command and control type of regulation towards co-regulation that is based on the industry's self-regulation supervised by the regulatory body (Baram and Lindoe 2014). Co-regulation is a manifestation of so-called decentralised regulation in which several actors ranging from the regulatory body to other governmental agencies, firms, non-governmental organisations and media participate in regulatory activities (Black 2002; Baram and Lindoe 2013). Hence, safety regulation is an outcome of the interactions between different actors and networks thus making the regulation of safety control complex. The decentralised understanding of regulation is characterised by complexity and fragmentation of knowledge and of the exercise of power and control among actors. The fragmentation on knowledge means that no actor has all the relevant knowledge required to deal with complex and multifaceted safety problems or no actor has an overview regarding safety and the ability to employ all means necessary for

[1] There are long theoretical discussions and disagreements about whether societal structures should be seen as external or internal to culture (Reckwitz 2002). I understand that societal structures and culture are inextricably interwoven. Therefore, culture is understood here as institutional networks, such as organisations with their normative, cognitive and material dimensions (e.g., technical devices as well as power relations and how they function).

[2] Regulation can be defined as: *"the continuous activity to improve safety through standard-setting, information gathering, development of technologies, and precaution. It includes attempts to alter the behavior of others with the intention of producing broadly identified outcomes. Regulation activity is the outcome of actors and technologies within larger institutional setting."* The definition is modified on the basis of Schelznick's (1985, 363) and Black's (2002, 19) definitions.

effective regulation. Therefore, interactions between actors becomes important. Autonomy of actors means that an external regulatory body does not easily regulate their actions. In addition, actors involved in regulatory activities can be severely restricted by the autonomy of others in reaching their own goals and objectives (See Black 2002, 4-5). The decentralised understanding of regulation stresses interactions and interdependencies between actors across the nations, as well as the need for coordination of actions of several actors (Black 2002, 16). These characterisations of decentralised regulation represent general challenges in the contemporary field of regulation. Hence, reflecting upon those features in the context of nuclear safety may contribute to practical discussions of how regulation might be improved in the future.

When regulation is decentralised, rather than simple and focused, the mixing of strategies may be necessary and desirable. Even though it seems that Finnish nuclear sector regulation is quite centralised, there are features that also make it decentralised. First, the main responsibility for safety belongs to the licensees and the role of the regulatory body is to ensure that requirements are met. Second, in addition to licensees and regulators, there are several other actors, subcontractors, and vendors whose actions also affect the end result of safety.

A network approach to safety regulation provides useful insights into regulatory developments. It highlights the relevance of various institutions with divergent cultural characteristics that affect regulatory realities. In addition, the network approach draws attention to coordination challenges caused by various actors and networks involved in safety activities. In the nuclear sector there are several actors, namely, the IAEA, and transnational regulators, such as WENRA and ENSREG setting soft law standards, state regulators implementing supra-national legal requirements, industry based certification bodies and the regulatory body applying different regulatory instruments. Hence, the regulatory body's attempts to improve safety are faced with various coordination challenges. Even coordination of the regulatory body's own inspectors' action in the face of different values, regulatory skills, technical knowledge, technical areas, or informal rules between different offices within the regulatory body may cause considerable challenges (Baldwin et al. 2012; Baldwin and Black 2007).

It cannot be assumed that all the inspectors involved in the end result of safety (for instance, within the regulatory body) will have the same substantive objectives or normative conceptions of what is good for safety, humans or the environment. Their capacities, skills and resources as well as their educational and social backgrounds, may vary and are likely to affect their approaches as well as to their responsiveness to regulation (Baldwin et al. 2012; Baldwin and Black 2007.)

Culture and institutional isomorphism

For the purposes of this study, I adopt a broad understanding of culture as a process that comprises not only normative (i.e., how safety should be dealt with) or cognitive (i.e., what is worth doing regarding safety) but also social (i.e., hierarchies and institutional

arrangements) and material dimensions that affect safety. I will apply a more dynamic conception than normally adopted in studies on national styles of regulation, in which the focus has been on underlying societal macro-institutions, such as legal systems (Halffman 2005). Macro-institutions are relevant but they cannot offer an explanatory model for changes in national regulatory regimes, because macro-institutions change more slowly than the regulatory regimes themselves. Therefore, it is of major importance to adopt a more dynamic conception of culture as institutional clusters (Halffman 2005) or networks of institutions with normative, cognitive, social and material aspects, which affect each other in a continuous interaction process (DiMaggio 1997; cf. also Rasmussen 1997). For instance, within the nuclear sector, one can distinguish between different relevant organisations, such as nuclear regulators, the nuclear industry and experts and universities, with their specific normative and cognitive frames. Within the institutional cluster frame, moreover, of special relevance is the phenomenon of institutional isomorphism.

The concept of institutional isomorphism is used as a tool to analyse the way cognitive, normative, social and material dimensions appear in the field of nuclear safety. The notion of isomorphism refers to the phenomenon by which organisations tend to become structurally or strategically more similar or homogeneous (DiMaggio and Powell 1983). "Isomorphism is a constraining process that forces one unit in a population to resemble other units that face the same set of environmental conditions" (mt. 1983, 149). The pervasiveness of culture makes its impact on specific areas of social action difficult to detect. If everything is culture, how is it possible to single out its specific contribution to nuclear safety? One reply is to search for partial but effective indicators. In this sense, institutional isomorphism can be regarded as a way in which cultural patterns are operationalised in the way a particular sphere of action is organised. Isomorphism, in other words, can be taken as an observable link between cultural frameworks and concrete behaviour, especially in areas such as nuclear safety, where purposefully regulated, organised collective action is of central relevance.

In contemporary society there are several processes that make organisations more similar to each other. DiMaggio and Powell (1983) have identified three basic mechanisms through which institutional isomorphic change occurs: coercive, mimetic, and normative. Coercive isomorphism stems from national institutional patterns, such as centralisation of the state, the structure of the national economy, or national patterns of interest organisations that can make national regulatory regimes more homogeneous and less similar to international regulatory regimes in the same sector. The opposite may occur as well, namely, that in a particular sector the national regulatory regime is more affected by international patterns, to which national governments have subscribed, than national ones. Mimetic isomorphism may derive from an uncertain environment that creates pressures to imitate other organisations, which are considered successful. Normative isomorphism derives from professionalisation, i.e., the need to establish a cognitive base and legitimise occupational autonomy. Formal education, training courses and professional networks are important centres for the development of

organisational norms, professional behaviour and similar orientations among certain professions and experts (Halffman 2005, 464). All three pressures on isomorphism may play a role in the nuclear sector, as they affect the what, how and who of safety-related actions. Isomorphism is important to the extent that it may strengthen and spread effective understandings of, and approaches to, safety (e.g., 'awareness'), but it may also engender the inability to detect specific needs and requirements (e.g., 'blindness'). It may also be that bodies involved in nuclear safety are exposed to different isomorphic pressures that may lead to contrasting understandings and approaches to safety.

One can discuss isomorphism a) inside the nuclear sector, b) between the nuclear sector and other regulatory regimes in the country and c) between national nuclear sector and international nuclear regulatory regimes. Comparisons are made between national nuclear sectors and international nuclear regulatory regimes.

In other words, this study of national cultural patterns of nuclear safety, will look at whether isomorphism exists in the Finnish nuclear sector in relation to the international nuclear safety regime, and the national patterns of such isomorphic (or non-isomorphic) development. In addition, isomorphic features are examined within the Radiation and Nuclear Safety Authority (STUK). There are three hypotheses related to isomorphism of the national nuclear safety sector.

1) The first hypothesis is that isomorphism (based on the Nuclear Energy Act, safety requirements, expert structure, and beliefs of experts) leads to consensus concerning relevant understandings of, and means to deal with, safety. This may enhance awareness and strengthen safety, yet it may also lead to blindness about relevant safety aspects, or approaches to safety that emerge from international or national discourses.

2) The second hypothesis is that the presence of contrasting isomorphic pressures leads to clashes between different principles and approaches at the national/international level and causes contradictions between different principles of societal actors or functions relevant to society.

3) The third hypothesis is that the presence of contrasting patterns between national and international approaches or between the approaches of different national bodies can be related to the presence of relevant national cultural patterns and to the greater or lesser role that international isomorphic pressures exert on different national bodies.

In summary, the basic hypotheses are that isomorphic tendencies are affected by, and thus express, international and national safety cultures; that these tendencies may either positively or negatively affect nuclear safety; and that of particular relevance, is to detect those aspects of 'blindness' and 'clash' that can hamper the effectiveness of safety approaches.

Regimes

There are various definitions regarding regimes (Boltanski and Thévenot 1991; Kringen 2008). Regimes are understood as consisting of institutional factors, such as operational rules and standards (cf. Baram and Lindoe 2014), and how the interaction between different actors within the nuclear sector has been organised. Here, regimes crystallise the composition of formal and informal principles and practices through which interaction is coordinated between the stakeholders and safety inspectors are oriented to safety regulations.

The research tasks are as follows:

1) Identification of international and national nuclear safety regimes after the Fukushima accident.
2) Identification of national cultural features that communicate with maintaining safety.
3) Analysis of the concept of safety based on the IAEA Safety Standards and the stress tests documents.

Research questions:

a) What kinds of isomorphic features can be found in international and national nuclear safety regimes?
b) What kinds of national cultural patterns may be argued to impinge on nuclear safety in Finland?
c) What are the characteristics of Finnish safety regulation?
d) How comprehensive are STUK's safety requirements (YVL Guides) in relation to IAEA's and WENRA's requirements or other regulatory fields (such as environmental protection) in Finland?
e) What are the signalled and silenced aspects of nuclear safety? What patterns of "awareness," "blindness" and "clash" stemming from institutional isomorphism can be detected?

3 THE DATA AND RESEARCH METHOD

Identification of an international nuclear regime is based on the International Atomic Energy Agency (IAEA) Safety Standards, the Western European Nuclear Regulators Association (WENRA) Reference Levels and revisions made to these documents in light of lessons learnt from the Fukushima nuclear accident. The IAEA documents include Safety Fundamentals SF-1 (2006); General Safety Requirements: GSR Part 1 (2010) and its revision DS462 (October 2012); GS-R-3 (2006) and its revision DS456; GSR Part 4 (2009) and its revision DS462; GS-R-2 (2002) and its revision DS457; and Specific Safety Requirements SSR-2/1, SSR-2/2. The WENRA documents embrace

revisions of Reference Levels: RHWG reports March 2013 and November 2013; Stress tests specifications proposal, April 2011; and WENRA conclusions arising from the Consideration of the Lessons from the TEPCO Fukushima Dai-ichi Nuclear Accident, March 2012.

The analysis of the concept of safety is based on the above-mentioned documents as well as the Organisation for Economic Cooperation and Development's Nuclear Energy Agency's OECD NEA documents (2008, 2011) and the final Stress tests reports of the UK and Finland (2012).

Analysis of the national nuclear regime is based on the national Nuclear Energy Act (1987/990) and its revision (410/2012) and decree (17.10.2013), the Nuclear Liability Act (484/1972) as well as nuclear safety regulators' safety requirements (YVL A.1, YVL A.3, draft 5; YVL A.4, draft 4; YVL A.5, draft 5; YVL A.6, draft 5; YVL A.7, draft 4; YVL A.9, YVL A.10, draft 5; YVL A.11, draft 5; YVL B.1, draft 5; YVL B.3, draft 5; YVL B.7, draft 5, YVL C.4)

Identification of national cultural patterns that communicate with safety is based on the European Social Surveys (2010 and 2012), and Summary of the Finnish Science Barometer (Alatarvas 2013). The European Social Surveys consist of 30 country surveys of citizen's attitudes and behaviours. The Centre for Comparative Social Surveys from the City University of London, in cooperation with other research institutes and universities in Europe, coordinates the survey. The core module monitors change and continuity, for instance in social trust and in moral, political and social values. In the identification of cultural patterns, descriptive statistical methods are applied, including cross tabulations and histograms.

Document analysis is important in the sense that, for instance, the IAEA and WENRA documents are central to the way in which the interaction of actors and safety practices are organised. Documents structure our notion of safety and the place of different actors in dealing with safety related issues. Documents can be seen both as objects and agents in a web of safety practices; as the ongoing revisions of the IAEA Safety standards show, documents are fluid objects of analysis.

Documents are approached as sources of information through content analysis. Here, content analysis refers to a theory-sensitised interpretation and rearticulation of given texts in new analytical terms (Krippendorff 2003). Analysis focuses on document content, such as meanings, patterns and themes, as well as the signalled and silenced aspects of safety. This study investigates aspects of safety that have been stressed or downplayed in the documents as well as consequences of such aspects for safety, regulation, and society.

Categories and "variables" (e.g., main actors, prevailing understanding of safety, means to enhance safety, emerging weaknesses) guide the study, but other issues are expected to emerge throughout the study. Although available documents can only give a tentative

picture, institutional isomorphic features are also examined. Typical of document analysis, the research was a process informed by empirical materials and emerging new questions; this lead to exploring additional documents, through which a more accurate picture was obtained. However, because of tight time limits, additional documents or emerging new questions were not included in the analysis.

Regarding the characteristics of Finnish nuclear safety regulations, 18 interviews with the inspectors of the Finnish Radiation and Nuclear Safety Authority (STUK) were carried out in during the spring and summer of 2014. I asked STUK for permission to interview 15-20 people. I wanted to interview people from different levels, ranging from inspector to project manager to manager. I also wanted to interview people with different backgrounds; some who had experience working with other organisations, also the nuclear industry, and those who worked only in the STUK. Based on my requests, a secretary in the STUK sent an email to inspectors and asked for interview volunteers. The interviewees ranged from newcomers to persons who had worked within the STUK for decades. The shortest work experience within the STUK was 2 years and the longest was 39 years. There were 7 interviewees who had worked in the STUK at least 10 years or more and 11 interviewees had worked in the STUK nine years or less. The interviewees represent 5 out of 9 the offices under the Department of Nuclear Reactor Regulation. The aim of the study is to get an understanding of cultural characteristics of safety regulations.

Interview themes included background information, education of the inspectors, their expertise, independence of the STUK, role of trust in regulation, attitudes regarding mobility from a regulator to regulatee and vice versa, characteristics of Finnish safety regulation, experiences regarding different generations, knowledge gaps, and targets of development. In addition to the above-mentioned themes, new topics also emerged during the interviews. The active interview was deployed as a method as it emphasises that both the interviewee and interviewer participate in creating meaning (Holstein and Gubrium 1995).

Each interview took approximately 1 hour and 30 minutes. Interviews were recorded and transcribed. The longest transcription was 20 pages and the shortest transcription was 14 pages; in total, there were approximately 270 pages of text. Interview themes structured the analysis. Within each theme contents and meanings were scrutinised in respect to competent actors, principles, goals, means, justifications and problems. In addition, I looked at content, their consistencies or inconsistencies, whether there were aspects that complemented each other or were in contradiction with each other. Through interviews and talks I traced inspectors' understandings of how safety regulations are dealt with and how they should be dealt with and developed and what aspects should be strengthened or avoided. Naturally, chosen themes affect what is discussed, but new topics also emerged during the interviews. The interview talk is not equated with action, but it gives a hint of inspectors' thinking and action.

4 OVERVIEW OF FINDINGS (YEAR 2013)

The main findings (of the 2013 study) are that the international nuclear safety regime is constructed through mechanisms, which increase homogeneity of the regime and create similar orientations to safety among the main organisations. Safety-intensified, technical and co-regulatory features characterise the international nuclear safety regime (Ylönen 2015). Safety Fundamentals (IAEA, SF-1 2006) include an emphasis on the operation and also a delicate balance between the operation and safety. One could call this a win-win situation, in which both operation and safety are taken into consideration in the protection of humans and the environment. Such a balance is not easily achievable and that is somewhat reflected in the different emphases posed by the Safety Requirements (Leadership and Management) and the Safety Fundamentals. The latter emphasises that the protection of humans and the environment from harmful radiation should not unduly limit the operation of nuclear power plants (IAEA, SF-1 2006) [3], while the former stresses that safety should not be compromised by other requirements or demands (IAEA, GS-R-3 2006)[4]. These different emphases do not necessarily mean a contradiction of principles, but rather, the simultaneous presence of two equally relevant perspectives that need to be concretely harmonised to the best of the technical and organisational possibilities. If harmony is not reached, there is the possibility for the presence of double standards, with a delicate balance between safety and operation (see Figure 1). Homogeneity of approaches, such as defence-in-depth safety, within the regime is beneficial to safety but as the analysis of the safety concept and Safety Standards show, the technical nature of the regime may restrict learning and provide patterned replies to safety. The safety concept is based on the distinction between safety (harms caused by the biophysical world, technical deficiencies and system disturbances) and security (harm caused by malicious intent). These concepts are not able to deal with safety critical aspects derived from society and inter-organisational aspects, or from good intentions, even though good intentions have been seen to cause the majority of organisational deviance.

[3] ”The fundamental safety objective of protection of people and the environment has to be achieved without unduly limiting the operation of facilities…to ensure that facilities are operated so as to achieve the highest standards of safety that can reasonably be achieved”. (IAEA, SF-1, 2006).

[4] ”Safety shall be a paramount within the management system overriding all other demands” (IAEA, GS-R-3, 2006, 5)”.

Figure 1. Two different emphases in achieving safety within the IAEA.

Isomorphic mechanisms at the international level

The mechanisms that create similar strong understandings of safety and approaches to safety refer to close co-operation and knowledge exchange between the IAEA, WENRA, ENSREG and OECD NEA as well as professionalisation of the nuclear safety field in terms of technical education, which fosters similar cognitive understanding of safety among experts. Homogeneity of approaches within the international regime is beneficial to safety as it creates a similar efficient understanding of safety among nuclear power countries. However, homogeneity also hides some potential clashes, as Figure 1 and the analysis of the safety concept and the signalled and silenced aspects of safety show.

Signalled and silenced aspects of safety

The signalled aspects of safety refer to a mainstream, relatively strong and consensual understanding of safety in the nuclear sector, whilst the silenced aspects of safety refer to underdeveloped or downplayed aspects of safety, as well as blind spots in the mainstream understanding of safety.

The way safety is classified and described is fundamental to our understanding of safety critical events and what can be learnt from accidents. In the IAEA safety standards, the safety concept builds on engineering science's understanding of safety. As already mentioned, the concepts of safety and security, do not consider harms caused by good

intentions. Such type of harm is anything but irrelevant, being often involved in organisational deviance and crimes. Harms caused by good intentions represent the silenced aspects of safety.

The concepts of safety culture, defence-in-depth safety and probabilistic safety assessment (PSA), including probabilistic risk assessment (PRA), are prevailing frameworks for evaluating safety at nuclear power plants (IAEA 2006a, SF-1, 13; IAEA 2009, GSR 4, 13, 20-24). These concepts focus on the inner aspects of nuclear power organisations and threats deriving from the biophysical world or malicious intent by humans, but tend to ignore the larger societal and cultural contexts, which are critical to safety. The concept of a safety culture often ignores even some of the organisation's relevant inner aspects, such as technological development, financial decision-making processes and business strategies that may be relevant for safety (Reiman & Oedewald 2004).

In addition, in the IAEA safety standards, human and organisational aspects of safety tend to be restricted to individual performance and qualified fit-for-duty personnel, management and leadership (IAEA 2006b, GS-R-3). This indicates an inadequate consideration of organisational dynamics and reality. People act in organisations, not as free individuals but in roles, which are constrained by different kinds of social pressures and expectations. These social pressures may have a big influence on individual performance, and thus they are relevant for safety. Questions related to the relationships of power or domination, hierarchies, loyalties and information gaps are not adequately addressed. Another neglected or less discussed aspect, which may have relevant influence on safety, is inter-organisational connections.

Despite the fact that safety is depicted as a phenomenon that requires more than quantification, there is a tendency to quantify safety and to get more transparent assessments of the safety. There have been efforts to find systematic ways to measure and analyse safety information and to get quantitative assessments of safety (OECD NEA 2008, 8; OECD NEA 2013). The Fukushima accident triggered efforts to develop advanced safety assessment methodologies and to evaluate the current state of the probabilistic safety assessment for natural external hazards (OECD NEA 2013; Asampsa 2014). Quantifiable aspects are inscribed in the elements of nuclear safety, but qualitative aspects, such as social pressures, loyalties and power relations remain unexplored factors.

Engineering science's understanding of safety is crucial to maintaining and improving safety. However, it is also important to look at those silenced or downplayed aspects of safety that this understanding tends to ignore as related to the larger societal context or power relationships between organisations. Paying attention to these aspects can lead to improving safety or at least to getting a broader picture of the issue, and possibility to raising additional questions that are critical for safety.

Finnish nuclear safety regime and cultural patterns that communicate with safety

The Finnish nuclear safety regime is constrained by the international nuclear safety regime, although this does not hollow out the role of national cultural features within the nuclear sector. Four cultural orientations relevant to safety were identified: generalised trust in other people, trust in institutions (e.g., authorities, education and science), obedience to the law and appreciation of diligence, honesty and promptness (European Social Survey 2010; 2012; Alatarvas 2013).

Ambitious, pragmatic, technical and co-regulatory characterise the Finnish safety regime. Ambitiousness refers to the fact that upgrading of the IAEA safety standards and the WENRA Reference Levels after the Fukushima accident were well incorporated into the Finnish YVL-guides.

Trust is characteristic to Finnish culture. Trust may be a double-edged sword in maintaining safety. On the one hand, public trust in authorities is a necessary precondition for a good working atmosphere. In addition, the prevailing co-regulatory regime, in which the main responsibility for safety rests on licensees (and inspectors need to supervise self-regulation) and requires mutual trust between operators and regulators. Trust saves scarce resources by reducing the need of additional checking of behaviour. On the other hand, in a changing international and national context one can ask whether national features and practices, such as trust, can be effectively transferred to other cultural contexts. If there is too much trust in actors who do not share similar cultural frameworks or orientations to work, trust may even reduce safety. A more detailed description of trust is provided in the next chapter.

The findings of this study, which is based on documentary analysis, cannot be regarded as exhaustive. Further inquiry is therefore needed regarding the ways safety requirements are understood and implemented in a national context and the role played by cultural aspects within safety regulations. The picture of the Finnish safety regime and cultural characteristics of safety regulation is elaborated further after the interviews in the next chapter.

5 CULTURAL CHARACTERISTICS OF FINNISH NUCLEAR SAFETY REGULATION (YEAR 2014)

On the basis of the content analysis of 18 interviews, cultural characteristics and related central themes are dealt with in the following subchapters. These themes include trust, independence, relationships between the inspectors and operators and two types of inspectors, different roles of inspectors, characteristics of safety regulation, individuality vs. uniformity, and mechanisms that contribute to similar or divergent understanding of safety among the regulatory body. Themes interweave and complement each other. Themes are discussed vis-à-vis the safety and regulatory literature.

5.1 Trust norm

Trust characterises the Finnish people's attitudes toward others (European Social Survey 2012). In addition, Finns trust in institutions, such as police, education, science and technology (European Social Survey 2012; Science Barometer 2013). However, the question remains: What does trust mean and what kind of role does it play in safety regulation?

The analytical framework for studying meanings that the safety inspectors attached to trust consists of following dimensions: functional trust and functional distrust vs. dysfunctional trust and dysfunctional distrust (Lindoe 2014; Tharaldsen 2011); trustworthiness, i.e., sources for regarding a person as trustworthy (Braithwaite 1998); levels of trust, whether at the individual or organisational level; and actors (trust between inspectors and operators). Inspectors were asked what makes operators trustworthy and what makes inspectors themselves trustworthy.

With regard to trust, one can distinguish between functional and dysfunctional trust as well as functional and dysfunctional distrust (Tharaldsen 2011). Dysfunctional trust refers to a blind or naïve trust indicating that inspectors trust in what operators say, without conducting any checks. Functional trust, instead, includes verification that things are as they have been said to be. Dysfunctional distrust refers to a biased and prejudiced distrust in the operator, and detailed surveillance, whilst functional distrust leans on documentation and experience that things have not been dealt with in a pertinent way. Functional trust and functional distrust mean that there is a rational, realistic and verified basis for trust or distrust and therefore these concepts are desirable regarding safety regulation (see Figure 2). Instead, dysfunctional trust and distrust are avoidable in safety regulation. Through this frame it is possible to analyse a combination through which trust and distrust function.

Conceiving a person or an institution as trustworthy may be based either on values and norms, which emphasise expertise, status and professional competence (i.e., exchange trust norms), or values that stress another person's benevolence, good will, and willingness to promote values and interests that are important for the trust giver (i.e., harmony values) (Braithwaite 1998; Pellizzoni and Ylönen 2008).

The inspectors recognised that trust is a very relevant factor in safety regulation as the citations below indicate. Interviews with inspectors also showed that the most common combination was functional trust and functional distrust. Indeed, inspectors saw dysfunctional trust and dysfunctional distrust as avoidable. An indication of functional trust is when inspectors think that operators are honest but still find it good to verify that operators have dealt with things in a pertinent way. In addition, functional distrust comes out in a situation in which one inspector emphasises that it is good not to trust too much because they have previous experience and verification supporting their belief.

"The role of trust is crucial. The power companies should be able to trust us and that we make rational decisions and that our line is stable." (Interviewee C).

"I think that trust works to both directions, that both (operators and inspectors) trust in each other. And appreciate one another's competence. Without that our system would not be so functional as it is." (Interviewee A).

"They (operators) are honest, but things can be interpreted in many ways. I have not realised betrayals from the part of the licensee. But it is good not to trust too much. Normally there are issues that relate to timetables, not so much how things are dealt with, but the delays in timetables…One does not need to be suspicious but to ensure that things are dealt with in an appropriate way." (Interviewee J).

The interviews with the inspectors showed that trust leans mainly on exchanged trust norms, i.e., technical expertise and competence, which reinforce mutual trust and understanding between regulators and regulatees about the approaches and means to deal with safety. In that sense, it is trust in the institution and a technical education. However, good will also plays a role in building of trustworthiness between the regulatory body and the industry. One indication of inspectors' trustworthiness based on good will is that they restrain from telling information about one nuclear power company to another one. When asked how the inspector can achieve the trust of a regulatee, one interviewee referred both to expertise and good will as building blocks of trust.

"By competence and expertise, and then by being humble and having courage to listen to the other party, their story, and by trying to understand and openly search for information, by combining knowledge and drawing right conclusions. It creates trust in a sense that the other party (operators) feels that the inspector really tries to clarify the thing." (Interviewee L).

"I do not chatter things of a power company to another one." (Interviewee D).

Furthermore, the inspectors also described situations where the trust norm is questioned, and when trust may turn to distrust. Situations of distrust may be due to newcomers both within the industry and authority. Newcomers have not yet internalised functional trust norms, and they are prone to enter into relationships that may be more adversarial. In addition, situations of distrust may be related to delays in timetables or divergent interpretations of the requirements, such as the technical terms and conditions of safety (TTKE, Turvallisuustekniset käyttöehdot). Instructions have been open to interpretations and the licensees have interpreted them in a different way than the inspectors.

"And when there are newcomers within the licensee's side, and when we have newcomers it may easily lead to a situation of conflict." (Interviewee A).

"Trust requires reciprocity, mutual trust if the action is to be fluent or flexible. But if one thing starts to get wrong it may lead to the reciprocal distrust."(Interviewee C).

Interviews with the inspectors show that trust is a key component in Finnish safety regulation. It is a precondition for the functioning of the Finnish safety regulatory system. It is a norm that provides a framework for an interaction between the inspectors and operators. According to interviews, trust requires reciprocity and if trust turns to distrust, it will take a long time to gain trust again. In a Finnish cultural context, trust is not blind and naïve, but functional. Hence, a combination through which trust and distrust function within the STUK is through functional trust and is based on verification that operators act as they have said, and functional distrust that refers to justified cautions in some regulatory situations. These can be seen beneficial to the safety regulation.

Even though this combination is ideal and desirable, it may be that some specific features in Finnish safety regulations may cause embarrassment among actors coming from different cultures. It may be that outsiders feel that Finnish inspectors are too strict and carriers of dysfunctional distrust rather than functional trust. This may be due to the YVL-guides, which include relatively detailed requirements that force inspectors to adopt strict, detailed control. It may be that Finnish inspectors' style to verify that things have been dealt with according to the YVL-guides is interpreted by outsiders as dysfunctional distrust instead of functional trust. Figure 2 illustrates different forms of trust and distrust and the risk that functional trust is understood as dysfunctional distrust by outsiders.

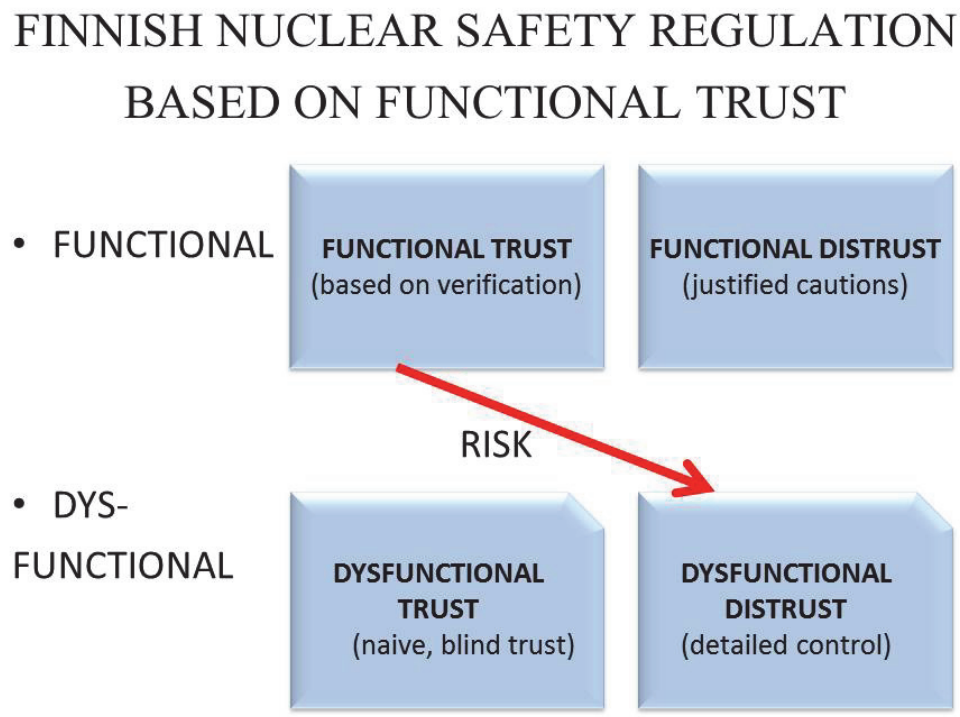

Figure 2. Risk that the inspectors' functional trust can be mixed with dysfunctional distrust.

It seems that Finnish safety inspectors do not themselves reflect that their regulatory practices, this could be seen as dysfunctional by others, even though they have realised that actors from other countries may be surprised by the detailed practices of Finnish nuclear safety authority. Here, it is important to remind that the regulatory authorities' supervisory duties may vary in different countries. It may be that actors who come from other cultures do not know or understand the duties of the STUK (see e.g., STUK 2011). Therefore, it would be important to make duties visible to outsiders. In Finland, the STUK has a supervisory duty regarding pressure devices. Differences in duties also affect the regulatory style and are relevant when comparing different cultural characteristics. In any case, relatively detailed regulatory practices may be a point of disagreement and confusion between Finnish inspectors and actors from different cultures; in the worst case it may undermine trust in inspectors. Therefore, it would be interesting to further study how different stakeholders understand Finnish inspectors' regulatory work. In addition, it would be worth studying cultural features of other nuclear safety regulatory bodies, in order to make comparisons and gain a better understanding of cultural differences and similarities that could be beneficial for the improvement of nuclear safety.

5.2 Independence of the regulatory body

After the Fukushima accident, the IAEA emphasised the need for independence of the regulatory authority from outside pressures. The regulatory body *"should be able to make independent regulatory judgments and decisions timely both in normal and emergency situations"* (IAEA 2012, DS462). The STUK inspectors were asked to reflect on how independence is achieved in Finland. The interviews showed that Finnish nuclear safety inspectors feel they are independent from outside pressures and are able to act independently despite the fact that within the nuclear sector in a small country there are relatively few actors and that the inspectors and the operators may know each other. The inspectors based their independence arguments on three types of justifications: institutional arrangements, which separate the regulatory body from the body that allows licenses; inspectors' practices and decisions, which do not follow the expectations of licensees; and inspectors' high professionalism and focus on pertinent things and facts, which guarantee independence.

The following citations illustrate the inspectors' justifications of their independence. The first citation refers to the institutional arrangements and structural factors that make STUK independent from the body that allows licensees.

"*Independence is accomplished in the sense that the STUK is a separate actor in regard to power companies. The STUK belongs under the Ministry of Social Affairs and Health and not under the Ministry of Employment and the Economy, which allows licenses." (Interviewee C).*

In addition to structural aspects, independence was seen as coming from the inspectors' everyday practices. Inspectors do not hesitate to intervene when they see problems.

Moreover, a sign of independence is engaging in actions that do not always please the industry, but can be the opposite of their expectations. These kinds of actions and decisions require courage from the inspectors and are indications of their ability to act autonomously.

"Anytime we see some problems we will tackle them… I think we are independent. It is seen in the form of decisions that the (operators, licensees) do not like." (Interviewee M).

"We have an ability to say, and we have said, to operators that you disagree but we go this way, the decision stays." (Interviewee N).

Finally, inspectors' sense of professional integrity and their attempts to focus on pertinent things are seen as contributing to independence. In addition, inspectors say that there will always be more than one person who is involved in regulating safety activities, so it is not possible that one person's biased understanding would affect the decision and action of the regulatory body.

"I think that independence has become true very well and we are in Finland direct and we can say to ex-colleague[s] (from industry) that you are now in that job and you think in a certain way that is understandable but you may understand why we inspectors act in this way…Independence means that things are dealt with on [a] professional level…Things are never dealt with so that they are dependent on one person." (Interviewee D).

Critical reflections also appeared regarding independence. Inspectors highlighted situations, which could risk independence. One of these situations is when an inspector knows operators too well and that could affect an inspector's capacity to act objectively. Moreover, inspectors have sometimes exposed themselves to difficult situations by promising the industry that prompt action would be taken. If it turns out that the operators' documents are not adequate, it requires courage from inspectors to go back on their words.

"Perhaps the biggest problem in our action is that if we promise that we deal with some issues quickly, and if it appears that it is not possible… one should have courage to cancel the promises because it is safety - not timetables - that we are controlling." (Interviewee C).

"It [independence] can be difficult to achieve, because one acts in a narrow sector. One needs to invest in independence." (Interviewee Q).

Despite critical reflections, the general tone in inspectors' talks was that they are able to act independently even if they would have friends within the nuclear industry. The ability to act independently derives from professionalism and strong self-discipline. One manifestation of self-discipline and also a means of keeping independence is the refusal to take offered lunches from the operators/licensees. In the past, a general custom was

that the licensee/operator could serve a steak dinner for inspectors. Nowadays, inspectors are required to refuse any offered meals. One could call all the actions and precautions that are done to reinforce authorities' independent position "independence works." Figure 3 synthesises different aspects of authorities' justifications of independence.

"I have never seen it [independence] to be a problem. I do not know anybody who would favour power companies or think about them in an exceptionally positive way. We in Finland have such tough self-discipline for this job. Those who come here [STUK] know that then we are independent even though one would have friends on the other side." (Interviewee G).

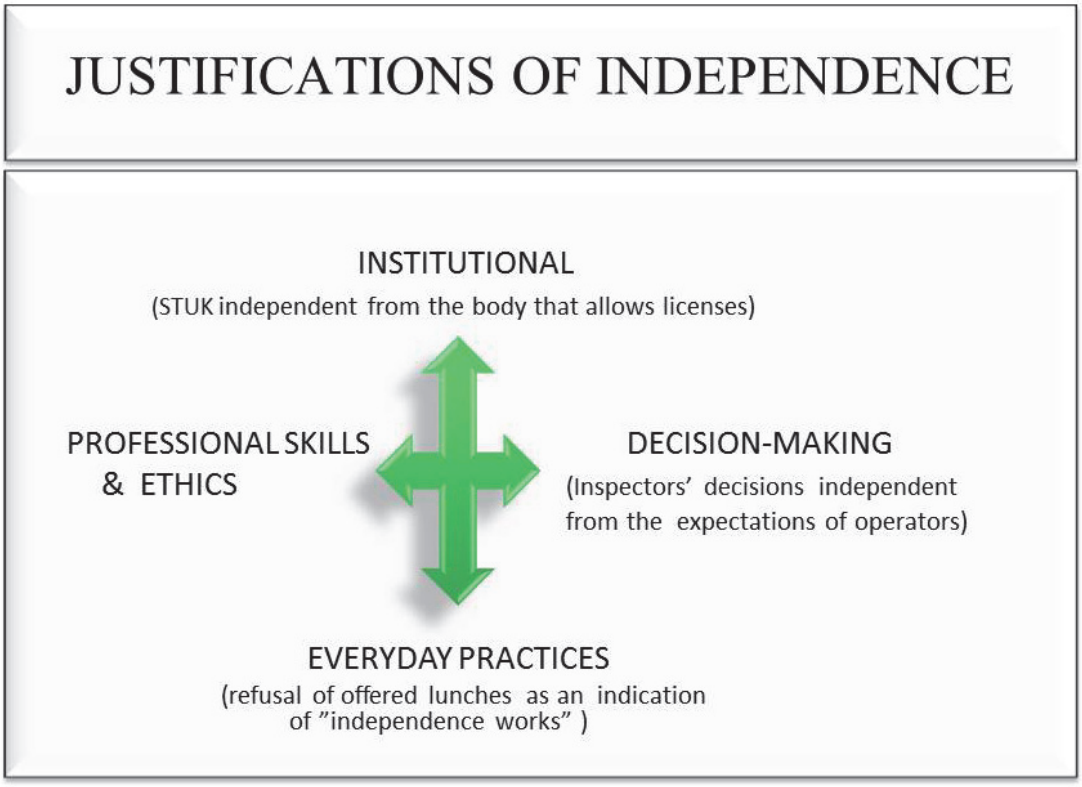

Figure 3. Finnish inspectors' justifications of independence based on institutional factors, professionalism and practices.

There is a strong sense of professional integrity among inspectors. They feel they do not need to compromise their independent position even if they have friends who work at power companies, or even if they would belong to the same association as the representatives of the industry.

5.3 Relationships between the operators and the inspectors and two types of inspectors

Closely related to the independence item, but still forming its own field of discussion is the relationship between the operators and the inspectors. From the point of view of safety regulation, too close as well as too distant relationships between the inspectors and the operators should be avoided. If relationships are too close then there is a risk of "regulatory capture," i.e., inspectors start to promote interests to the industry (Hawkins 1984; Friedrichs 1996). Whereas, in the case of relationships that are too distant, inspectors would not be aware of what is happening in the facilities and that is unlikely to improve safety (Baldwin et al. 2012). The question is then how to balance adequate proximity and distance in the relationships.

Two types of inspectors can be identified on the basis of how inspectors think about operator-inspector relationships. Within the STUK, one can find some dissenting opinions regarding whether there should be distant or close relationships between the inspectors and operators. Reflections of the relationship emerged in the interviews while discussing personnel mobility between the nuclear industry and the regulatory body. In addition, membership in the Finnish Nuclear Society (ATS) triggered reflections of the inspector-operator relationship. There are inspectors who prefer neutrality and relatively distant relationships with the industry as well as those who think that neutrality is possible even though inspectors know the operators. Inspectors who have ex-colleagues or friends within the industry think that friendship does not compromise safety regulations or their role of inspector. They believe they are able to differentiate between work and leisure time and treat work things in a pertinent way, on a professional level.

The following citations describe the range of opinions regarding appropriate relationships between the operator and the inspector. The opinions ranged from those who prefer relatively distant relationships to those who favour close relationships between inspectors and operators.

"Pertinent, good relations, but not friends and not in close contacts, because there is always a risk that one's own perspective becomes narrow and one starts to understand [the operators a] little bit too much." (Interviewee Q).

"I think it is not a problem if the inspectors and the operators know each other, if we put safety as the paramount. ... On the contrary, if the relationship with the inspector and the operator is such that the other decides and dominates that leads, according to my view and experience,...to bad field and bad rules as regards safety." (Interviewee L).

"Lawyers are very strict because they cannot say otherwise than the law says. And one young person (inspector) asked whether he needs to leave all his friends [in the industry]… work is work and leisure time is leisure time, that has been understood within this sector." (Interviewee A).

"In my opinion, one needs to be able to talk about technical issues in a detailed way, and if one discusses… these solely in some meetings then it may be that one does not reach understanding about it." (Interviewee D).

The citations reveal that inspectors see it as important to have adequately good relationships with the industry. Some inspectors may know operators relatively well. This may lead to reflections about what is appropriate and what is not. There were also those who see it only as a benefit for the safety regulation if inspectors know the operators well. There is an opportunity for informal discussions that happen outside inspection situations and which may provide valuable information about technical issues and provide opportunities to gain better understanding of such issues. Furthermore, background information that may come out in an informal context is seen as beneficial to safety. Inspectors confirmed that the information they got from an informal context has never led to compromises in safety regulations.

Mobility

There is personnel mobility from the regulatory body to the nuclear industry, from the nuclear industry to the regulator body, as well among the nuclear industry companies because of new nuclear power plant projects. Attitudes towards mobility from the nuclear industry to the regulatory body were mostly positive among inspectors. Mobility brings about a required technical understanding of the functioning of the nuclear power plants and their systems. Examples were drawn from Great Britain, where inspectors need to have experience in working with the industry. Mobility was seen as bringing better knowledge, an important aspect for improving safety. On the other hand, some inspectors mentioned that there are also those inspectors who are concerned that the industry loses relevant know-how in safety if the regulatory body hires people from the industry.

"Free mobility is our strength." (Interviewee D).

"Mobility brings in-depth knowledge and understanding." (Interviewee H).

"When people are recruited [to STUK], it would be good if there would not be such an attitude that [it is] better not to recruit from the power companies, because then this decreases their safety." (Interviewee D).

With regard to mobility, some disadvantages were mentioned. These included concerns that the newcomers are too biased and have loyal attitudes towards operators.

"*Those who come from the industry to the regulatory body may have too strong [of] views. It may be that [one's] own viewpoint is not critical or objective, that kind of risk there can be." (Interviewee C).*

"*One can ponder things in favour of power plants, and think that certain kinds of things are not important because things have been always dealt with similar ways." (Interviewee R).*

Belonging to the Finnish Nuclear Society and two types of inspectors

Belonging to the Finnish Nuclear Society (ATS), which was originally established for promoting[5] nuclear power, divides opinions among the safety inspectors. The attitudes range from a shared normative understanding of the need for neutrality of the inspector, and thus avoiding membership, to a positive understanding of the usefulness of a membership for engineers' professional competence. In the latter case, membership is seen as providing relevant knowledge and contacts and strengthening engineers' skills. Interviewees think that many inspectors belong to the ATS. Some inspectors pondered that STUK has a relatively neutral attitude regarding membership, whilst some mentioned that in an education course a lawyer had suggested that they should not to become members. Moreover, there are also inspectors who expressed indignation if the inspector position would dictate their right to belong to the ATS or their leisure time activities.

"I'm not a member. [At the] coffee table I have heard discussions, some are very strongly in favour of belonging to the ATS and some are strongly against it. I have thought that I do not want to belong to it, if there is even [a] tiny risk (for neutrality)." (Interviewee Q).

"I'm not a member, but have thought about it. There are quite many members from STUK. It may be that some want to promote their career and get contacts through the association or want…doors…open to different directions. There are also many excursions and that can be a nice change in everyday life. (Interviewee R).

"I do not belong to it anymore. I was a member for a while, but then I thought that I do not want to become profiled as …I want to be as neutral as possible...I think it is good to be neutral so that it does not look outwards that we would be the same family [with the industry]." (Interviewee B).

"I belonged to ATS, but I'm not a member any more. As an engineer, I see it is fine to be a member because excursions improve your professional skills. But what it is and how it looks may be different. I thought it is better in my position that I withdraw." (Interviewee D).

"I say this as an anecdote that I joined immediately [ATS] after our lawyer mentioned [it] in one education course in STUK that it would be good not to join. I immediately joined. I have also human rights even though I'm [an] inspector. I can support [the]

[5] According to one interviewee, in the 1990s the text related to promotion of nuclear power was removed from the ATS pages.

green or blue or red party and belong to a registered association. I took that as a personal right." (Interviewee N).

"I'm a member. I think in STUK, attitudes are quite neutral. I think many see it as a forum where one can see other people. It is an association that aims at promoting the nuclear power and expanding it. There are two schools so to say, as regards whether you could be a member or not. I think STUK has not taken a strict stand on it, to either direction. I think many are members. For me personally, it has affected that ATS is not any lobbying organisation. It has always been able to be neutral." (Interviewee G).

Dissent opinions regarding membership can be interpreted through the framework of regimes of justification (Boltanski and Thévenot 1991). The regimes of justification crystallises the principles on the basis of how the interaction between inspectors and operators has been coordinated. One can distinguish between two different types of inspectors according to their opinions on belonging to the ATS (See Figure 4). Non-members have internalised the role of inspector as a promoter of public interest, justice and democracy; they are more collectivistic oriented. One could call it civic regime. This idea is illustrated by the following expression: *"We are the eyes and ears of citizens, and we will ensure their safety" (Interviewee L)*. Non-members identify themselves with the role of public servant. Their relationship with the operators is coordinated on the basis of their principal commitment to serve the public. They are most worried about the neutrality of the inspector. Therefore, they try to keep a certain kind of distance to operators.

Those inspectors who are members of the ATS have adopted different types of roles; they are more open and informal in their interaction with operators. Inspectors feel they do not need to be distant or bossy; one could call this domestic regime. This idea is characterised by trust and negotiations between the inspectors and operators. In addition, it seems that these inspectors are more individually oriented. They also have internalised the principles of effectiveness and functionality of the industrial regime and they appreciate development of their engineering skills. Often these inspectors seem to be more open to other job opportunities or they have a background in working in the industry.

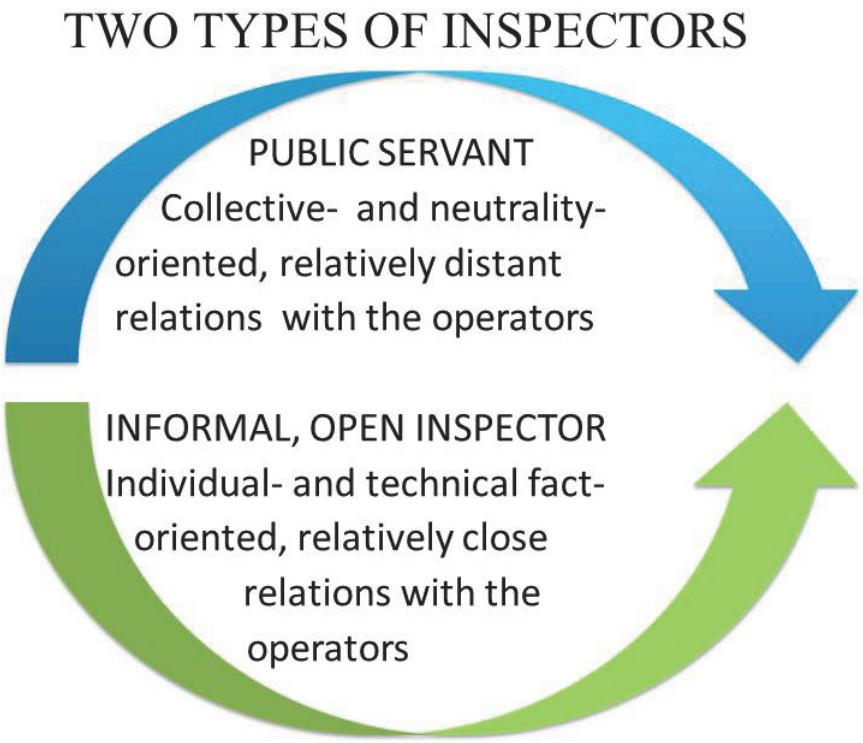

Figure 4. Two types of inspectors based on their opinions on belonging to the Finnish Nuclear Society (ATS).

It is important to add that both types of inspectors were interested in developing their skills. So this can be regarded as a common goal. Moreover, both types of inspectors are obviously needed in the current regulatory context, even though their different framings can lead to disagreements. The public servant type of inspector has internalised a role that takes into consideration both industry and public points of view, whilst the informal and open type of inspector is more focused on the inspector-operator relationship and believes that their technical expertise guarantees efficient regulation and competence as inspectors. Moreover, they are less concerned about public opinions. The following chapter further highlights the regulatory context and different roles of inspectors.

5.4 Different roles of inspectors

Studies on safety regulation emphasise that, over the last thirty years, a shift has occurred from a command and control type of regulation towards a decentralised regulation, where safety is an outcome of actions of different actors and networks (Baldwin et al. 2012; Lindoe et al. 2014). In decentralised regulation, knowledge is fragmented, meaning that no actor has all the relevant knowledge required to deal with complex and multifaceted safety problems or no actor has an overview of safety regulations and the ability to employ all means necessary for effective regulation (Black 2002; Baldwin et al. 2012). The decentralised understanding of regulation also stresses

interactions and interdependencies between actors, and a challenge to coordinate actions of different, autonomous actors who are involved in, for instance, nuclear activities (Black 2002, 16). In a situation of decentralised regulation, where the outcome of the safety regulation is a consequence of actions of several actors and networks, the role of a motivator is emphasised. How did the different roles of inspectors come out in the Finnish context? What kinds of meanings did inspectors attach to roles?

The role of inspector came out in different contexts in the interviews. The role was mostly associated with neutrality and independence. In addition, four additional roles related to inspector were mentioned. Two of them were desirable roles related to controller and motivator, and the others two were undesirable roles related to advisor and quality controller (see Figure 5). The inspectors identified themselves most frequently with the role of a controller who ensures that the industry complies with the requirements. In the citation, one inspector also acknowledges the risk of having too detailed control.

"We have a strong control function, and one negatively-oriented word is that we are sometimes [a] little bit too meticulous" (Interviewee G).

Instead the role of a motivator did not come out of interviews, at least not directly. One can ponder why the motivator role seemed to be weaker, or not as strong as the role of controller. Is it because YVL-guides strengthen the role of controller and there is therefore, not so much space left for the role of motivator? Or is it just that that the role of a motivator did not come out verbally even though it is adopted in regulatory practices?

The following features in Finnish safety regulation suggest that the motivator role is also present. Finnish inspectors work closely with operators in the facilities. There is a site inspector, who works continuously in a facility. This kind of solution differs from many other nuclear power countries. Finnish inspectors also closely follow the modernisation works in reactors. In that sense, they have experience with what is happening in the reactors and they have practical experience in the functioning of the reactors. One could think that if inspectors follow the modernisation and other development projects in facilities and are close to operators that would open up several opportunities to motivate the operators. In addition, inspectors' willingness to follow the process because they are interested to see and learn how things are done, speaks to inspectors' strong motivation. That practice may also motivate operators to find better solutions.

When the inspector so closely follows the process, the benefit is that they acquire a deep understanding about what is happening in the installations, which is an advantage regarding controlling overall safety. However, a risk that inspectors are too closely involved in the development processes that belong to power companies, and inspectors may easily take the role of an advisor, a role that does not belong to their mandate, might also be present. In addition, the role of quality controller is a risk if authorities

visit producers to ensure that the structures of devices and components are according to the requirements.

"They (power company) made a modernisation project related to the system X, and I asked whether another inspector could participate as an observer in their work group. We both emphasised that we do not want to advice how you do this, but we want to look how you do things and we may comment. This way we are able to stay up-to-date. And they said of course..." (Interviewee O).

"When I was still a beginner as an inspector, I was told, that never advice licensees how you should do things because it is not our task. And it took about one or two years to take the inspector's role." (Interviewee N).

"It is important to keep the inspector's role. We do not run the plants, and we shall not plan and present solutions on behalf of power companies, because then we would take responsibility for solutions that belongs to the company. And if one is not alert it may easily lead to a situation in which inspectors are asked and tested by the company, that what could be accepted by the STUK…One shall not advice, guide or lead. And even though there would be a temptation to say what is [a] more right solution, one should avoid that. It is possible to ask why so but nothing one should suggest directly." (Interviewee J).

The citations show that younger inspectors are warned not to adopt the role of a consultant or advisor, however, the line between consulting and just following and commenting can be thin. Experienced inspectors have learnt to avoid the risk of consulting, for instance by asking why operators do something in a certain way. That may make operators reflect and justify their actions. This kind of practice is skilful and may motivate operators to find better solutions. Hence, this kind of practice may refer to the role of inspectors' as motivators.

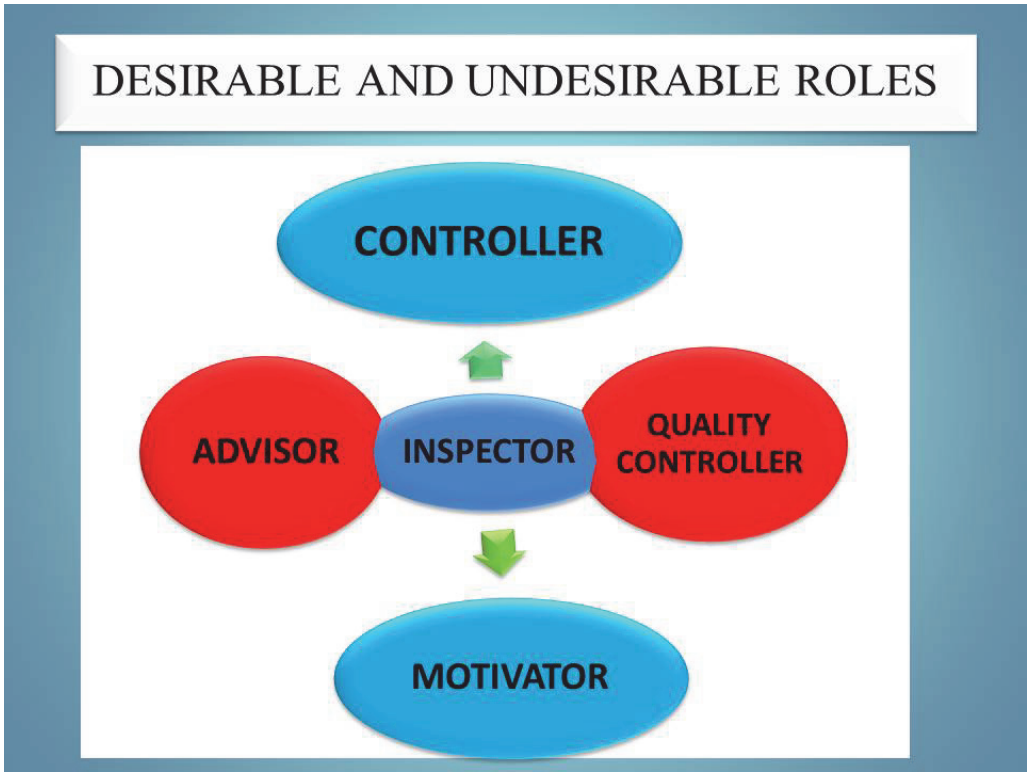

Figure 5. Two desirable roles (controller and motivator) and two undesirable roles of inspector.

The roles of controller and motivator may easily contradict one another. The former follows rules relatively strictly, whilst the motivator is more oriented towards negotiations. In the decentralised regulation context, the role of motivator is desirable. However, it is good to remember that safety regulation is always a mixture of command and control regulation and self-regulation, and within the high-risk industry, the role of controller is also relevant (Bieder and Bourrier 2012; Baldwin et al. 2012); both are needed. Even though the role of motivator did not come out clearly, it may well belong to the inspectors' practices. This could be worth further study. Furthermore, it may be that newcomers and open and informal types inspectors who are technically ambitious and close to operators, may be more susceptible to adopt the role of advisor or quality controller.

5.5 Characteristics of Finnish safety regulation

On the basis of previous chapters, we can say that the trust norm and control-function characterise Finnish safety regulation. In addition, inspectors are divided between two main groups: the public servant type of inspectors characterised by collectivistic orientation and the neutrality principle and the open and informal type of inspectors that are more individualistically, technical and fact oriented. These types are ideal types, meaning they are not average types, but opposite types of inspectors, abstracted on the

basis of interviews. Most likely, the majority of inspectors have both kinds of features. It may be that in some contexts these two inspector types may get into an argument. At the same time, both types of inspectors are needed in the current regulatory context. However, coordination of their action and getting them to act in concert can be challenging.

In addition to above-mentioned (trust norm, control-function, inspector types divided between public servant and open and informal authority) four other characterisations can be added. First, Finnish safety regulation differ from many other nuclear safety regulations in the sense that in addition to upper level requirements we also have relatively detailed administrative safety requirements – YVL-guides - for the licensees and operators. In the new safety requirements, the aim has been to write requirements on a more general level, however, in some safety areas, there are still detailed requirements. This is due to the official supervisory duties, which require detailed requirements.

Second, Finnish inspectors work closely with operators in the facilities. As mentioned in the previous chapter, there is a site inspector who works in a facility continuously and that kind of solution differs from many other nuclear power countries. Moreover, close follow-up of the modernisation projects in the facilities provides inspectors with high technical competence and up-to-date knowledge about the nuclear facilities' situation. In addition, inspectors may also visit producers of various components in order to ensure that the components meet the requirements. All these indicate that Finnish inspectors work on a grass-roots level and that they have a deeper understanding of what is going on in the facilities. Regarding safety regulations, this can be seen as an advantage.

In grass-roots level regulation there is a continuous need for balance so that inspectors do not infringe upon operators' responsibility for safety. Due to grass-roots level work, there are better opportunities for control but also for motivation of operators. The citations below indicate that Finnish inspectors have adopted close grass-roots level regulation. This provides inspectors with deep knowledge about the situation in facilities. The control function is prevailing and sometimes inspectors themselves see regulations as being too detailed. In addition to rigid and control-based regulations, there are also many situations that are open for negotiations and discretion. In particular, it is possible to negotiate procedures. Hence, Finnish regulation is a combination of rigidity and flexibility. Moreover, there is a continual need to find a balance between the grass-roots level action and the ability to restrain oneself from giving advice to operators and thus, not taking responsibility for safety from operators.

"If the licensees make some changes or modernisation works in reactors, we are there all the time and go and see the realisation of the works…We are very close to operators, on the grass-root level. We are in facilities, and in no other country the inspector is on such level, on the nut level." (Interviewee E).

"Finnish safety regulation is very competent. We have [a] lot of know-how and the level of our requirements is one of the most rigid, if not the most rigid, in the world. And it is rigid in the sense that it is ensured that requirements are met so they are not only soft talks." (Interviewee G).

"We have these YVL-guides but they are not 'carved in stone'. If the matter is not safety-significant, we can be flexible. And it is impossible to have instructions to all cases." (Interviewee M).

"Strict but flexible, procedures can be negotiated." (Interviewee K).

Third, Finnish nuclear safety inspectors have participated in improving and writing the WENRA Reference Levels after the Fukushima accident. In addition, Finnish nuclear safety inspectors have been in the forefront in adopting new safety standards (the IAEA and WENRA). The following citations suggest that the Finnish cultural style is to adopt new requirements in full and Finns are accustomed to writing requirements. This may also shed some light on the ambitious attitude of Finnish safety inspectors.

"Finland has adopted learnings from Fukushima in a way that is typical of Finnish - that means learning in full." (Interviewee D).

"We have renewed our requirements, we are used to writ[ing] requirements." (Interviewee C).

Within the safety and regulatory literature, there have been discussions about the risks related to proceduralisation i.e., detailed descriptions about safety objectives and the ways they should be obtained (Bieder and Bourrier 2012). It has been acknowledged that proceduralisation may encourage self-learning capacity of actors and thus contribute to safety. On the other hand, the recent safety literature also has problematised the increasing push towards a widening scope of norms because too general or too detailed norms, in respect to context, could threaten progress in safety (ibid.). Norms that are too detailed will not provide sufficient incentives for operators to improve safety. Furthermore, following detailed instructions may take resources from further safety developments. Moreover, it may block the industry's capability for creative developments within different safety areas. Hence, the risk of negative effects of proceduralisation lurks in the ambitious Finnish safety regulations.

Risk-informed safety regulation

Fourth, after the Fukushima accident, the role of probabilistic risk analysis was strengthened as a means to manage safety at the international level. The Fukushima accident showed some lacunae regarding risk analysis. Re-evaluation of the current state of probabilistic safety assessments for natural external hazards is seen as relevant as well as needed in order to share methods and good practices among the OECD NEA member countries (OECD NEA 2013, 40). In Finland, the analysis of extreme weather conditions, such as floods, was already carried out in the 1990s. In that sense, new

requirements set by the IAEA, in light of lessons learnt from Fukushima concerning the analysis of natural hazards, have not brought much that is new to the Finnish nuclear safety regulatory context. However, probabilistic risk analysis (PRA) forms a basis for managing nuclear safety related risks throughout the lifetime of facilities and activities (STUK YVL A.7 2013). Probabilistic risk assessment (PRA) has been deployed in the Finnish nuclear industry since the first half of the 1980s, thus approximately 30 years. Finnish inspectors have used PRA as a tool to improve regulatory practices in regard to what, how and how often the structures, systems and components should be checked; PRA is positively valued within the nuclear sector. Interviews showed that inspectors trust in the probabilistic risk analysis and its usefulness in safety regulation. Apart from the PRA experts, there were few inspectors who reflected the challenges related to risk analysis.

"Risk-informed selection is always used to clarify what is the probability that some device gets broken and what are its consequences." (Interviewee H).

"Our task as inspectors is not to tell that this is very dangerous, or say that this is safe, without risks. Instead our task is just to tell in an understandable way that this industry includes risks and what we are doing in order to further minimise the small risks and improve safety." (Interviewee D).

"PRA is not able to take into consideration uncertainties, there are different types of uncertainties…the more difficult are uncertainties related to knowledge and their modelling." (Interviewee C).

However, a growing number of researchers and analysts have found the probability-based approaches for understanding risk to be too narrow (Aven 2014; Linnerooth-Bayer and Walhström 1991, 239). The criticism is targeted towards heavy reliance on probability models and frequentist probability. PRA includes assumptions, which can conceal important aspects of risk and uncertainties. In some cases, the probabilities can be the same, but the knowledge upon which they are built, can either be strong or weak. These aspects of the PRA have often remained unaddressed. Even though the PRA is a good tool in analysing risks, too much reliance on it would not be ideal due to weaknesses related to the abilities of the tool.

Finnish nuclear safety regime

Cultural characteristics of Finnish safety regulation can be crystallised as highly professional, trust and control-based regulation entailing grass-roots level, relatively detailed, proceduralised, ambitious, technical and risk-informed safety regulations. In addition, a combination of rigidity and flexibility characterise Finnish safety regulations.

Safety regimes create a social order through cultural characteristics, principles, and formal and informal norms and practices, which affect the interaction of stakeholders. The interaction between stakeholders is affected by the functional trust and functional distrust, which can, however be mixed with the dysfunctional distrust due to a detailed regulation. In particular, people coming from different cultures could interpret inspectors' functional trust as dysfunctional distrust and that could undermine trust in inspectors. In addition, the two different types of inspectors affect interactions between inspectors and operators as well as between inspectors and the public. The public servant type of inspector is more concerned with the neutrality of the inspectors and thus, the balance between the public-inspector-operator relationship. The public servant type of inspector takes the public into consideration better than the open and informal type of inspector does as this type of inspector is more individually and technical, fact-oriented and more focused on the inspector-operator relationship.

5.6 Uniformity vs. individuality

The STUK is an expert organisation, where each inspector's expertise is appreciated. Interviewees were satisfied with their opportunity to think individually and use their creativity and skills. At the same, some inspectors recognised a problem of the existence of too much individuality that does not necessarily contribute to safety or "overall safety"[6]. Individualism was seen as a problem in the context where inspectors should act in a uniform way regarding the nuclear industry. Individualistic practices and different regulatory responses and requirements presented by individual regulators would threaten the industry's trust to the regulatory body. In addition, there is the OECD NEA's report (2014) on the Characteristics of an Effective Regulator that works as an incentive to harmonise the regulatory practices within a regulatory body. The requirement of uniformity relates to the need to act in a predictable and coherent way. In addition, too much emphasis on secondary issues that are not principal regarding safety might even work against safety, if resources are targeted to unimportant tasks. Therefore, coordinated practices based on the graded approach and safety significance of the matters have been suggested as a solution to somewhat diffused practices among the STUK. Furthermore, overall safety was seen as a key target for development. The need to understand overall safety has actualised in the context of ongoing changes and modernisation processes in nuclear reactors. Lots of changes made in components and systems have triggered a need to understand the total safety situation in the facilities. Therefore, there is a need to combine expert knowledge from different safety areas represented by different offices within the regulatory body and get them to serve the overall safety goals.

"Every office within the STUK has its expertise but each office looks at safety from its own narrow viewpoint." (Interviewee A).

[6] By overall safety I mean an integrated consideration of the manifold aspects of safety, as regards both the various systems levels (from component to plant) and the different expert perspectives involved.

"It is good that there is individual thinking, but in principle the action should be quite unified and predictable." (Interviewee J).

"One should be able to understand the totality, overall safety and this is a difficult thing." (Interviewee L).

"The scope of regulation should be on the level of [the] plant and system, so that we follow realisation of safety on upper level[s]. It is important to target our resources to a plant level that is more complex. There are more interfaces and one needs to discuss more with people who are experts in reactor techniques and automation, there needs to be inner interaction within the STUK. Increasing of interaction will be crucial." (Interviewee D).

In addition to the need to increase inner interaction among inspectors and homogeneity in their regulatory activities, individual thinking also was appreciated and understood as crucial for inspectors. Too much push towards similar behaviour would not lead to good results. Literature on safety regulations has also acknowledged that too much similarity based on certain norms (proceduralisation) may be detrimental to the improvement of safety (Kringen 2012; Bieder and Bourrier 2012). In that sense, some sort of differences between practices of safety could be beneficial to the safety goals, as they would keep people alert.

The following citation refers to how new technology has provided new information about risks and also challenged the earlier interpretations of the situation. Every situation, in which interpretation is different from what it was earlier, requires courage from inspectors to intervene. In that sense, an ability to intervene and question the existing consensus is also important.

"I said that it is justified to assume [on the basis of new ultra voice technique] that the fracture [in certain parts of a device] proceeds…it has been calculated and assessed but it has not been seen as a big risk...I just wanted to wake up people to realise that if in the next [measurement] the result is this, whether [or not] they have a readiness to prepare it." (Interviewee E).

There is an increasing strive for uniform practices and a willingness to limit unnecessary individuality among the STUK. However, at the same time, inspectors' individual thinking and courage is needed. Therefore, a search for a reasonable co-existence between uniformity and individuality seems to be an important task within the regulatory body.

5.7. Mechanisms that create consensus or disagreements regarding safety within the STUK

Interviews with the inspectors illuminated some isomorphic mechanisms through which similar, effective understanding of safety and safety regulation is created within the STUK. The majority of safety inspectors have a technical education. Hence, the expert structure of the STUK provides a similar cognitive basis for understanding nuclear safety. In addition, the "YK-course," a specific training course arranged for the newcomers within the STUK and the nuclear industry, provides information that contributes to a similar understanding of safety. Furthermore, the administrative "YVL-guides" provide an efficient framework for safety regulation. Similarly, certain safety approaches, such as the probabilistic safety assessment and the deterministic safety assessment, or defence-in-depth safety with related assumptions will provide reservoirs of understandings and; in this way, they create similar shared understandings of the right ways to deal with safety.

There are also mechanisms that create disagreements or different understandings of safety among the inspectors. With regard to YVL-guides, co-existence of a more general as well as more detailed guides may give contradictory normative understandings of how safety should be regulated. However, STUK has different types of official supervisory duties concerning, for instance, structures and pressure devices, which require more detailed YVL-guides. When, in the conventional industry, many requirements are written in the decrees, in the nuclear industry the requirements are presented in the YVL-guides. In that sense, one can understand the relevance of detailed requirements in some technique areas.

In addition, the STUK consists of different offices, each of which focuses on different technical areas of expertise, such as risk analysis, operational safety, reactor and systems safety and mechanical devices. Each office examines safety matters from their own technical expertise viewpoint. Documents related to, for instance, changes in nuclear reactor's systems are dealt with competently but with a specific focus, and the more specific is the technical focus, the narrower is likely to be the understanding of the overall situation of a plant. That means that the understanding of the overall situation and safety in the plant may often remain obscure and fragmented to inspectors, notwithstanding those inspectors or personnel of the STUK authority who are in the position of a coordinator. The technical area they are specialised in and their position dictate inspectors' understanding of safety. The upper level personnel of the STUK have a broader understanding of safety than the lower level one. Therefore, within the same organisation there can be different groups with different views of safety.

"These offices are quite differentiated. When some changes in systems of a nuclear reactor are made, these are dealt with through documents that [have] different areas of technique [to] look at, but [the] overall picture is not achieved. Possibly only a coordinator has an overall picture." (Interviewee J).

Concerns about the lack of understanding of overall safety as well as the lack of uniformity in the regulatory practices among inspectors were expressed in the interviews. The different practices between the inspectors reside between different offices. In addition, there are differences between the newcomers and more experienced inspectors in their approaches to safety. However, a better and more detailed understanding of different subcultures would require further research. In any case, it seems that there is quite a strong normative understanding among the inspectors about the need to get more uniform regulatory responses that would follow matters of safety-significance.

"The most important thing is that we get the STUK to act as a unity. There are things to be developed, such as making offices (within the STUK) to co-operate better, the management of resources and the allocation of time to inspection of safety-significant things." (Interviewee C).

Recent change in organisational structure, from a line organisation to a matrix organisation, has been seen as an opportunity to promote mutual interaction between different offices within the STUK. However, structural changes can be one promoter in social interaction and the desirable changes may require a long time in order to take effect.

6 OVERVIEW OF FINDINGS (YEAR 2014)

General features related to the Finnish culture, such as trust in other people and institutions (e.g., science, technology and education), obedience to the law, appreciation of honesty, promptness and diligence, recur and get amplified in Finnish nuclear safety inspectors' interviews.

The trust norm is a cornerstone of Finnish nuclear safety regulation. Trust is based on reciprocity between inspectors and operators. The building blocks of trustworthiness are technical expertise as well as benevolence. However, inspectors' trust in operators is not naïve or blind rather, it is based on verification that things are as operators have said them to be. Hence, functional trust and functional distrust characterise Finnish safety inspectors' practices. However, due to the administrative YVL-guides that force inspectors to adopt relatively detailed regulation, there is a risk that outsiders interpret inspectors' style as dysfunctional distrust, which could undermine outsiders' trust in Finnish inspectors.

Within a nuclear sector in a small country, the inspectors and the operators may know each other well, despite the fact that inspectors conceived themselves as independent from outside pressures. Independence of the STUK was based on three types of justifications. First, institutional arrangements, which separate the STUK from the body that allows licenses, second, inspectors' practices that do not follow industry's

expectations and third, inspectors' professionalism. The report on the Characteristics of an Effective Nuclear Regulator by the OECD NEA (2014) distinguishes between different types of independence, one being economic independence. The current cuttings in the work force in the research department of the Radiation and Safety Authority increase the need to consider the economic independence of the authority (cf. OECD NEA 2014).

Relationships between inspectors and the industry were examined through inspectors' normative attitudes on whether the relationships should be "close and warm or cold and distant" as one inspector formulated. According to the safety regulatory literature, too close as well as too distant relationships, are both undesirable. Too close relations could endanger the neutrality of inspectors whilst too distant relationships would alienate inspectors' from operators' reality and that could hamper safety.

Two types of inspectors were identified on the basis of inspectors' opinions on belonging to the Finnish Nuclear Society (ATS) and whether the closeness between the inspector and the operator would be desirable or avoidable. There are inspectors who are members of the ATS, and who found membership useful regarding their engineering skills. In addition, there were also inspectors who recently joined or who are considering joining in ATS. Some non-members have recently left the organisation due to the fact that their position requires neutrality and some non-members have never considered a membership because of their desire to maintain their neutrality. One type of inspector is the public servant type who is collectively oriented and to whom neutrality is the main principle; this type of inspector wants to keep adequate distance from operators. On the other hand, the informal and open type of inspector is more individualistic and technical, fact-oriented, focused on inspector-operator relationships and is less concerned about the public. This type of inspector believes they are able to be more efficient in regulation by being more open and informal in their relationships with the industry. It is their technical expertise that guarantees their neutrality. These two types of inspectors could be contradictory in some circumstances. Hence, a need to reflect upon the balance between the two types of inspectors so that adequate uniformity is found and so that adequate distant in the relationships between the inspectors and operators is achieved, arises.

Four additional roles of inspectors were identified: two desirable roles of controller and motivator and two undesirable roles of advisor and quality controller. The role of a controller was dominant among the inspectors. The role of a motivator came out only indirectly. For instance, there are practices, such as conducting close follow ups with different kinds of changes in the nuclear power plants' systems and opening up several opportunities to motivate operators that highlight the role of motivator. Even inspectors' own interest in the modernisation processes may motivate operators.

Interviews could give only hints as to how the two types of inspectors are related to different roles. Open and informal type of inspectors may have better adopted the role

of motivator in their interaction with the operators. On the other hand, the public servant type of inspectors may be more oriented to command and control types of regulation and have adopted the role of a motivator less. With regard to avoidable roles of quality controller and advisor, it may be that newcomers and the open and informal type of inspectors, who are in close contact with the operators, may have a temptation to act as an advisor. However, the inspectors have well acknowledged just such a risk and are trying to avoid it.

Cultural characteristics of Finnish safety regulations and regimes entail trust and control-based, risk-informed, ambitious, technical and professional, relatively detailed, proceduralised, grass-roots level regulation that is both rigid and flexible.

In the safety regulation continuum, Finnish safety regulations could be set on the command and control end of the continuum instead of on the self-regulation end. Even though Finnish regulation has been described as rigid, it also entails flexibility. There is always space for negotiations regarding the procedures; this kind of duality might not be visible to outsiders.

Interviews indicate that safety regulation is under pressure to become more uniform, coordinated, and focused on upper level safety issues, i.e., plant and system level safety. Screening the significance of safety was seen by the interviewees as relevant in improving safety regulation for a more uniform direction, as it would prevent inspectors from paying attention to less important things. The probabilistic risk analysis (PRA) is a relevant tool in screening the significance of safety. This came out in the interviews with the inspectors. However, if there was too much reliance on the PRA that would not be ideal either because the PRA entails a lot of uncertainties and assumptions that often remain unaddressed (Linnerooth-Bayer and Wahlström 1991; Aven 2014).

Mechanisms that maintain similar understandings of safety stem from the YVL-guides and expert structure of the regulatory body. The majority of the inspectors have a technical education, which contributes to a homogeneous understanding of safety. At the same, however, there are various areas of technical expertise and different offices within the regulator body that have promoted somewhat different practices. In addition, there are differences in safety practices between the newcomers and more experienced inspectors. For this reason, efforts have been made to streamline the safety regulation and to make it more focused on safety-significant matters.

7 DISCUSSION: FUTURE CHALLENGES OF NUCLEAR SAFETY REGULATION

This study shows that nuclear safety predominantly approached from a technical perspective is also affected by societal and cultural factors. Culture is understood here as consisting of institutional dimensions, i.e., how organisations, such as the regulatory body, act with regard to safety. Culture includes normative (how safety should be dealt with), cognitive (what is relevant for safety), social (how the relationships among the inspectors and between inspectors and the industry have been arranged) and material (e.g., practices, how safety is dealt with) dimensions. Cultural features often remain invisible and thus, require social science's means to become visible.

In 2013, the research on *Signalled and Silenced Aspects of Nuclear Safety* showed that there is a strong push toward a homogeneous understanding of safety and efficient approaches to safety among the international nuclear energy and safety organisations. Close co-operation and exchange of knowledge between national and international organisations (The IAEA, WENRA, ENSREG, OECD NEA) work as mechanisms that promote similar orientations to safety among the organisations. The signalled aspects of safety showed that the technical visions of safety are dominant. Despite that, these aspects are highly relevant in improving the safety they also silence and leave the social, cultural, intra-organisational and inter-organisational aspects of safety underdeveloped. For instance, human and organisational aspects have been restricted to individual performance that is an inadequate understanding of organisational level action.

In 2014, the study focused on cultural characteristics of Finnish safety regulation. Even though the international nuclear safety regime, with technical, co-regulative and safety-intensifying features, affects the Finnish regime, this happens at a general level. The national cultural features give the eventual form to safety regulations. Cultural characteristics of Finnish nuclear safety regulations as well as the nuclear safety regime consist of highly professional, technical, functional, trust and control-based regulation, entailing grass-roots level, relatively detailed, ambitious, proceduralised and risk-informed regulation. The study illuminated the composition of trust, independence, relationships between the inspectors and the operators. In addition, the study brings insight into two types of inspectors and the regulatory body's strive for the uniformity with regard to regulatory responses.

Two types of inspectors – the public servant, with neutrality, public oriented attitudes and relatively distant relations to the industry and the open, and the informal type, with individualistic and technical, fact-oriented attitudes, relatively close interaction with the industry and less concern about the public – may create tensions within the STUK and a challenge regarding coordination of their action. Moreover, these two types of inspectors may have different responsiveness to matters of safety.

Seven points of future challenges worthy of reflection were drawn from the research results and the safety and regulatory literature (see Figures 6, 7 and 8). The first point relates to the role of the inspector and the challenge of coordinating the activities of two types of inspectors. With regard to the inspector's role in safety regulation, the question of how far the role of inspector can extend arises. Can it also extend to one's private life and leisure time? Some inspectors that could be classified as the informal and open expressed their indignation towards restrictive recommendations and instructions, e.g., not belonging to the Finnish Nuclear Society (ATS). They possibly interpreted detailed instructions as too officious and meddlesome. They felt their technical expertise and professionalism make them capable of maintaining their inspector role despite their close relations with the operators.

The second point is linked to the first point and concerns the need for balance between the adequately distant and adequately close relationships between the inspectors and the operators. The safety regulation literature has shown that too close or too distant relationships between inspectors and the industry do not promote safety. Too close relations could lead to 'regulatory capture or agency capture' (Friedrichs 1996), which refers to inspectors' adoption of the interests of the industry. On the other hand, too distant relationships between the inspectors and the industry would also be detrimental to safety. If inspectors are too distant then they will not get adequate information about the situation of the facilities, which could hamper safety efforts.

When the licensees have the main responsibility for safety, then the question of how best to motivate them in improving safety arises. Can proceduralisation motivate the operators to develop safety? Hence, the third point relates to motivation and proceduralisation, i.e., relatively detailed descriptions and prescriptions of procedures for achieving certain safety objectives (Bourrier and Bieder 2012, 3). Proceduralisation that takes into account the context and encourages the self-learning capacities of the operators is beneficial to safety. However, studies of safety management have shown that even though increasing use of procedures contributes to safe practices, a risk that too detailed descriptions may be detrimental to safety if actors just follow the detailed rules without reflecting upon them and improving them arises. In addition, if there are plenty of procedures and processes to be followed and if these are too general or too detailed in respect to context then safety can also be compromised. There is a risk that proceduralisation does not improve safety or motivate actors to use their creativeness, but instead consumes their resources and blocks their innovative efforts to improve safety (Schulman 2012; Bieder and Bourrier 2012). In a Finnish context, the YVL-guides represent relatively detailed requirements. So the questions are: How well do the requirements motivate operators to improve safety? Are there safety areas that require or benefit from more detailed guides? Do the YVL-guides block the licensees and operators own creative efforts to develop safety?

The fourth point relates to the balance between the command and control type of regulation and self-regulation. If a command and control type of regulation and self-

regulation are the opposite ends of the same continuum, Finnish regulatory style could be set closer to the command and control type of regulation. However, all the regulatory systems are a combination of command and control types and self-regulation types of instruments, a pure self-regulatory or pure command and control type of regulation simply does not exist (Baldwin et al. 2012; Baram and Lindoe 2014). Possibly within a high risk industrial sector in a small country, there is a need to apply relatively stable and rigid, command and control types of regulations that is, however, combined with some features of flexibility and relatively close grass-roots level regulations. The Finnish regulatory style is a unique combination of principles and practices that have developed over the decades. The regulatory style is in a continuous process. The question of how to maintain adequate command and control types of regulation and at the same time ensure that it provides space for the operators' own developments arises. As does the question regarding whether or not the inspector at grass-roots level so closely follows what is happening in the facilities that it may be difficult to distinguish between command and control, motivation or command and control and self-regulation?

The fifth point entails a need to balance individuality and uniformity within the regulatory body. Individuality is needed in terms of a questioning attitude that is crucial in improvement of safety. However, safety regulations need to be uniform. There are increasing attempts for uniformity within the regulatory body in terms of inspectors' practices. These efforts are in accordance with the OECD NEA's Characteristics of the Effective Regulator (2014), with uniformity and predictability in their action. The relevant question is how to support individual thinking and at the same time promote more uniform, coordinated regulation.

The OECD NEA (2014) in its report on effective regulator stressed that "trust and respect should permeate the organisation." Even though the inspectors considered the Radiation and Nuclear Safety Authority (STUK) a good place to work because of the pleasant and encouraging atmosphere and mutual respect of expertise, there are some fractures among the inspectors that may decrease trust among them. These fractures stem from different values, or technical areas, or different offices with their divergent practices or informal rules. These may cause tensions or embarrassment among the inspectors and increase distrust. Hence, the sixth point refers to the need to develop trust among the inspectors.

In addition, in the face of current work force layoffs within the research department of the Radiation and the Nuclear Safety Authority, the seventh point refers to a need to consider the independence of the regulatory body in terms of economy (cf. OECD NEA 2014). This question becomes urgent in the current situation in which the Finnish nuclear sector is changing fast because of furthering new nuclear power capacity. In addition, there is a need for more personnel within the regulatory body.

The national cultural characteristics are important to detect and understand if safety is to be improved at the national and international level; this study cannot be regarded as

exhaustive. Further inquiry is therefore needed into different stakeholders' understanding of Finnish inspectors' safety regulations. In addition, international comparisons between nuclear safety inspectors' practices in other countries would be useful for gaining a better understanding of cultural features, similarities and differences, and consistencies and inconsistencies between them. Moreover, further research is needed in order to understand the conditions under which both the inspectors and operators operate daily when dealing with safety.

Nuclear safety is a complex phenomenon, cultural and socio-technical by nature. Therefore, there is an urgent need for multidisciplinary research, a true co-operation between the engineering sciences and social sciences in concrete research. Through it, the possibility of gaining a better understanding of how cultural, social and technical are participating in the end result of nuclear safety exists.

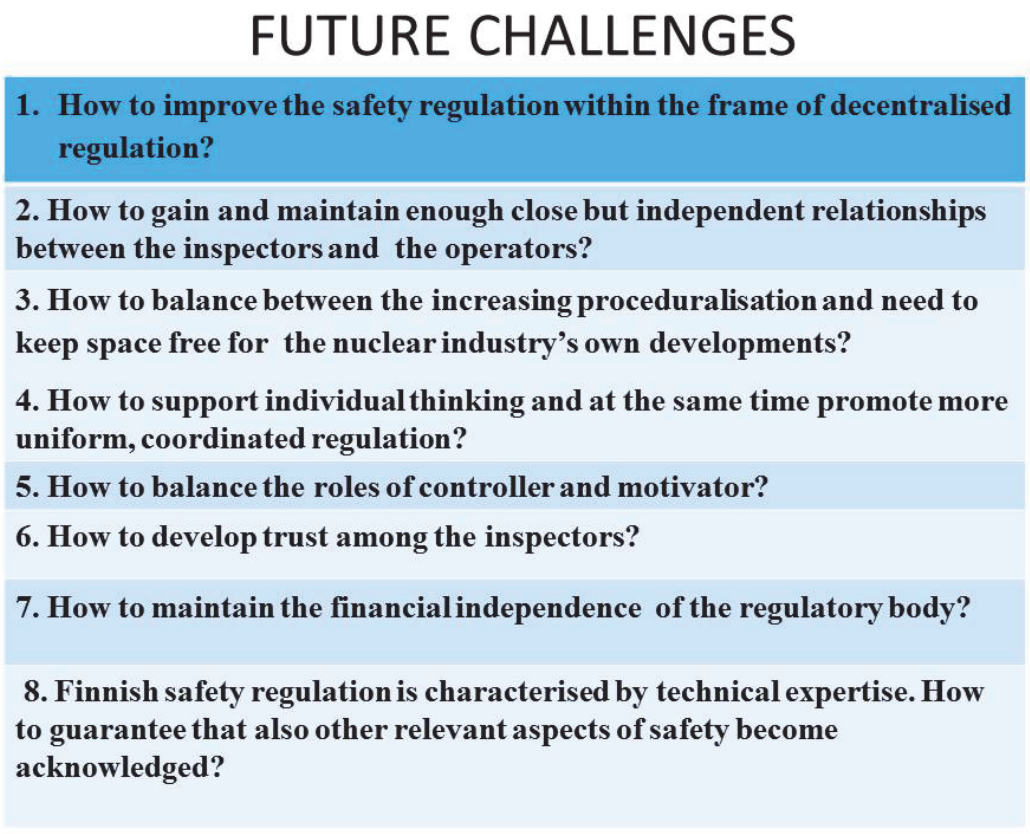

Figure 6. Future challenges based on the cultural characteristics of Finnish safety regulation.

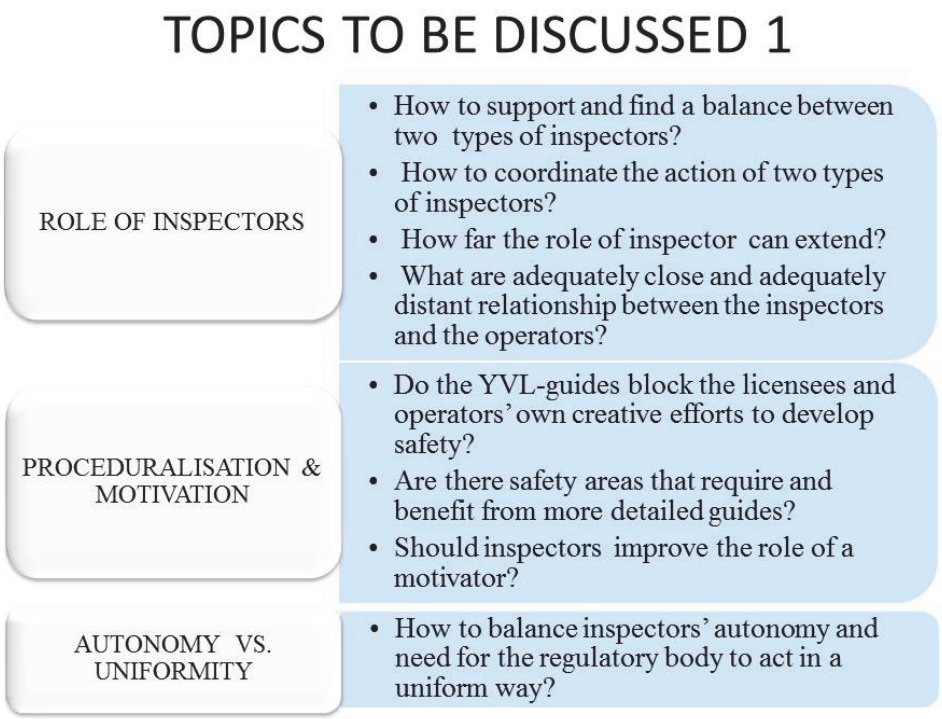

Figure 7. Topics to be discussed based on the cultural characteristics of Finnish safety regulation.

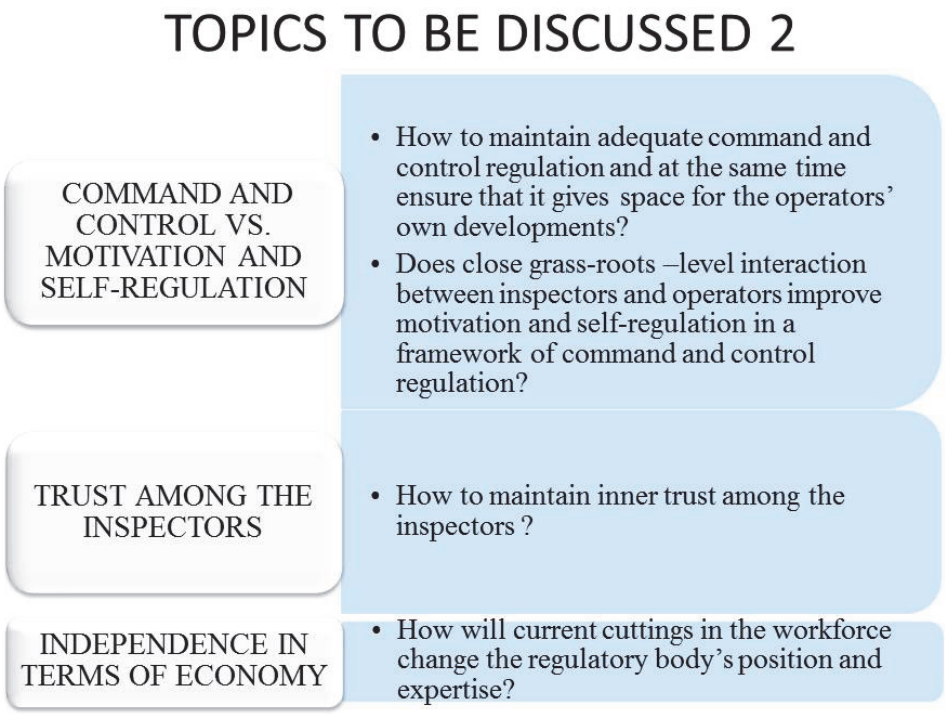

Figure 8. Topics to be discussed 1 based on the cultural characteristics of Finnish safety regulation.

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